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## **PART 1 - GENERAL**

### **1.1 WORK OF THIS SECTION**

- A. This section of the specifications details the components to be provided by the BMCS subcontractor relating to the following:
1. General Requirements
  2. Warranty.
  3. Codes, Permits, and Approvals.
  4. Schedule.
  5. Information to Accompany Bid.
  6. Subcontractor Qualifications.
  7. System Compliance and Performance Certification.
  8. Training.
  9. Installation Requirements.
  10. Electrical Requirements.
  11. Conduit.
  12. Cabling
  13. Panels

### **1.2 ABBREVIATIONS**

AD	-	Automatic Damper
ANSI	-	American National Standards Institute
ASHRAE	-	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASTM	-	American Society for Testing Materials
AWG	-	American Wire Gauge
BMCS	-	Building Management and Control System
CA	-	Commissioning Authority
CAD	-	Computer-Aided Design
CCP	-	Communication Control Panel
CHW	-	Chilled Water
CPU	-	Central Processing Unit
CVTU	-	Constant Volume Terminal Unit
CW	-	Condenser Water
DCP	-	Distributed Control Panel
DDC	-	Direct Digital Control
EEPROM	-	Electrically Erasable Programmable Read Only Memory
EMT	-	Electrical Metallic Tubing
EPA	-	Environmental Protection Agency
ETL	-	Electric Testing Laboratory
FDACS	-	Fire Detection, Alarm and Communication System
FLAN	-	Field Level Local Area Network
FM	-	Factory Mutual
FSD	-	Fire / Smoke Damper
FTS	-	Field Termination Schedule
HVAC	-	Heating, Ventilation and Air Conditioning
IEEE	-	Institute of Electrical and Electronics Engineers
I/O	-	Input/Output
ISA	-	International Society of Automation
ISP	-	Internet Service Provider
LAN	-	Local Area Network
LCD	-	Liquid Crystal Display
LCRP	-	Lighting Control Relay Panel
LED	-	Light Emitting Diode
MCC	-	Motor Control Center
MLAN	-	Management Level Local Area Network
MSDS	-	Material Safety Data Sheet
NEC	-	National Electrical Code

NEMA	-	National Electrical Manufacturers Association
NFPA	-	National Fire Protection Association
OIW	-	Operator Interface Workstation
OSHA	-	Occupational Safety and Health Association
PC	-	Personal Computer
PCB	-	Polychlorinated biphenyl
PIM	-	Point Interface Module
PVC	-	Polyvinyl Chloride
RAM	-	Random Access Memory
ROM	-	Read-Only Memory
RFI	-	Radio Frequency Interference
RH	-	Relative Humidity
ROW	-	Remote Operator Workstation
SD	-	Smoke Damper
SVGA	-	Super Video Graphics Array
UC	-	Unitary Controller
ULC	-	Underwriters Laboratory Canada
VDU	-	Video Display Unit
UPS	-	Uninterruptible Power Supply
XML	-	Extensible Markup Language

### 1.3 DEFINITIONS

- A. "SUBCONTRACTOR" shall mean the BMCS subcontractor who shall provide the Building Management and Control System.
- B. "PROVIDE" shall mean furnish, install, commission, test and warrant.
- C. "FURNISH" shall mean purchase and deliver to the appropriate installing Contractor, complete with every appurtenance, document, commission and warranty.
- D. "CAD" shall mean AutoCAD 2013 (or later version) or Visio Technical 2009 (or later version).

