PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

A. All work under this Section shall comply with the requirements of General Conditions, Supplemental Conditions, Special Conditions and Division 01 - General Requirements, and shall include all Mechanical Sections specified herein.

1.2 SCOPE OF THIS SECTION

A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
1. Compliance with all codes and standards applicable to this jurisdiction
2. Shop Drawings for Equipment
3. Coordination Documents
4. Record Drawings
5. Start-up Service and Building Commissioning
6. Instruction, Maintenance, and O & M Manuals
7. Work associated with Delivery, Storage, and Handling of products
8. Work associated with provision of Temporary Facilities
9. Preparation of Posted Operating Instructions
10. Meeting Project Safety and Indemnity requirements
11. Proper Cleaning and Closing
12. Supplying proper Warranty information
13. Supply specified Guarantee documentation
14. Design and provision of Supports and Anchors
15. Pipe Portals
16. Pipe Supports
17. Equipment Rails
18. Access Panels and Doors
19. Identification Markers
20. Coordination of Electrical requirements for equipment provided

1.3 DESCRIPTION OF WORK

A. The Contract Documents, including Specifications and Construction Drawings, are intended to provide all material and labor to install complete heating, ventilating, air conditioning systems for the building and shall interface with all existing building systems affected by new construction.

B. The Contractor shall refer to the architectural interior details, floor plans, elevations, and the structural and other Contract Drawings and shall coordinate this work with that of the other trades to avoid interference. The plans are diagrammatic and show generally the locations of the fixtures, equipment, and pipe lines and are not to be scaled; all dimensions and existing conditions shall be checked at the building.

C. The Contractor shall comply with the project closeout requirements as detailed in General Requirements of Division 01.

D. Where project involves interface with existing building and site systems, every effort has been made to note existing utilities and services. However, the Contractor should thoroughly familiarize themselves with existing conditions and be aware that in some cases information is not available as to concealed conditions, which exist in portions of the existing building affected by this work.

1.4 DESCRIPTION OF BID DOCUMENTS

A. Specifications:
1. Specifications, in general, describe quality and character of materials and equipment.
2. Specifications are of simplified form and include incomplete sentences.

B. Drawings:
1. Drawings in general are diagrammatic and indicate sizes, locations, connections to equipment and methods of installation.
2. Before proceeding with work check and verify all dimensions.
3. Assume all responsibility for fitting of materials and equipment to other parts of equipment and structure.
4. Make adjustments that may be necessary or requested, in order to resolve space problems, preserve headroom, and avoid architectural openings, structural members and work of other trades.
5. Where existing pipes, conduits and/or ducts prevent installation of new work as indicated, relocate, or arrange for relocation, of existing pipes, conduits and/or ducts. Verify exact location and elevation of existing piping prior to any construction.
6. If any part of Specifications or Drawings appears unclear or contradictory, apply to Owner's Representative interpretation and decision as early as possible, including during bidding period.

1.5 DEFINITIONS

A. "Above Grade": Not buried in the ground and not embedded in concrete slab on ground.

B. "Accessible": Ability to perform recommended maintenance without removal of services or equipment and requiring no special platforms.

C. "Actuating" or "Control" Devices: Automatic sensing and switching devices such as thermostats, pressure, float, electro-pneumatic switches and electrodes controlling operation of equipment.

D. "Below Grade": Buried in the ground or embedded in concrete slab on ground.

E. "Concealed": Embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces, or in enclosures. In general, any item not visible or directly accessible.

F. "Connect": Complete hook-up of item with required service.

G. "Exposed": Not installed underground or "concealed."

H. "Furnish": To supply equipment and products as specified.

I. “Indicated,” “Shown” or “Noted”: As indicated, shown or noted on Drawings or Specifications.

J. “Install”: To erect, mount and connect complete with related accessories.

K. “Motor Controllers”: Manual or magnetic starters (with or without switches), individual push buttons or hand-off-automatic (HOA) switches controlling the operation of motors.

L. "Must": A desire to complete the specified task. Allows some flexibility in application as opposed to "Shall."

M. “NRTL”: Nationally Recognized Testing Laboratory, including UL and/or ETL.

N. “Piping”: Pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation, and related items.

O. “Provide”: To supply, install and connect as specified for a complete, safe and operationally ready system.

P. “Reviewed,” “Satisfactory” or “Directed”: As reviewed, satisfactory, or directed by or to Architect/Engineer/Owner.

Q. “Rough-In”: Provide all indicated services in the necessary arrangement suitable for making final connections to fixture or equipment.

R. “Shall”: An exhortation or command to complete the specified task.

S. “Similar” or “Equal”: Of base bid manufacture, equal in materials, weight, size, design, and efficiency of specified products.

T. “Supply”: To purchase, procure, acquire and deliver complete with related accessories.

U. “Typical” or “Typ”: Exhibiting the qualities, traits, or characteristics that identify a kind, class, number, group or category. Of or relating to a representative specimen. Application shall apply to all other similarly identified on plan or detail.

V. “Will”: A desire to complete the specified task. Allows some flexibility in application as opposed to “Shall”.

W. “Wiring”: Raceway, fittings, wire, boxes and related items.

X. “Work”: Labor, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.

1.6 RELATED WORK SPECIFIED ELSEWHERE

A. All Division 23 Mechanical sections included herein.

B. Division 33: Utility Site Work. <<<<<Coordinate with Civil Engineer>>>>>
   1. Coordination of excavation of trenches and the installation of mechanical systems and piping on site.

C. Division 03: Concrete.
   1. All concrete work required for plumbing work shall be coordinated by Division 23 with Division 03 including:
      a. Concrete curbs and housekeeping pads for the mechanical equipment.
      b. Thrust blocks, pads, and boxes for mechanical equipment.

D. Division 07: Thermal and Moisture Protection.
   1. Flashing and sheet metal
   2. Sealants and caulking
   3. Firestopping

E. Division 09: Painting:
   1. Division 23 shall coordinate with Division 09 to perform all painting, except where specifically stated otherwise in Division 09.
   2. Painting of all exposed steel, piping, ductwork, insulation, equipment and materials
   3. Paint all exposed gas piping, interior and exterior to the building, yellow.

F. Division 10: Miscellaneous Metals.
   1. Exterior louvers and grilles shall be included in this Section.

G. Division 26: Electrical is related to work of:
   1. Power connections to all mechanical equipment

H. Division 28: Electronic Safety and Security is related to work of:
   1. Fire protection alarms and relays
   2. Smoke detector and monitoring
   3. Life Safety Systems

1.7 CODES AND STANDARDS

A. The Contractor is cautioned that code requirements not explicitly detailed in these specifications or drawings, but which may be reasonably inferred or implied from the nature of the project, must be provided as part of the contract.

B. Perform all tests required by governing authorities and required under all Division 23 Sections. Provide written reports on all tests.

C. Electrical devices and wiring shall conform to the 2013 standards of CEC; all devices shall be UL listed and labeled.

D. All accessible mechanical work shall comply with the minimum requirements of the Americans with Disabilities Act (ADA) and local amendments. Compliance requirements applicable to HVAC work includes, but is not limited to, the following:
   1. Section 309: Operable parts shall be operable with one hand and shall not require tight grasping, pinching, or twisting of the wrist. The force required to activate operable parts shall be 5 pounds maximum.
   2. Section 308.3: Temperature control devices mounted on walls with operable buttons shall be placed where clear floor or ground space allows a parallel approach and the side reach is unobstructed. Operable parts shall be located 48” maximum above finished floor.