### 1.4 WARRANTY AND SERVICES DURING THE WARRANTY PERIOD

- A. The warranty period for all components of the new BMCS and their installation shall be a minimum of two years from the date of substantial completion. The date of substantial completion shall be the date when all components have been certified by the Consultant and accepted by the Owner to be complete in accordance with the definition of substantial completion.
- B. Any material furnished by the BMCS subcontractor which is defective, any workmanship of the BMCS subcontractor which is defective and any resulting damage to work of other trades shall be remedied immediately by the BMCS subcontractor at no cost to the Owner during the period prior to the issue of the certificate of substantial completion and during the warranty period. The BMCS subcontractor shall comply with the General Conditions in all respects with regard to responsibility during the warranty period.
- C. Repair work subsequent to the issuance of the occupancy certificate shall only be undertaken at times approved by the Owner.
- D. The Base Bid price shall include the cost of all replacement parts during the warranty period, all of the associated installation costs and all of the costs associated with the repair of components during the warranty period but shall not include the cost of labor for routine maintenance during the warranty period. The cost of labor for routine maintenance during the warranty period shall be provided separately as an Alternate Price as detailed below.
- E. Replace or repair all defective installations, which are the responsibility of the BMCS subcontractor. Respond and be on site within four hours of the Owner placing a system trouble call for items of an immediate nature (eg: failed component, non-functioning controller, etc.). Response to Warranty call out by the Owner shall be within 24 hours for items not requiring immediate attention. Work to trouble shoot and identify the cause of the BMCS system or component failure shall begin immediately and shall continue until repaired to the satisfaction of the Owner.

- F. Any software modifications or upgrades that become standard product offerings from the BMCS subcontractor and/or BMCS equipment vendors during the warranty period shall be brought to the attention of the Owner and, if the Owner wishes, shall be provided at no additional cost to the Owner.
- G. The BMCS subcontractor shall maintain an inventory of common components in the local office for the replacement of failed components.
- H. Provide replacement components within the specified time periods for the following components. The subcontractor shall guarantee to the Owner that the delivery of replacement components shall be provided within the specified time periods.

<u>BMCS Component</u>	<u>Delivery Time</u>
1. Workstation Computer Equipment:	
a. Server/central computer components	Five days
b. Operator Workstations and components	Five days
c. Management, and field BMCS communication LAN components including any hubs, network interface cards, bridges, routers, concentrators, protocol converters, termination plugs, etc.	One day
2. CCP including interface cards.	One day
3. DCP including any required input/output point interface modules.	Two days
4. Unitary controllers including any input/output point interface modules.	Two days
5. Temperature sensors.	Two days
6. Any other items of instrumentation.	Five days

**1.5 ROUTINE MAINTENANCE SERVICES DURING THE WARRANTY PERIOD (ALTERNATE PRICE)**

- A. Submit an alternate price to provide routine maintenance services during the initial warranty period. Provide the pricing as an add-on price not included in the Base Bid Pricing. The maintenance services shall cover routine preventative maintenance and shall not include emergency maintenance or the cost of materials, which are to be covered by the warranty.
- B. Schedule maintenance and repair work with the Owner's representative to prevent interference with normal building activities.
- C. Components of the BMCS shall be selectively inspected and serviced during the warranty period. Provide, at minimum, four preventative service inspections during the warranty period. Perform, at minimum, the following during each preventative service inspection:
  - 1. Verify the proper operation of the workstations including:
    - a. Cooling fans
    - b. Power supplies
    - c. PC diagnostics
  - 2. Clean housings, keyboard, etc. Change or clean filters.
  - 3. Verify proper operation of each CCP, DCP, UC and network. Clean enclosures.
  - 4. Verify the satisfactory operation of at least 25 percent of each type of field device. All field devices shall be checked at least once during the initial warranty period and shall be calibrated and adjusted as necessary.
  - 5. Provide a comprehensive written report to the Owner indicating the results of each inspection and all repairs and adjustments made.
  - 6. Perform a complete backup of all data.
- D. Update record drawings as necessary and provide the Owner with a copy for information.

**1.6 EXTENDED WARRANTY AND MAINTENANCE FOLLOWING THE COMPLETION OF THE WARRANTY PERIOD (ALTERNATE PRICE)**

- A. Submit an alternate price for one year warranty and preventative maintenance following the completion of the initial warranty period. The routine maintenance shall be the same as that detailed in Part 1.5 of this Section and the extended warranty and maintenance coverage for services and equipment shall be the same as that detailed in Part 1.4 of this Section. The all-inclusive, i.e. labor and parts, maintenance agreement shall be submitted as a fixed price for a five year term.
- B. The extended warranty and maintenance shall be renewable for up to a five year period on an annual basis with only consumer price index adjustments.

**1.7 CODES, PERMITS AND APPROVALS**

- A. Obtain all required permits and inspection certificates. All permits and certificates shall be made available to the Owner.
- B. The latest requirements of all national, state, county, municipal and other authorities having jurisdiction shall be met.
- C. Work that is not clearly defined by local ordinance or amendment shall be governed by the National Electrical Code and the City of San Francisco Building Code.
- D. The requirements of The Federal Occupational Safety and Health Act (OSHA) and Environmental Protection Agency (EPA) shall be followed for all job-site procedures and installation methods.
- E. Work shall be performed in compliance with Owner's insurance underwriters' requirements.
- F. All equipment and materials furnished under this subcontract shall be new, and shall meet all applicable UL standards and all requirements of these specifications.

**1.8 SCHEDULE**

- A. Complete all requirements of the BMCS subcontract prior to the scheduled substantial completion date for each portion of the work.
- B. Provide to the General Contractor a schedule indicating the sequence of work, durations of individual tasks, delivery dates for all material, devices and equipment and detail any interface that must be coordinated with any other subcontractors.
- C. Attend all project meetings as requested by the Owner and the General Contractor.
- D. Provide written status reports at required intervals and in a format acceptable to the Owner. An updated schedule of work shall be included in each status report.
- E. Comply with the Project Construction Schedule. Provide additional staff and work overtime as required to comply with the Project Schedule and so as not to interfere with other on-site subcontractors in their effort to comply with the Project Schedule.
- F. Provide written Request For Information notices to the Owner when specific information or clarification of the specifications is required. Request For Information notices shall be provided at least two weeks prior to the need for the information.
- G. The following is the scheduling required by these specifications.
  - 1. Immediately after Notice to Commence, the General Contractor, together with the major Subcontractors, shall have a preconstruction meeting with the Architect, Engineer and Owner.
  - 2. It is expected that an expedited submittal review process shall be utilized on this Project. The Subcontractor shall start on or schedule the following upon receiving Notice to Commence. Approximately four to six weeks after Notice to Commence, the expedited submittal review meeting shall be conducted with the Owner, Architect, Engineer,

- Consultant, General Contractor and all major Subcontractors. Subcontractors shall provide complete, certified, documented Equipment Data including Compliance Reviews for all equipment and materials required for the project.
3. On or before two weeks after the expedited submittal review the Mechanical and Electrical Subcontractors shall furnish interlock wiring diagrams to the BMCS Subcontractor.
  4. Shop Drawings and Coordination Drawings shall follow a normal sequential review by the Consultant as detailed in the BMCS Documentation section of these specifications. Submit all required information within two months of expedited equipment submittal review.
  5. Respond in writing to FINAL REVIEW – EXCEPTIONS NOTED comments on submittals within two weeks after receipt of the comments indicating acceptance and compliance of the comments. If the response and compliance is not received, the status of the submittal shall be revised to RESUBMIT.
  6. On or before four months after receipt of FINAL REVIEW or FINAL REVIEW – EXCEPTIONS NOTED shop drawings, demonstrate the completed BMCS mockup.
  7. Respond in writing to Field Observation Report comments within two weeks after receipt of the comments indicating acceptance of the comments.
  8. Submit initial copies of the operation and maintenance books and training outline to the Owner on or before six months after Notice to Commence.
  9. Submit final copies of the Operation and Maintenance books to the Consultant for review at least four weeks before acceptance testing of the Project.
  10. Submit completed test sheets indicating the test results for each BMCS component within the system with a detailed schedule for acceptance testing at least one week prior to the proposed acceptance testing.

#### 1.9 INFORMATION TO ACCOMPANY BID

- A. The information identified within the bid invitation letter shall be submitted with the BMCS bid in a 3 ring binder with each piece of information tabbed in the order indicated.