3. Section 308.3.2: Where a clear floor or ground space allows a parallel approach to an element and high reach is over an obstruction, the height of the obstruction shall be 34” maximum and depth of obstruction shall be 24” maximum.
4. Section 404.2.9: Fire doors shall have a minimum opening force allowable by the applicable Building Code. The force for pushing or pulling open a door other than fire doors shall be 5 pounds maximum.

E. All excavation work must comply with all provisions of state laws including notification to all owners of underground utilities at least 48 business day hours, but not more than 10 business days, before commencing an excavation.

F. Provide in accordance with rules and regulations of the following:
1. Building Codes enforced by the Authority Having Jurisdiction in California:
   a. 2013 Building Standards Administrative Code, Part 1, Title 24 California Code of Regulations (CCR).
   b. 2013 California Building Code (CBC), Part 2, Title 24 CCR (2012 International Building Code with California Amendments)
   c. 2013 California Electrical Code (CEC), Part 3, Title 24 CCR (2011 National Electrical Code with California Amendments)
   d. 2013 California Mechanical Code (CMC) Part 4, Title 24 CCR 2011 Uniform Mechanical Code with California Amendments)
   e. 2013 California Plumbing Code (CPC), Part 5, Title 24 CCR (2011 Uniform Plumbing Code with California Amendments)
   f. 2013 California Energy Code (CEC), Part 6, Title 24 CCR
   g. 2013 California Fire Code, Part 9, Title 24 CCR (2012 International Fire Code with California Amendments
   h. 2013 California Green building Standards Code (CALGreen), Part 11, Title 24 CCR.
   i. 2013 California Referenced Standards, Part 12, Title 24 CCR.
   j. Title 19 CCR Public Safety, State Fire Marshal Regulations.
2. Local Health Department
3. State Fire Marshal
4. State Administrative Codes

G. Provide in accordance with appropriate referenced standards of the following:
1. NFPA - National Fire Protection Association
2. AABC - Associated Air Balance Council
3. CSA - Canadian Standards Association
4. ADC - Air Diffuser Council
5. AMCA - Air Moving and Conditioning Association
6. ANSI - American National Standards Institute
7. ARI - Air Conditioning and Refrigeration Institute
8. ASHRAE - American Society of Heating, Refrigerating & Air Conditioning Engineers
9. ASME - American Society of Mechanical Engineers
10. ASTM - American Society for Testing Materials
11. AWS - American Welding Society
12. FM - Factory Mutual
13. MSS - Manufacturer's Standardization Society
14. NEMA - National Electrical Manufacturer's Association
15. SMACNA - Sheet Metal and Air Conditioning Contractors National Association

16. UL - Underwriter's Laboratories
17. ADA - Americans with Disabilities Act
18. ETL - Electrical Testing Laboratories

1.8 QUALITY ASSURANCE

A. Manufacturer's Nameplates: Nameplates on manufactured items shall be metallic riveted or bolted to the manufactured item, with nameplate data engraved or punched to form a non-erasable record of equipment data suitable for the ambient exposure.

B. Current Models. All work shall be as follows:
1. Manufactured items furnished shall be the current, cataloged product of the manufacturer.
2. Replacement parts shall be readily available and stocked in the USA.

C. Experience: Unless more stringent requirements are specified in other sections of Division 23, manufactured items shall have been installed and used, without modification, renovation or repair, on other projects for not less than one year prior to the date of bidding for this project.

1.9 GENERAL REQUIREMENTS

A. Examine all existing conditions at building site.

B. Review contract documents and technical specifications for extent of new work to be provided.

C. Provide and pay for all permits, licenses, fees and inspections.

D. Prepare a Construction IAQ Management Plan meeting the SMACNA IAQ guidelines. See Section 233113 Air Distribution for a summary of requirements.

E. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing. This work shall include furnishing and installing all access doors required for mechanical access.

F. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected. Refer to Equipment Specifications in Divisions 02 through 48 for rough-in requirements.

G. Coordinate mechanical equipment and materials installation with other building components.

H. Verify all dimensions by field measurements.

I. Arrange for chases, slots, and openings in other building components to allow for mechanical installations.

J. Coordinate the installation of required supporting devices and sleeves to be set in

poured-in-place concrete and other structural components, as they are constructed.

K. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing-in the building.

L. Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials. Contractor shall provide for all cutting and patching required for installation of this work unless otherwise noted.

M. Where mounting heights are not detailed or dimensioned, install mechanical services and overhead equipment to provide the maximum headroom possible.

N. Install mechanical equipment to facilitate maintenance and repair or replacement of equipment components. Connect equipment for ease of disconnecting, without interference with other installations.

O. Coordinate the installation of mechanical materials and equipment above ceilings with ductwork, piping, conduits, suspension system, light fixtures, cable trays, sprinkler piping and heads, and other installations.

P. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

Q. Coordinate with Owner's Representative in advance to schedule shutdown of existing systems to make new connections. Provide valves in new piping to allow existing system to be put back in service with minimum down time.

R. All materials (such as insulation, ductwork, piping, wiring, controls, etc.) located within air plenum spaces, air shafts, and occupied spaces shall have a flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) Method. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories, Inc., label or listing, or satisfactory certified test report from an approved testing laboratory to prove the fire hazard ratings for materials proposed for use do not exceed those specified.

S. Coordinate installation of floor drains and floor sinks with work of other trades, such that finished floor slopes to drains and floor sinks are flush with surrounding floor.

T. Products made of or containing lead, asbestos, mercury or other known toxic or hazardous materials are not acceptable for installation under this Division. Any such products installed as part of the work of the Division shall be removed and replaced and all costs for removal and replacement shall be borne solely by the installing Contractor.

1.10 MINOR DEVIATIONS

A. The Drawings are diagrammatic and show the general arrangements of all mechanical work and requirements to be performed. It is not intended to show or indicate all offsets, fittings, and accessories which will be required as a part of the work of this Section.

B. The Contractor shall review the structural and architectural conditions affecting their work. It is the specific intention of this section that the contractor's scope of work shall include:
   1. Proper code complying support systems for all equipment whether or not scheduled or detailed on drawings or in these specifications
   2. Minor deviations from the mechanical plans required by architectural and structural coordination.

C. The Contractor shall study the operational requirements of each system, and shall arrange work accordingly, and shall furnish such fittings, offsets, supports, accessories, as are required for the proper and efficient installation of all systems from the physical space available for use by this section. This requirement extends to the Contractor's coordination of this section's work with the “Electrical Work”. Should conflicts occur due to lack of coordination, the time delay, cost of rectification, demolition, labor and materials, shall be borne by the Contractor and shall not be at a cost to the Owner.

D. Minor deviations in order to avoid conflict shall be permitted where the design intent is not altered.

E. Advise the Owner’s Representative, in writing, in the event a conflict occurs in the location or connection of equipment. Bear all costs for relocation of equipment, resulting from failure to properly coordinate the installation or failure to advise the Owner’s Representative of conflict.

1.11 SHOP DRAWINGS AND EQUIPMENT SUBMITTALS

A. Prior to construction submit for review all materials and equipment in accordance with Division 01 requirements.

B. After approval of preliminary list of materials, the Contractor shall submit Shop Drawings and manufacturer's Certified Drawings to the Owner’s Representative for approval.

C. The Contractor shall submit <u>approved</u> Shop Drawings and manufacturer's equipment cuts, of all equipment requiring connection by Division 26, to the Electrical Contractor for final coordination of electrical requirements. Contractor shall bear all additional costs for failure to coordinate with Division 26.

D. Submittals and Shop Drawings:
   1. Submit electronic copies of manufacturer's submittal sheets in one (1) coordinated package per Division. Multiple submissions will not be accepted without prior approval of Engineer. Organize submittal sheets in sequential order aligned with matching specification section numbers.