#### 1.10 SUBCONTRACTOR QUALIFICATIONS

- A. The BMCS subcontractor shall:
  1. Have a local staff in the San Francisco, CA area of trained personnel capable of giving instructions and providing routine and emergency maintenance on the BMCS, all components and software/firmware and all other elements of the BMCS.
  2. Have a proven record of experience in the supply and installation of equivalent systems over a minimum period of five years.
  3. Document at least three and no more than six projects of equal or greater size and complexity.
  4. Have been a factory certified representative for the BMCS manufacturer for a minimum of three years for design, installation, and maintenance of the proposed systems.
  5. Have comprehensive local service and support facilities for the total BMCS as provided.
  6. Maintain a local, or have approved local contracted access to, supplies of essential expendable parts.
- B. Subject to their complete compliance with these Contract Documents, the BMCS subcontractor and the associated systems shall one of the following companies:
  1. Delta Control/Delta Controls EnteliWEB.
  2. Johnson Controls/Johnson Controls Metasys.
  3. Schneider Electric/Schneider Struxeware with Continuum controllers.
  4. Sunbelt Controls/Automated Logic Corp WebCTRL.
  5. Syserco-Waypoint/Tridium with Alerton controllers.

#### 1.11 SYSTEM COMPLIANCE AND PERFORMANCE CERTIFICATION

- A. The BMCS subcontractor shall certify in writing with the bid submittal that all components proposed for this project comply with all of the following requirements:
  1. Complete and thorough testing has proven that performance shall not be affected when the building electrical distribution system experiences disturbances up to the maximum levels allowed under IEEE Standard 519, Table 2 for General Systems (460V) Applications.

2. An Owner approved testing laboratory has verified that instrumentation used to monitor the flow rate in the terminal units meets the performance requirements detailed in the BMCS Testing and Inspections section of these specifications. The testing laboratory test report is to be submitted.
  3. Power line disturbance tests involving the cycling of mains voltage showed that all components operated satisfactorily when the voltage dropped to 75% or less of the nominal mains voltage and normal operation resumed when the voltage returned to less than 85% of the nominal mains voltage. Following these brownout conditions the components were free of any stress and/or damage, operated as normal and no data at the PC, CCP, DCP and/or UC was lost or corrupted.
- B. The BMCS subcontractor shall thoroughly review all aspects of the BMCS and certify they are in compliance with the Contract Documents. The Subcontractor shall provide a compliance review ("Compliance Review") of all Specifications and Addenda as part of the Subcontractor's proposal. The Compliance Review shall be a paragraph-by-paragraph review of the Specifications with the following information marked for each Specification section paragraph or in the margin of the original Specification and any subsequent Addenda.
1. "C": Comply with no exceptions.
  2. "D": Deviation. Equipment, product or material does not comply. For each and every deviation, provide a numbered footnote with reasons for each deviation and suggest possible alternatives for the Owner's consideration.
  3. "N/A": The specification paragraph does not apply to the proposed equipment, material or product.

Unless a deviation is specifically noted in the Compliance Review, it is assumed that the Subcontractor is in complete compliance with the Contract Documents. Deviations taken in cover letters, subsidiary documents, by omission or by contradiction do not release the Subcontractor from being in complete compliance unless the exception or deviation has been specifically noted (explicitly, not by implication) in the Compliance Review.

#### 1.12 TRAINING

- A. Submit an outline of the training courses to be provided as part of the work. The training outline shall include a schedule of the proposed training sessions which shall be broken down into four hour segments. The course content of each segment shall be itemized in detail. The training outline shall provide details of the topics to be covered in each session and identify the tasks that attendees should be able to undertake following completion of each session. The outline shall also identify prerequisite requirements that should be met prior to attendance. Identify the type of venue best suited to each training session (e.g. Control Room, Engineer's office, meeting room etc.). Training shall be conducted for each and every system, product, and interface to be provided under this subcontract.
- B. The training outline shall be submitted with the shop drawing submittal. Training shall not commence until the Owner and Consultant have approved the outline.
- C. Training sessions shall be conducted in a classroom environment with sufficient "hands on" instruction for the attendees to become familiar and competent with the tasks demonstrated.
- D. Training shall be provided by the BMCS subcontractor on site using the completed installations. Coordinate use of the OIW equipment for training with the Owner. Where specific training requires the use of the Owner's meeting room space, co-ordinate these requirements with the Owner.
- E. Training shall consist of, at minimum, the following:
1. Ten 8-hour sessions presented on-site using the installed system. This training shall be for up to four operators and shall be given within the final month prior to the anticipated date of issue of the Certification of Substantial Completion.
  2. One 40-hour session for up to two management level operators at the subcontractor's factory training facility. The Owner shall pay for any travel related expenses for the operations staff.
  3. Two 8-hour on-site session during the warranty period.
  4. These training sessions shall be scheduled with the Owner and shall be structured with the format and content required by the Owner.

- F. Provide all training materials (hand-outs, textbooks, workbooks etc.) and any audiovisual equipment required to execute the training.
- G. Training sessions shall be formatted to optimize the attendee's time such that items already covered are not repeated unnecessarily. Training sessions shall be tailored to suit the experience and knowledge of the attendees scheduled to participate in each training session.
- H. Operator training shall be specific to this project and shall cover, at minimum, the following subjects:
  - 1. Hardware review.
  - 2. Installation methods, component replacement, routine maintenance requirements.
  - 3. Application programs.
  - 4. Defining application program parameters.
  - 5. Point creation, definition, and modification.
  - 6. Data base features, backup, retrieval process.
  - 7. Operator interface features.
  - 8. Standard reports and custom report creation.
  - 9. VDU graphics set up and modification.
  - 10. Other subjects necessary to ensure that the operators shall be able to operate the BMCS without any on-going assistance from an outside source.
- I. Manager training shall be specific to this project and shall cover, in addition to the above, the following subjects:
  - 1. Operating sequence programming.
  - 2. Custom report generation.
  - 3. Password access applications.
  - 4. Other subjects necessary to ensure that the managers shall be able to operate and manage the BMCS without any on-going assistance from any outside source.

## **PART 2 - PRODUCTS**

### **2.1 EQUIPMENT AND MATERIALS - GENERAL**

- A. When a specific reference to a manufacturer or a product is made, and the terms "or approved equal" are used, substitutions of a product by another manufacturer shall be allowed, but the substituted product must conform to all specified requirements. The Consultant determination on the acceptability of substitutes shall be final. Approved substituted equipment shall conform to available space requirements. Substituted equipment that does not conform to the available space requirements shall be replaced or required modifications shall be made at no additional cost to the Owner.
- B. All equipment and materials shall be new and without any defect. All components of one type shall be products of one manufacturer (temperature sensors, butterfly valves, dampers, etc.).
- C. Equipment and materials shall be UL or ETL listed, in accordance with the requirements of the authorities having jurisdiction, and suitable for its intended use.
- D. Hazardous Materials Notification: In the event no product or material is available that does not contain asbestos, PCB, or other hazardous materials as determined by the Owner, a "Material Safety Data Sheet" (MSDS) equivalent to OSHA Form 20 shall be submitted for the proposed product or material prior to installation.
- E. Asbestos and PCB Certification: After completion of the installation, but prior to Substantial Completion, the BMCS subcontractor shall certify in writing that products and materials installed, and the processes used, do not contain asbestos or polychlorinated biphenyls (PCB's).

### **2.2 EQUIPMENT - MOUNTING AND FINISHES**

- A. Visible identification logos, trademarks, or evidence of their removal are not permitted on any equipment, devices, etc. that are located in areas accessible to the public. Equipment, devices or enclosures accessible to the public shall utilize tamper proof fasteners.
- B. Mounting locations in public areas shall be verified with the Architect prior to installation. Notify the Architect if a particular location is not acceptable for the application.

### 2.3 ELECTRICAL EQUIPMENT AND ELECTRICAL ROOM PRECAUTIONS

- A. In general, the Subcontractor shall not install piping or ductwork in any switchboard, switchgear, transformer, elevator equipment, telephone, telecommunications or electrical equipment room unless this piping or ductwork serves only these rooms. Installation is strictly prohibited where it violates the requirements of the applicable electrical code and/or the elevator code.
- B. No piping shall be installed above switchboards, panel boards, control panels, motor control centers, individual motor controllers, etc. No piping shall be installed above or within 6 feet of bus duct unless specifically shown on the Drawings.