2. Provide electronic copies of shop drawings prepared to show details of the proposed installation. Copies of contract design drawings submitted to demonstrate shop drawing compliance will not be accepted.
3. Paper submittals will only be acceptable if specifically required by Division 01.
4. The approved submittals shall be converted into Operations & Maintenance Manuals at the completion of the project. Refer to Division 01 for additional requirements.

1.12 COORDINATION DOCUMENTS/SHOP DRAWINGS

A. The Contractor shall prepare coordinated Shop Drawings using the same electronic format as the contract documents.
   1. The shop drawings shall serve to record the coordination of the installation and location of all HVAC equipment, ductwork, grilles, diffusers, piping, fire sprinklers, lights, audio/video systems, electrical services and all system appurtenances.
   2. The Drawings shall include all mechanical rooms and floor plans.
   3. The Drawings shall be keyed to the structural column identification system, and shall be progressively numbered. Prior to completion of the Drawings, the Contractor shall coordinate the proposed installation with the Owner's Representative and the structural requirements, and all other trades (including HVAC, Plumbing, Fire Protection, Electrical, Ceiling Suspension, and Tile Systems), and provide maintenance access clearance as required by manufacturer installation instructions and as required to meet minimum code clearances. When conflicts are identified, modify system layout as necessary to resolve. Do not fabricate, order or install any equipment or materials until coordination documents are approved by the General Contractor and Owner's Representative.
   4. Within thirty (30) days after award of Contract, submit proposed coordination document Shop Drawing schedule, allowing adequate time for review and approval by parties mentioned above. Drawings or electronic coordination should be prepared and submitted for approval on a floor-by-floor basis to phase with building construction.

B. The coordination work shall be prepared as follows:
   1. Two dimensional AutoCAD / Revit based documents:
      a. Contractor shall prepare AutoCAD/Revit coordination drawings to an accurate scale of 1/4" = 1'-0" or larger. Drawings are to be same size as Contract Drawings and shall indicate locations, sizes and elevations above finished floor, of all systems. Lettering shall be minimum 1/8" high.
      b. Contractor shall obtain AutoCAD/Revit drawings from all other trades as required to fully coordinate the installation with architectural, structural, HVAC, plumbing, electrical, fire alarm devices, low voltage devices, and other systems that interface with and/or impact the HVAC work.
      c. Provide maintenance access clearance as required by manufacturer installation instructions and as required to meet minimum code clearances.
      d. Drawings shall incorporate all addenda items and change orders.

e. Distribute drawings to all other trades and provide additional coordination as needed to assure adequate space for piping, equipment and routing to avoid conflicts. When conflicts are identified, modify system layout as necessary to resolve.

2. Three dimensional Revit / BIM based documents (if required for project):
   a. Provide three dimensional Revit model and BIM input information locating all equipment and piping, including valves and fittings, dimensions from column lines, and bottom of pipe elevations above finished floor.
   b. Contractor shall obtain Revit model and BIM input from all other trades as required to fully coordinate the installation with architectural, structural, HVAC, plumbing, electrical, fire alarm devices, low voltage devices, and other systems that interface with and/or impact the fire protection work.
   c. Model shall indicate locations of all equipment and piping, including valves and fittings, dimensions from column lines, and bottom of pipe elevations above finished floor.
   d. Provide maintenance access clearance as required by manufacturer installation instructions and as required to meet minimum code clearances.
   e. Model shall incorporate all addenda items and change orders.
   f. Distribute Revit model and BIM input information to all other trades and provide additional coordination as needed to assure adequate space for equipment and piping and routing to avoid conflicts. When conflicts are identified, modify system layout as necessary to resolve.

C. Advise the Owner's Representative in the event a conflict occurs in the location or connection of equipment. Bear all costs for relocation of equipment, resulting from failure to properly coordinate the installation or failure to advise the Owner's Representative of conflict.

D. Verify in field exact size, location, invert, and clearances regarding all existing material, equipment and apparatus, and advise the Owner's Representative of any discrepancies between those indicated on the Drawings and those existing in the field prior to any installation related thereto.

E. Final Coordination Drawings with all appropriate information added are to be submitted as Record Drawings at completion of project.

F. Provide copy of Record Drawings to Testing and Balancing Contractor for their use when doing their work.

1.13 REQUESTS FOR INFORMATION (RFIS)

A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified (refer to Division 01).
   1. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
   2. RFIs shall address single questions and related issues only.

3. All RFIs shall be thoroughly reviewed and approved by the General Contractor and/or Construction Manager for accuracy and need for information required before submittal to Owner's Design Representative.

B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
1. Project name.
2. Project number.
3. Date.
4. Name of Contractor.
5. Name of Architect[and Construction Manager].
6. RFI number, numbered sequentially and unique.
7. RFI subject.
8. Specification Section number and title and related paragraphs, as appropriate.
9. Drawing number and detail references, as appropriate.
10. Field dimensions and conditions, as appropriate.
11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
12. Contractor's signature.
13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
    a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.

C. Engineer's Action: Engineer will review each RFI, determine action required, and respond. Allow a minimum three business days for Engineer's response for each RFI, plus additional time for Architect and General Contractor to review and forward. RFIs received by Engineer after 1:00 p.m. will be considered as received the following working day.
1. The following Contractor-generated RFIs will be returned without action:
    a. Incomplete RFIs or inaccurately prepared RFIs.
    b. RFIs submitted without indication of review and approval for submission by General Contractor [or Construction Manager].
    c. RFIs addressing multiple unrelated issues.
    d. Requests for approval of submittals.
    e. Requests for approval of substitutions.
    f. Requests for approval of Contractor's means and methods.
    g. Requests for information already indicated in the Contract Documents.
    h. Requests for adjustments in the Contract Time or the Contract Sum.
    i. Requests for interpretation of Engineer's actions on submittals.
2. Engineer's action may include a request for additional information, in which case Engineer's time for response will date from time of receipt of additional information.

1.14 RECORD DOCUMENTS

A. Maintain set of Coordination Documents (drawings and specifications) marked "Record Set" at the job site at all times, and use it for no other purpose but to record on it all the changes and revisions during construction.

B. Record Drawings shall indicate revisions to piping and ductwork, size and location both exterior and interior; including locations of coils, dampers and other control devices, filters, boxes and similar units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned to column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e. – valves, traps, strainers, expansion compensators, tanks, etc.).

C. Record Specifications shall indicate approved substitutions; Change Orders; and actual equipment and materials provided.

D. Provide copy of Record Documents to Testing and Balancing Contractor and Commissioning Agent for use when performing their work.

E. At the completion of the construction transfer all "Record Set" notations to a clean set of drawings and specifications in a neat and orderly fashion that incorporates all site markups to clearly show all changes and revisions to the Contract Documents. Submit copies of Record Documents and CD/DVD disks labeled with all drawings and specifications and other supporting documentation.

F. Refer also to Division 01 for full scope of requirements.

1.15 START-UP SERVICE AND BUILDING COMMISSIONING

A. Prior to start-up, be assured that systems are ready, including checking the following: Proper equipment rotation, proper wiring, auxiliary connections, lubrication, venting, controls, and installed and properly set relief and safety valves.

B. Provide services of factory-trained technicians for start-up of major pieces of equipment. Certify in writing compliance with this Paragraph, stating names of personnel involved and the date work was performed.

C. Provide certificates of calibration for all sensors required for control and monitoring including temperature and pressure.