### 2.4 INTERFERENCES

- A. Equipment, devices and materials shall conform to all performance requirements of the specifications when exposed to the following interferences:
  - 1. Project lighting, telephone and elevator equipment.
  - 2. VHF and UHF signals as generated by external or internal portable or fixed transmitters.
  - 3. AM signals as generated from transmitters.
  - 4. Cellular telecommunications.
  - 5. Electrical noise on the building power system, both spurious and harmonics.
- B. Provide adequate grounding on all equipment to prevent the build-up of electromagnetic voltage potentials. Provide shielding of panels, enclosures, devices, or components that emit interferences.
- C. The installations shall not radiate signals that cause interference to the correct operation of any other tenant or Owner on-site equipment.
- D. All electrical equipment, devices and components shall be in compliance with the requirements of the Federal Communication Commission rules and regulations Part 15, sub part J and other applicable statutes with respect to the radiation and conduction of radio frequency interference.

### 2.5 ELECTRICAL POWER PROVISIONS

- A. 120 Vac power shall be provided by the Electrical subcontractor to the locations indicated below. All circuits shall be provided in closed junction boxes with labeling indicated BMCS power. The BMCS subcontractor shall provide conduit, cabling, and final terminations to these locations.
- B. Power fed from normal power circuits shall be provided with junction boxes at the following locations:
  - 1. Each Motorized Butterfly Valve - One 120 Vac, 20 amp circuit. Motorized butterfly valves located at the following locations:
    - a. Level 2 Central Cooling Plant.
    - b. Level 35 Chilled Water Heat Exchanger Room.
    - c. Level 62 Condenser Water Pump Room.
    - d. Level 63 Cooling Towers.
    - e. Level 2 Heating Hot Water Plant.
    - f. Level 34 Heating Hot Water Pump Room.
- C. Power fed from emergency power circuits shall be provided with junction boxes at the following locations:
  - 1. Central Cooling Plant - Two 120 Vac, 20 amp circuits.
  - 2. Level 36 Chilled Water Pump Room - One 120 Vac 20 amp circuit.
  - 3. Level 62 Pump Room - Two 120 Vac, 20 amp circuits.
  - 4. Heating Hot Water Plant - Two 120 Vac, 20 amp circuits.



5. Level 34 Heating Hot Water Pump Room - One 120 Vac, 20 amp circuit.
  6. Each AHU - One 120 Vac, 20 amp circuit.
  7. Fire Pump Rooms - One 120 Vac, 20 amp circuit.
  8. Domestic Pump Rooms - One 120 Vac, 20 amp circuit.
  9. Main Electrical Rooms - One 120 Vac, 20 amp circuit.
  10. Level P2 and P1 Garage Electrical Rooms - One 120 Vac, 20 amp circuit.
- D. Power shall be provided to the UC serving constant volume toilet exhaust air terminal units via the power sources above.
- E. Power shall be provided to the UC serving fan powered VAV terminal units via the control transformer provided with the unit.
- F. Power shall be provided to the dampers interlocked to fans via the control transformer provided with the motor starter.
- G. All components of the BMCS shall be powered from the sources above. Provide final terminations from the locations indicated on the Electrical Drawings.
- H. The BMCS subcontractor shall confirm within the bid submittal that the sources and locations of electrical power shown on the Electrical Drawings are adequate for the proposed BMCS. Any additional provisions requested shall be added to the Electrical scope of work. If confirmation is not received, or power is required for the BMCS in addition to that requested or confirmed, then the additional power shall be provided by the BMCS subcontractor at no additional cost to the Owner. This shall include all conduit, cabling, circuit breakers, interfaces, etc. All electrical power cabling, conduit, etc. provided by the BMCS subcontractor shall meet the requirements detailed in the Electrical Contract Documents.

## 2.6 CONTROL POWER TRANSFORMERS

- A. Provide 24 VAC power transformers with appropriate primary voltage rating as required. 24 VAC power transformers shall meet, at minimum, the following requirements:
1. Input frequency of 50/60 Hz.
  2. 24 VAC Secondary with internal circuit breaker.
  3. Rated at minimum 96 VA.
  4. Foot mounted.
  5. Temperature range of -0 Deg. C. to 40 Deg. C. (32 Deg. F. to 104 Deg. F.).
- B. Provide panel enclosure for each transformer meeting the panel requirements within this section of the specifications. The transformer and UPS may utilize a single panel enclosure. The transformer enclosure shall not contain other BMCS components unless properly shielded from other components within the panel enclosure,
- C. 24 VAC power transformers shall be Kele & Associates RIB TR series or approved equal.

## 2.7 OIW UN-INTERRUPTIBLE POWER SUPPLY (UPS)

- A. Provide UPS units at locations as required in the OIW and NDS specifications. The UPS units shall meet, at minimum, the following requirements:
1. 1400 VA or larger to handle the continuous full load use of all connected equipment for a period of five (5) minutes.
  2. Audible alarm when main power is not available to the equipment.
  3. RF noise filtering.
  4. Over voltage protection.
  5. Four outlet receptacles.
  6. Visual alert status light.
  7. Sealed maintenance free batteries.
  8. Desktop mount type unit.
- B. UPS unit shall be APC or approved equal.

## 2.8 PANEL MOUNTED UN-INTERRUPTIBLE POWER SUPPLY (UPS)

- A. Provide UPS units at panel locations as required in the controller specifications. The UPS units shall meet, at minimum, the following requirements:
  - 1. 100 VA or larger to handle the continuous full load use of all connected equipment for a period of five (5) minutes.
  - 2. Audible alarm when main power is not available to the equipment.
  - 3. RF noise filtering.
  - 4. Over voltage protection.
  - 5. Two outlet receptacles.
  - 6. Visual alert status light.
  - 7. Sealed maintenance free batteries.
- B. Provide panel enclosure for each UPS meeting the panel requirements within this section of the specifications. The transformer and UPS may utilize a single panel enclosure. The UPS enclosure shall not contain other BMCS components unless properly shielded from other components within the panel enclosure,
- C. UPS unit shall be APC or approved equal.

## 2.9 CONDUIT AND FITTINGS

- A. Provide all conduit, raceways, and fittings for the BMCS monitoring, communication, and control cabling. All work shall meet all applicable codes.
- B. Conduit shall be provided whenever one of the following conditions exists:
  - 1. Conduit is required by code.
  - 2. Conduit is indicated on the drawings or specifically required by the specifications.
  - 3. Cabling runs through inaccessible areas such as within partitions/walls, above closed in ceilings, under slab, within trenches on the exterior of the building, when encased in concrete or other material that makes the cable inaccessible or when located such that access to the cable is not readily obtained.
  - 4. Cable within mechanical, telecommunications and electrical equipment rooms and control rooms.
  - 5. Cable run on the exterior of the building.
  - 6. Cable run on an exposed surface.
  - 7. Conduit shall be provided for all MLAN communication (Ethernet TCP/IP or equivalent) cable.
- C. Conduit exposed to the weather, in concrete slabs, in hazardous locations shall be rigid steel conduit. Rigid steel conduit shall meet, at minimum, the following requirements:
  - 1. Conduit shall have a cross section formed with a sufficient degree of accuracy to permit the cutting of clean, true, full threads. Conduit shall be joined with pipe couplings and shall be secured in cabinets, outlets, etc. with double locknuts. Conduits terminating in cabinets, outlets, etc., shall be provided with Midwest Catalog Number 931 to 942 or approved equal steel insulating bushings. Cast metal or pot metal fittings are not acceptable. Couplings, etc. shall be threaded.
  - 2. Hot dipped galvanized inside and out.
  - 3. Where exposed to weather, rigid steel conduit shall be Robroy Industries "Plasti-Bond-Red" complete with "Plasti-Bond-Red" fittings or approved equal plastic coated nonflexible metal conduit and fittings. Exposed threads, damaged coatings, etc. shall be field coated with Robroy Industries "Plasti-Bond-Red Touch Up" or approved equal.
  - 4. Full lengths of pipe shall have galvanized or zinc coated threads on both ends.
  - 5. Running threads shall not be used. Where such a device is required, use T&B "Erickson" Type union or O.Z./Gedney Type SSP split coupling or approved equal.
- D. All other conduit shall be Electrical Metallic Tubing (EMT). EMT shall meet, at minimum, the following minimum requirements:
  - 1. Formed with a sufficient degree of accuracy to permit the use of connectors. EMT shall be joined with Midwest Catalog Nos. 460-469 steel couplings or approved equal. EMT and rigid steel conduit shall be joined with Midwest Catalog Nos. 420-422 steel couplings or approved equal. Conduits shall be secured with Midwest Catalog Nos. 1450-1459 or approved equal steel set screw type insulated connectors at panels, junction boxes,