D. Refer to other Division 23 Sections for additional requirements.

1.16 INSTRUCTION, MAINTENANCE, AND O&M MANUALS

A. O&M Manuals: Upon completion of the work, and prior to training of Owner's personnel, the Contractor shall submit to the Owner's Representative complete set of operating instructions, maintenance instructions, part lists, and all other bulletins and brochures pertinent to the operation and maintenance for equipment furnished and installed as specified in this section, bound in a durable binder. Refer to Division 01.

B. Contractor shall be responsible for providing proper instruction of the of Owner's personnel for operation and maintenance of equipment, and apparatus installed as specified in Division 23. Training is to be appropriate to the complexity of the equipment. The Contractor shall develop and submit training materials prior to this training. These materials shall include qualifications of the trainer, training agenda, learning objectives, and a written test to be administered at the end of the training session. Operation and Maintenance manuals must present, incorporated and referenced in the training sessions.

1.17 DELIVERY, STORAGE AND HANDLING

A. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.

B. Store equipment and materials in an environmentally controlled area at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage. Piping and equipment showing signs of rust shall be removed from site and replaced with new.

1.18 POSTED OPERATING INSTRUCTIONS

A. Furnish approved operating instructions for systems and equipment indicated in the technical sections for use by operation personnel. The operating instructions shall include wiring diagrams, control diagrams, and control sequence for each principal system and equipment. Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. Attach or post operating instructions adjacent to each principal system and equipment including start-up, operating, shutdown, safety precautions and procedure in the event of equipment failure. Provide weather-resistant materials or weatherproof enclosures for operating instructions exposed to the weather. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal.

1.19 SAFETY AND INDEMNITY

A. The Contractor shall be solely and completely responsible for conditions of the job site including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal hours of work.

B. No act, service, Drawing, review, or Construction Review by the Owner’s Representative, Architect, the Engineers or their consultants, is intended to include the review of the adequacy of the Contractor's safety measures, in, on, or near the construction site.

C. The Contractor performing work under this Division of the Specifications shall hold harmless, indemnify and defend the Owner, the Architect, the Engineers and their consultants, and each of their officers, employees and agents from any and all liability claim, losses or damage arising, or alleged to arise from bodily injury, sickness, or death of a person or persons, and for all damages arising out of injury to or destruction of property arising directly or indirectly out of, or in connection with, the performance of the work under the Division of the Specifications, and from the

Contractor's negligence in the performance of the work described in the Construction Contract Documents; but not including the sole negligence of the Owner's Representative, the Architect, the Engineers, and their consultants or their officers, employees and agents.

1.20 CLEANING AND CLOSING

A. All work shall be inspected, tested, and approved before being concealed or placed in operation.

B. Upon completion of the work, all equipment installed as specified in this section, and all areas where work was performed, shall be cleaned to provide operating conditions satisfactory to the Owner's Representative.

1.21 WARRANTIES

A. All equipment shall be provided with a minimum one-year warranty to include parts and labor. Refer to individual Equipment Specifications for extended or longer-term warranty requirements.

B. Provide complete warranty information for each item, to include product or equipment, date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, telephone numbers and procedures for filing a claim and obtaining warranty services.

C. Service during warranty period: Contractor shall provide maintenance as specified elsewhere during the 12-month warranty period.

1.22 GUARANTEE

A. The Contractor shall guarantee and service all workmanship and materials to be as represented by him and shall repair or replace, at no additional cost to the Owner, any part thereof which may become defective within the period of one (1) year, minimum, after the Date of Final Acceptance, ordinary wear and tear excepted.

B. Contractor shall be responsible for and pay for any damages caused by or resulting from defects in this work.

1.23 COMMISSIONING

A. Commissioning requires the participation of Division 23 mechanical contractor to work to ensure that all systems are operating in a manner consistent with the construction documents and design intent. The general commissioning requirements and coordination are detailed in Division 1 and Division 23. This Division shall be familiar with all parts of Division 1 and Division 23 and the commissioning plan issued by the Commissioning Authority and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

B. The mechanical contractor is responsible for assisting the commissioning agent throughout the entire commissioning process. The work is not complete until the commissioning agent and the University has signed off on the commissioned systems.

PART 2 - PRODUCTS

2.1 GENERAL

A. Furnish and install all new material, equipment, and apparatus hereinafter specified unless specifically noted otherwise. All material, equipment, and apparatus shall be identified by the manufacturer's name, nameplate, and pertinent data.

B. All materials, equipment, and apparatus are mentioned as standards unless noted otherwise. The words “or approved equal” shall be considered to be subsequent to all manufacturers’ names used herein, unless specifically noted that substitutes are not allowed.

2.2 SUPPORTS AND ANCHORS

A. General: Comply with applicable codes pertaining to product materials and installation of supports and anchors, including, but not limited to, the following:
1. UL and FM Compliance: Provide products, which are UL listed and FM approved.
2. ASCE 7-05: “American Society of Civil Engineers.”
3. MSS Standard Compliance: Manufacturer's Standardization Society (MSS).
4. SMACNA: “Seismic Restraint Manual: Guidelines for Mechanical Systems.”
5. NFPA: Pamphlet number 13 and 14 for fire protection systems.
6. Provide copper plated or plastic coated supports and attachment for copper piping systems. Field applied coatings or tape is unacceptable.
7. Manufacturer: Hilti Inc., B-Line, Anvil International, Erico, Tolco, Kin-Line, Simpson Strong-Tie Co. Inc., Superstrut, or Powers Fasteners.

B. Horizontal Piping Hangers and Supports: Except as otherwise indicated, provide factory-fabricated hangers and supports of one of the following MSS types listed.
1. Adjustable Steel Clevis Hangers: MSS Type 1.
2. Adjustable Steel Swivel Band Hangers: MSS Type 10.
3. U-Bolts: MSS Type 24.
4. Pipe Slides and Slide Plates: MSS Type 35, including one of the following plate types:
   a. Plate: Unguided type.
   b. Plate: Guided type.
   c. Plate: Hold-down clamp type.
5. Pipe Saddle Supports: MSS Type 36, including steel pipe base support and cast iron floor flange.
6. Pipe Saddle Supports with U-Bolt: MSS Type 37, including steel pipe base support and cast iron floor flange.
7. Adjustable Pipe Saddle Supports: MSS Type 38, including steel pipe base support and cast iron floor flange.
8. Single Pipe Roller with Malleable Sockets: MSS Type 41.
9. Adjustable Roller Hangers: MSS Type 43.
10. Pipe Roll Stands: MSS Type 44.
11. Pipe Guides: Provide factory-fabricated guides of cast semi-steel or heavy fabricated steel, consisting of a bolted two-section outer cylinder and base with a two-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.

C. Horizontal Cushioned Pipe Clamp: Where pipe hangers are called out to absorb vibration or shock install a piping clamp with thermoplastic elastomer insert. Cush-A-Clamp or equal.

D. Vertical Piping Clamps: Provide factory-fabricated two-bolt vertical piping riser clamps, MSS Type 8.

E. Hanger-Rod Attachments: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments of one of the following MSS types listed.
   1. Steel Turnbuckles: MSS Type 13.
   2. Steel Clevises: MSS Type 14.
   3. Swivel Turnbuckles: MSS Type 15.
   4. Malleable Iron Eye Sockets: MSS Type 16.
   5. Steel Weldless Eye Nuts: MSS Type 17.

F. Building Attachments: Except as otherwise indicated, provide factory-fabricated building attachments of one of the following types listed.
   1. Concrete Inserts: HCI-MD (for metal deck) or HCI-WF (for wood forms) cast-in anchors by Hilti Inc. or MSS Type 18, Blue Banger Hanger by Simpson Strong-Tie Co. Inc., or Bang-It (for metal deck) or Wood-Knocker (for wood forms) by Powers Fasteners.
   2. Steel Brackets: One of the following for indicated loading:
      a. Light Duty: MSS Type 31.
      b. Medium Duty: MSS Type 32.
      c. Heavy Duty: MSS Type 33.
   3. Horizontal Travelers: MSS Type 58.
   4. Concrete Screw Anchors: KWIK HUS EZ-I by Hilti Inc., Titen HD (or Rod Hanger version) by Simpson Strong-Tie Co. Inc., Wedge-Bolt+ (Screw Anchor) by Powers Fasteners, or Vertigo+ (Rod Hanger) by Powers Fasteners, or Snake+ (Internally Threaded Screw Anchor) by Powers Fasteners or approved equal.
   5. Torque-Controlled Expansion Anchor: KWIK BOLT-TZ by Hilti Inc., Strong-Bolt 2 by Simpson Strong-Tit Co. Inc., Power-Stud+ SD1 and Power-Stud+ SD2 by Powers Fasteners, or approved equal.

G. Saddles and Shields: Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.
   1. Pipe Covering Protection Saddles: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation.
   2. Insulation Protection Shields: MSS Type 40, 18" minimum, or of the length recommended by manufacturer to prevent crushing of insulation. High-density insulation insert lengths shall match or exceed shield length.
   3. Thermal Hanger Shields: Constructed of 360° insert of waterproofed calcium silicate (60 psi flexural strength minimum) encased in 360° sheet metal shield. Provide assembly of same thickness as adjoining insulation. Shield length shall match or exceed length of calcium silicate insert. Alternately Polyisocyanurate Urethane with a minimum flexural strength of 60psi, fully encased in 360 PVC (1.524 mm thick)SNAPPITZ. Provide assembly of same thickness as adjoining insulation.
   4. Thermal Hanger Couplings: Constructed of high strength plastic coupling to retain tubing and join insulation at clevis hangers and strut-mounted clamps. Klo-Shure Insulation Coupling or equal.

H. Miscellaneous Materials:
1. Metal Framing: Provide products complying with NEMA STD ML1.
2. Steel Plates, Shapes, and Bars: Provide products complying with ASTM A36.
3. Cement Grout: Portland Cement (ASTM C150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand by volume, with minimum amount of water required for placement and hydration.
4. Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required. Weld steel in accordance with AWS standards.
5. Pipe Brackets: “HoldRite” copper plated brackets. Insulate brackets attached to metal studs with felt.

2.3 PIPE PORTALS

A. Where pipe portals are not provided by other sections of Specification, provide prefabricated insulated pipe portals as required for piping penetrating through the roof where shown on plans. Field built pipe portals are acceptable alternatives - provide detail of construction for review.

B. Standard pipe portals, unless otherwise noted, shall be constructed as follows:
1. Curb shall be constructed of heavy gauge galvanized steel with continuous welds on shell seams.
2. Insulation to be 1-1/2" thick, 3 lb density rigid fiberglass.
3. Curb to have a raised 3" (minimum), 45° cant.
4. Curb to have 1-1/2" x 1-1/2" wood nailer (minimum).
5. Curb height to be 8" (minimum) above roof deck.
6. Cant shall be raised to match roof insulation thickness.
7. Cover or flashing to be constructed of galvanized steel or other suitable material to provide sturdy weather tight closure. Provide collars and rubber nipples with draw bands of sizes required by piping. Size curb, cover and nipples per manufacturer's recommendations.

C. Manufacturer: Roof Products Systems, Pate, or equal.

2.4 PIPE STANDS

1 General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

2 Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

3 Low-Type, Single-Pipe Stand: One-piece plastic or stainless steel base unit with plastic roller, for roof installation without membrane penetration.

4 High-Type, Single-Pipe Stand:

a Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
b Base: Plastic or stainless steel.
c Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.

d Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

5 High-Type, Multiple-Pipe Stand:

a Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
b Bases: One or more; plastic.
c Vertical Members: Two or more protective-coated-steel channels.
d Horizontal Member: Protective-coated-steel channel.
e Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

6 Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

7 Manufacturer: Pate, Roof Products Systems, Portable Pipe Hangers, Roof Top Blox, Erico Caddy Pyramid, or equal.

2.5 EQUIPMENT/PIPING RAILS

A. Where equipment/pipe rails are not provided by other sections of Specification, provide prefabricated reinforced equipment rails as required for support of equipment and piping. Field built curbs are acceptable alternatives - provide detail of construction for review.

B. Standard equipment rail, unless otherwise noted, shall be constructed as follows:
1. Construct of heavy gauge galvanized steel with continuous welds on shell seams.
2. Provide internal reinforcing supports welded as required to meet application requirements.
3. Equipment rails to have raised 3" (minimum), 45° cant.
4. Equipment rails to have 1 1/2" x 1 1/2" wood nailer (minimum) and counterflashing.
5. Equipment rail height to be 6" (minimum) above roof deck.
6. Cant shall be raised to match roof insulation thickness.

C. Equipment rails to be constructed to meet equipment size and weight requirements. Provide tapered rails to match roof pitch where required.

D. Manufacturer: Pate, Vent Products, Thy Curb, Roof Products Systems, or equal.

2.6 ACCESS PANELS AND ACCESS DOORS

A. Provide all access doors and panels to serve equipment under this work, including those which must be installed, in finished architectural surfaces. Frame of 16-gauge steel, door of 20 gauge steel. 1" flange width, continuous piano hinge, key operated, prime coated. Refer to Division 01 Architectural specifications and drawings for the required product Specification for each surface. Contractor is to submit schedule of access panels for approval. Exact size, number and location of access panels are not shown on Plans. Access doors shall be of a size to permit removal of equipment for servicing. Access door shall have same rating as the wall or ceiling in which it is mounted. Provide access panel for each trap primer or concealed valve, for fire and

combination fire/smoke dampers, and for volume dampers. Use no panel smaller than 12" x 12" for simple manual access, or smaller than 24" x 24" where personnel must pass through. Provide cylinder lock for access door serving mixing or critical valves in public areas.

B. Included under this work is the responsibility for verifying the exact location and type of each access panel or door required to serve equipment under this work and in the proper sequence to keep in tune with construction and with prior approval of the Owner's Representative. Access doors in fire rated partitions and ceilings shall carry all label ratings as required to maintain the rating of the rated assembly.

C. Submit markup of architectural plans showing size and location of access panels required for equipment access for approval by Owner's Representative.

D. Manufacturers: Milcor, Karp, Nystrom, Elmdor/Stoneman, or equal.

2.7 IDENTIFICATION MARKERS

A. Mechanical Identification Materials: Provide products of categories and types required for each application as referenced in other Division 23 Sections. Where more than single type is specified for application, selection is installer's option, but provide single selection for each product category. Stencils are not acceptable.

B. Plastic Pipe Markers:
1. Snap-On Type: Provide pre-printed, semi-rigid snap-on, color coded pipe markers, complying with ANSI A13.1.
2. Pressure Sensitive Type: Provide pre-printed, permanent adhesive, color coded, pressure sensitive vinyl pipe markers, complying with ANSI A13.1. Secure both ends of markers with color coded adhesive vinyl tape.
3. Insulation: Furnish 1" thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125°F (52°C) or greater. Cut length to extend 2" beyond each end of plastic pipe marker.
4. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

C. Plastic Duct Markers:
1. Provide duct labels to indicate the system and direction of flow. Submit a labeling product that is suitable for the surface to be labeled.
   a. 4 1/2" x 6" laminated plastic, ANSI A13.1 color coded duct markers with white core lettering
   b. Pressure Sensitive Type: Provide pre-printed, permanent adhesive, color coded, pressure sensitive vinyl pipe markers, complying with ANSI A13.1. Secure both ends of markers with color coded adhesive vinyl tape.
2. Nomenclature: Include the following:
   a. Direction of air flow
3. Duct service (supply, return, exhaust, etc.).
   a. Duct origin (from)
   b. Duct destination (to)
   c. Design cfm
4. Provide a minimum of every 20 feet on all ducts with a diameter or width

greater than 12".

D. Valve Tags:
1. Brass Valve Tags: Provide 1 1/2" diameter 19-gauge polished brass valve tags with stamp-engraved piping system abbreviation in 1/4" high letters and sequenced valve numbers 1/2" high, and with 5/32" hole for fastener. Fill tag engraving with black enamel.
2. Plastic Laminate Valve Tags: Provide 3/32" thick engraved plastic laminate valve tags, with piping system abbreviations in 1/4" high letters and sequenced valve number 1/2" high, and with 5/32" hole for fasteners.
3. Valve Tag Fasteners: Provide solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.
4. Access Panel Markers: Provide 1/16" thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include 1/8" center hole to allow attachment.
5. Non-potable Water Tags: 1/16" thick, engraved, plastic tags as indicated on Drawings.
6. All valves shall be scheduled and provided to SDSU facilities for identification.

E. Plastic Equipment Signs:
1. Provide 3" x 5" plastic laminate sign, ANSI A.13 color coded with engraved white core lettering.
2. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.
3. Sign Text: Include the equipment tag number as found on the construction documents.

F. Acceptable Manufacturers: Craftmark, Seton, Brady, Marking Services, Inc., or Brimar.

2.8 ELECTRICAL

A. General:
1. All electrical material, equipment, and apparatus specified herein shall conform to the requirements of Division 26.
2. Provide all motors for equipment specified herein. Provide motor starters, controllers, and other electrical apparatus and wiring which are required for the operation of the equipment specified herein.
3. Set and align all motors and drives in equipment specified herein.
4. Provide expanded metal or solid sheet metal guards on all V-belt drives to totally enclose the drive on all sides. Provide holes for tachometer readings. Support guards separately from rotating equipment.
5. Provide for all rotating shafts, couplings, etc., a solid sheet metal, inverted “U” cover over the entire length of the exposed shaft and support separately from rotating equipment. Cover shall extend to below the bottom of the shaft and coupling, and shall meet the requirements of the State Industrial Safety Regulations.
6. Specific electrical requirements (i.e., horsepower and electrical characteristics) for mechanical equipment are scheduled on the Drawings.

B. Quality Assurance:
   1. Electrical components and materials shall be UL or ETL listed/labeled as suitable for location and use - no exceptions.

C. Motors:
   1. The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are specified in the individual equipment Specifications.
   2. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.
   3. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range. Unless otherwise noted on plans, all motors 1/2 HP or larger shall be rated for 208, 227, or 460 volt, 3-phase, operation. Unless otherwise noted on plans, all motors less than 1/2 HP shall be rated for 120, 227 volt, single phase operation.
   4. Temperature Rating: Motor meets class B rise with class F insulation.
   5. Service Factor: 1.15 for poly-phase motors and 1.35 for single phase motors.
   6. Motor Construction: NEMA Standard MG 1, general purpose, continuous duty, Design “B”, except “C” where required for high starting torque.
      a. Frames: NEMA Standard No. 48 or 56; use driven equipment manufacturer's standards to suit specific application.
      b. VFD driven motors to be provided as inverter ready and equipped with a shaft grounding device, or inverter duty complying with NEMA Standard MG-1, Part 31 as supplied by same manufacturer as VFD.
      c. Bearings:
         1) Ball or roller bearings with inner and outer shaft seals.
         2) Re-greasable, except permanently sealed where motor is normally inaccessible for regular maintenance.
         3) Designed to resist thrust loading where belt drives or other drives product lateral or axial thrust in motor.
         4) For fractional horsepower, light duty motors, sleeve type bearings are permitted.
         5) Enclosure Type:
            a) Open drip-proof (ODP) motors for indoor use in clean air environments.
            b) Totally enclosed fan cooled (TEFC) motors for outdoor use and indoor application in dirty environments.
            c) Totally enclosed air over (TEAO) motors for motors in the airstream of cooling towers and fluid coolers.
            d) Guarded drip-proof motors where exposed to contact by employees or building occupants.
            e) Weather protected Type I for outdoor use, Type II where not housed.
      d. Overload Protection: Built-in thermal overload protection where external overload protection is not provided and, where indicated, internal sensing device suitable for signaling and stopping motor at starter.
      e. Noise Rating: “Quiet.”
      f. Efficiency: (Note to Engineer: Edit to select either State code efficiency or NEMA Premium efficiency. NEMA efficiency is between 3 and 0.5% higher than current State codes and costs 25%

more. NOTE REGARDING FEDERAL PROJECTS: All motors must meet the NEMA standard per the 2005 Energy Policy Act Section 104.)

1) Motors shall have a minimum efficiency per governing State or Federal codes, whichever is higher.
2) And, motors shall meet the NEMA premium efficiency standard.

g. Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.

D. Starters and Electrical Devices:

1. Motor Starter Characteristics:
   a. Enclosures: NEMA 1, general purpose enclosures with padlock ears, except in wet locations shall be NEMA 3R with conduit hubs.
   b. Type and size of starter shall be as recommended by motor manufacturer and the driven equipment manufacturer for applicable protection and start-up condition.
2. Manual switches shall have pilot lights and all required switch positions for multi-speed motors. Overload Protection: Melting alloy or bi-metallic type thermal overload relays, sized according to actual operating current (field measured).
3. Magnetic Starters:
   a. Heavy duty, oil resistant, hand-off-auto (HOA), or as indicated, and pilot lights, properly arranged for single speed or multi-speed operation as indicated.
   b. Trip-free thermal overload relays, each phase, sized according to actual operating current (field measured).
   c. Interlocks, pneumatic switches and similar devices as required for coordination with control requirements of Division 23 Controls sections.
   d. Built-in primary and secondary fused control circuit transformer, supplied from load side of equipment disconnect.
   e. Externally operated manual reset.
   f. Under-voltage release or protection for all motors over 20 hp.
4. Motor Connections: Liquid tight, flexible conduit, except where plug-in electrical cords are specifically indicated.

E. Low Voltage Control Wiring:

1. General: 14 gauge, Type THHN, color coded, installed in conduit.
2. Manufacturer: General Cable Corp., Alcan Cable, American Insulated Wire Corp., Senator Wire and Cable Co., or Southwire Co.

F. Disconnect Switches:

1. Fusible Switches: For equipment 1/2 HP or larger, provide fused, each phase; heavy duty; horsepower rated; spring loaded quick-make, quick-break mechanism; dead front line side shield; solderless lugs suitable for copper or aluminum conductors; spring reinforced fuse clips; electro silver plated current carrying parts; hinged doors; operating lever arranged for locking in the “OPEN” position; arc quenchers; capacity and characteristics as indicated.
2. Non-Fusible Switches: For equipment less than 1/2 horsepower, switch

shall be horsepower rated; toggle switch type with thermal overload quantity of poles and voltage rating as required.

PART 3 - EXECUTION

3.1 GENERAL

A. Workmanship shall be performed by licensed journeymen or master mechanics and shall result in an installation consistent with the best practices of trades.

B. Install work uniform, level and plumb, in relationship to lines of building. Do not install any diagonal, or otherwise irregular work unless so indicated on Drawings or approved by Owner's Representative.

3.2 MANUFACTURER'S DIRECTIONS

A. Follow manufacturers' directions and recommendations in all cases where the manufacturers of articles used on this Contract furnish directions covering points not shown on the Drawings or covered in these Specifications.
1. If the contractor must deviate from the manufacturer's recommendations provide a letter from the manufacturer indicating the clearance to be provided is acceptable for scheduled performance and maintenance.

3.3 INSTALLATION

A. Coordinate the work between the various Mechanical Sections and with the work specified under other Divisions. If any cooperative work must be altered due to lack of proper supervision or failure to make proper and timely provisions, the alternations shall be made to the satisfaction of the Engineer and at the Contractor's cost. Coordinate wall and ceiling work with the General Contractor, and other trades in locating ceiling air outlets, wall registers, etc.

B. Inspect all material, equipment, and apparatus upon delivery and do not install any damaged or defected materials.

3.4 SUPPORTS AND HANGERS

A. Prior to installation of hangers, supports, anchors, and associated work, installer shall meet at project site with Contractor, installer of each component of associated work, inspection and testing agency representatives, (if any), installers of other work with requirements specified.

B. Installation of Building Attachments: Install building attachments at required locations within concrete or on structural steel for proper piping support. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed. Fasten insert securely to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through opening at top of inserts.

C. Proceed with installation of hangers, supports, and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including, but not limited to, proper placement of

inserts, anchors, and other building structural attachments.

D. Install hangers, supports, clamps, and attachments to support piping properly from building structure. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.

E. Install hangers within 12 inches of every change in piping direction, end of pipe run or concentrated load, and within 36 inches of every major piece of equipment. Hangers shall be installed on both sides of flexible connections. Where flexible connection connects directly to a piece of equipment only one hanger is required.

F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.

G. Support sprinkler piping and gas independently of other piping.

H. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated, or by other recognized industry methods.

1. Steel Pipe (Water Filled):

Pipe Size	Max. Hanger/Support Spacing	Rod Size
1/2” to 1-1/4”	5 feet	3/8”
1-1/2” to 2”	7 feet	3/8”
2-1/2” to 3”	10 feet	1/2”
4” to 10”	12 feet	5/8”
12” to 16”	20 feet	2@5/8”

2. Steel Pipe (Gas/Air Filled):

Pipe Size	Max. Hanger/Support Spacing	Rod Size
1/2" to 1-1/4"	6 feet	3/8"
1-1/2" and larger	10 feet	1/2"

3. Copper Pipe:

Pipe Size	Max. Hanger/Support Spacing	Rod Size
1/2" to 2"	6 feet	3/8"
2-1/2" and larger	8 feet	1/2"

4. Glass Pipe:

Pipe Size	Max. Hanger/Support Spacing	Rod Size
1/2" to 2"	6 feet	3/8"
2-1/2” and larger	8 feet	1/2"

5. Plastic/Fiberglass Pipe:

Pipe Size	Max. Hanger/Support Spacing	Rod Size
1/2" to 2"	4 feet	3/8"
2-1/2" and larger	6 feet	1/2"

6. Caulked Bell and Spigot and Glass Pipe: Provide hanger for each section of pipe, located at shoulder of bell. Where an excessive number of fittings are installed between hangers, provide additional reinforcing.
7. Trapeze support: Provide details stamped by a registered structural engineer for the project state indicating trapeze channels, support rod sizes, and spacing.

I. Provisions for Movement:
1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
2. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connecting equipment.
3. Insulated Piping: Comply with the following installation requirements:
   a. Clamps: Attach clamps, including spacers, (if any), to piping with clamps projecting through insulation.
   b. Shields: Where low compressive strength insulation or vapor barriers are indicated on cold or chilled water piping, install shields or inserts.
   c. Saddles: Where insulation without vapor barrier is indicated install protection saddles.

J. Installation of Anchors:
1. Install anchors at proper locations to prevent excessive stresses and to prevent transfer of loading and stresses to connected equipment.
2. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure.
3. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to limit movement of piping and forces to maximums recommended by manufacturer for each unit.
4. Anchor Spacings: Where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends.

K. Equipment Supports:
1. Provide all concrete bases, unless otherwise furnished as work of Division 03. Furnish to Division 03 Contractor scaled layouts of all required bases, with dimensions of bases, and location to column centerlines. Furnish templates, anchor bolts, and accessories necessary for base construction.
2. Provide structural steel stands to support equipment not floor mounted or hung from structure. Construct of structural steel members or steel pipe and fittings. Provide factory-fabricated tank saddles for tanks.

L. Adjusting:
1. Hanger Adjustment: Adjust hangers so as to distribute loads equally on attachments.
2. Support Adjustment: Provide grout under supports so as to bring piping and equipment to proper level and elevations.
3. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.5 WALL, FLOOR, AND ROOF PENETRATION SIZING

A. All pipe penetrations through rated and non-rated assemblies shall be sized to allow for compliance with structural integrity and fire ratings, as applicable. Where sleeves are required, the sleeve size shall be installed with the inside clear diameter providing clearances as required below. Coordinate the required opening sizes with the manufacturer of the fire protection products.

1. Uninsulated pipe penetrations through non-rated walls and floors: pipe penetration sizes shall be a 1” (minimum) to 2” (maximum) larger than the outside diameter of each uninsulated pipe.
2. Insulated pipes penetrations through non-rated walls and floors: pipe penetration sizes shall be a 1” (minimum) to 2” (maximum) larger than the outside diameter of each pipe, including insulation.
3. Uninsulated pipe penetrations through fire rated walls and floors, and through roof: penetration sizes shall be a 1/2” (minimum) to 1-1/2” (maximum) larger than the outside diameter of each uninsulated pipe to provide minimum 1/4” annular space between the outside of the pipe surface and assembly. Coordinate with specific manufacturer requirements and UL listing.
4. Insulated pipe penetrations through fire rated walls and floors, and through roof: pipe penetration sizes shall be a 1/2” (minimum) to 1-1/2” (maximum) larger than the outside diameter of each insulated pipe to provide minimum 1/4” annular space between the outside of the insulation surface and assembly. Coordinate with specific manufacturer requirements and UL listing.
5. Uninsulated pipe penetrations through foundation and basement walls: penetration sizes shall be larger than the outside diameter of each uninsulated pipe to allow adequate space for installation of mechanical link seals. Coordinate with specific manufacturer requirements.

3.6 ROOF CURBS, EQUIPMENT RAILS, PIPE PORTALS

A. Install per manufacturer's instructions.

B. Coordinate with other trades so units are installed when roofing is being installed.

C. Verify roof insulation thickness and adjust raise of cant to match.

3.7 ELECTRICAL COORDINATION

A. Division 23 installers shall coordinate with Division 26 work to provide complete systems as required to operate all mechanical devices installed under this Division of work.

B. Installation of Electrical Connections: Furnish, install, and wire (except as may be otherwise indicated) all heating, ventilating, air conditioning, etc., motors and controls in accordance with the drawings and in accordance with equipment manufacturer’s written instructions and with recognized industry practices, and complying with applicable requirements of UL, CEC, and NECA’s “Standard of Installation” to ensure that products fulfill requirements.

C. Division 23 has responsibilities for electrically powered mechanical equipment which is specified in Division 23 Specifications or scheduled on Division 23 Drawings as follows:
   1. Motors: Furnish and install all motors necessary for mechanical equipment.
   2. Magnetic Starters: Furnish all magnetic starters whether manually or automatically controlled which are necessary for mechanical equipment. Furnish these starters with all control relays or transformers necessary to interface with mechanical controls. If the starter is factory installed on a piece of Division 23 equipment, also furnish and install the power wiring between starter and motor.
   3. Variable Frequency Drives: Provide all VFD's associated with mechanical equipment. If the drive is installed on a piece of factory assembled equipment the wiring between motor and drive is to be provided as part of the factory equipment.
   4. Disconnects: Provide the disconnects which are part of factory wired Division 23 equipment. Factory wiring to include wiring between motor and disconnect or combination starter/disconnect.
   5. Controls: Division 23 Contractor (including the Building Automation System (BAS) Controls subcontractor) is responsible for furnishing the following equipment in its entirety. This equipment includes but is not limited to the following:
      a. Control relays necessary for controlling Division 23 equipment.
      b. Control transformers necessary for providing power to controls for Division 23 equipment.
      c. Line voltage thermostats.
      d. Low or non-load voltage control components.
      e. Remote bulb thermostats.
      f. Non-life safety related valve or damper actuators.
      g. Float switches.
      h. Solenoid valves, EP and PE switches.
      i. Refrigeration controls.
      j. Communications wiring and conduit between control devices and mechanical equipment.
      k. Raceway to support control cabling.
   6. Fire/Smoke Dampers: Division 23 is responsible for providing and physically installing the damper and for installing any required control interface wiring to Division 23 controls.
      a. Where fire/smoke dampers are part of an integrated smoke control system, Division 23 is responsible for providing dampers with necessary end switches for use by Division 28 in providing proof of closure.
      b. Where these dampers are not part of an integrated area wide smoke detection system, Division 23 is responsible for providing each fire/smoke damper with a dedicated duct detector installed per the requirements of the building code. If not integral with the damper assembly, the detector is to be installed in ductwork by Division 23 but wired to the damper controller by Division 26.

D. Division 26 Electrical Responsibilities:
   1. Motors: Provide the power wiring for the motors from servicing panel to motor controller.

2. Magnetic Starters: Except where magnetic starters are factory installed on Division 23 factory assembled equipment, Division 26 is to install magnetic starters furnished by Division 23 and install the necessary power wiring to the starter and from the starter to the motor. In the case of factory installed starters, Division 26 is to install the necessary power wiring from source panel/disconnect to the starter.
3. Variable Frequency Drives: Provide the necessary power wiring to the VFD and from the VFD to the motor except in the case of factory installed VFD's where wiring between the motor and VFD is to be by Division 23.
4. Disconnects: Provide all disconnects necessary for Division 23 mechanical equipment which are not provided as part of factory wired Division 23 equipment. Provide power wiring to all disconnects. In addition provide power wiring between motor and disconnect when the disconnect is not factory installed.
5. Controls: Division 26 is responsible for providing power to mechanical control panels and provide final power connection to Division 23 provided control transformers.
6. Fire/Smoke Dampers: Division 26 is responsible for power wiring to each damper and as follows:
   a. Where these dampers are part of an integrated smoke control system Division 28 is responsible for providing the detectors and for all fire/smoke detection system wiring necessary to integrate dampers and related end switches into the system.
   b. Where these dampers are not part of an integrated area wide smoke detection system, Division 23 is responsible for providing each fire/smoke damper with a dedicated duct smoke detector installed per the requirements of the building code. If not integral with the damper assembly, the detector is to be installed by Division 23, but wired for damper control by Division 26.

E. Motors and Motor Control Equipment: Conform to the standards of the NEMA. Equip motors with magnetic or manual line starters with overload protection. Motor starters and line voltage controls shall be installed under Electrical Section but located and coordinated as required under this Section of the work. Starters shall be combination type with non-fusible disconnect switches. All single phase fractional horsepower motors shall have built-in overload protection.

3.8 PAINTING

A. All painting shall be provided under this Division work, unless otherwise specified under Section 099100: Painting. Painting schemes shall comply with ANSI A13.1. Paint all exposed materials such as piping, ductwork, equipment, insulation, steel, etc. Exposed gas piping inside and outside the building shall be painted with two coats of "Rust-O-Leum" Yellow. The inside surface of visible ductwork above diffusers/grilles shall be painted flat black. Exposed copper indirect waste piping serving food service equipment shall be painted metallic chrome.

B. All exposed work under Division 23 shall receive either a factory finish or a field prime coat finish, except:
   1. Exposed copper piping.
   2. Aluminum jacketed outdoor insulated piping.

3.9 IDENTIFICATION MARKERS

A. General: Where identification is to be applied to surfaces which require insulation, painting, or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

B. Piping System Identification:
1. Install pipe markers on each system indicated to receive identification, and include arrows to show normal direction of flow.
2. Locate pipe markers as follows:
   a. Near each valve and control device.
   b. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
   c. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
   d. At access doors, manholes, and similar access points which permit view of concealed piping.
   e. Near major equipment items and other points of origination and termination.
   f. Spaced horizontally at maximum spacing of 20' along each piping run, with minimum of one in each room. Vertically spaced at each story transversed.

C. Underground Piping Identification: During backfilling/topsoiling of each exterior underground piping system, install continuous underground-type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16", install single line marker.

D. Ductwork Identification: A minimum of every 20' for all ductwork 12" or more in diameter or width.

E. Mechanical Equipment Identification: Locate engraved plastic laminate signs on or near each major item of mechanical equipment and each operational device. Provide signs for the following:
1. Main control and operating valves, including safety devices.
2. Meters, gauges, thermometers, and similar units.
3. Pumps, compressors, chillers, and similar motor-driven units.
4. Hot water system mixing valves and similar equipment.
5. Heat exchangers and similar equipment.
6. Fans, blowers, primary balancing dampers, and mixing boxes.
7. Tanks and pressure vessels.
8. Strainers, filters, treatment systems and similar equipment.
9. Sprinkler and standpipe equipment.

F. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations. Equipment signs shall include an identification of the area or other equipment served by the equipment being labeled.

3.10 VIBRATION AND DYNAMIC BALANCING

A. All equipment submitted and installed by Div. 23 shall not exceed maximum tolerances as specified by the "International Research and Development Corporation", Worthington, Ohio, measured by the displacement, peak to peak, as follows:
   1. All Fans: Below severity chart labeled "FAIR", maximum velocity of 0.0786 in/sec, peak.
   2. Pump and Electric Motors: Below severity chart labeled "SLIGHTLY ROUGH", maximum vibration velocity of 0.157 in/sec, peak.
   3. Compressors: Same as pumps.

B. Where installed equipment noise or vibration is objectionable to the engineer, it shall be responsibility of the **contractor** to conduct testing to confirm that the equipment does not exceed the standard.

C. Correction shall be made to all equipment, which exceeds vibration tolerances specified above. Final vibration levels shall be reported as described above.

3.11 TESTING

A. Provide all tests specified hereinafter and as otherwise required. Provide all test equipment, including test pumps, gauges, instruments, and other equipment required. Test all rotational equipment for proper direction of rotation. Upon completion of testing, certify to the Owner's Representative, in writing, that the specified tests have been performed and that the installation complies with the specified requirements and provide a report of the test observations signed by qualified inspector.

B. Ductwork: Test all air quantities as specified in Section 230593 - Testing, Adjusting and Balancing. Pressure tests per SMACNA.

C. Registers and Diffusers: Test for proper operation of manually operated control feature. Test all air quantities as specified in Section 230593 – Testing, Adjusting and Balancing.

D. Ductwork Specialties: Test all operable ductwork specialties for proper operation. Check all fire, smoke and fire/smoke dampers to ensure that they are 100% open.

E. Temperature Control: Test all control functions to assure that all systems are controlling as specified or as otherwise necessary and that all controls are adjusted to maintain proper room temperatures. The manufacturer's representative shall perform all tests.

END OF SECTION