- outlets, etc. All connectors and couplings, etc. shall be steel and setscrew type. Die cast type connectors are not acceptable.
2. At the Subcontractor's option, metallic tubing using "Unicouple" Type connectors may be used instead of tubing and individual couplings. Where "Unicouple" connectors are used in vertical conduit runs, all flared conduit ends shall be oriented downward to prevent moisture from being "funneled" into the conduit.
- E. At the option of the Subcontractor, PVC conduit may be used instead of steel rigid conduit if approved by the Structural Engineer only where routed underground or in concrete slabs. PVC is not allowed in any other locations. PVC conduit shall meet, at minimum, the following minimum requirements:
1. UL approved Schedule 40 extruded Type II high impact virgin polyvinyl chloride conduits, similar and approved equal to Carlon PVC conduit.
- F. Flexible metal conduit shall be steel and shall only be used for connections to the following:
1. Motors.
  2. Equipment and devices requiring adjustment or removal for maintenance.
  3. Air handling units.
  4. Air terminal devices.
  5. Fan coil units.
  6. Ventilation fans.
- G. If it complies with these Specifications, conduit and fittings manufactured by one of the following manufacturers shall be acceptable:
1. Rigid Steel and Intermediate Metal Conduit:
    - a. Allied.
    - b. Republic.
    - c. Triangle.
    - d. Western.
    - e. Wheatland.
  2. Rigid Steel and Intermediate Metal Conduit Fittings:
    - a. Appleton.
    - b. Crouse-Hinds.
    - c. Efcor.
    - d. Midwest.
    - e. O. Z./Gedney.
    - f. Raco.
    - g. Spring City.
    - h. Steel City.
    - i. Thomas and Betts.
  3. Rigid Steel Conduit and Fittings(exposed to the weather):
    - a. Occidental Coating Company.
    - b. Perma-Cote.
    - c. Robroy Industries "Plasti-Bond-Red".
    - d. Triangle.
  4. Rigid Aluminum Conduit and Fittings:
    - a. Alcoa.
    - b. Harvey.
    - c. Kaiser.
    - d. Reynolds.
  5. Electrical Metallic Tubing (EMT):
    - a. Allied.
    - b. Republic.
    - c. Robroy Industries.
    - d. Triangle.
    - e. Western.
    - f. Wheatland.
  6. Flexible Metal Conduit:
    - a. AFC.
    - b. ALFLEX.
    - c. American Metal Molding.
    - d. Anaconda.

- e. Cerro.
  - f. International Metal Hose.
  - 7. Flexible Metal Conduit Fittings:
    - a. Appleton.
    - b. Efcor.
    - c. Midwest.
    - d. OZ/Gedney.
    - e. Raco.
    - f. Steel City.
    - g. Thomas and Betts.
  - 8. Liquid Tight Flexible Metal Conduit:
    - a. American Brass Company.
    - b. Anaconda (Type "UA").
    - c. Electri-Flex Company.
  - 9. Liquid Tight Flexible Metal Conduit Fittings:
    - a. American Brass Company.
    - b. Midwest.
    - c. O.Z./Gedney.
  - 10. Rigid Nonmetallic Electrical Conduit and Fittings:
    - a. Cantex
    - b. Carlton
    - c. Certain Teed.
    - d. Triangle.
- H. Coordinate installation of conduit with building structure and other trades. Conduit installation above accessible ceilings shall be such that there shall be no interference with the installation of lighting fixtures, fire protection, air outlets or other devices.
- I. BMCS monitoring and control cable shall not share conduit with cable carrying voltages in excess of 48 volts.

**2.10 MONITORING AND CONTROL CABLE**

- A. Provide all cables for the BMCS. Cable shall meet, at minimum, the following requirements:
1. Sized, at minimum, in accordance with the following:

Application	Cable Type
Analog Input	18 AWG with overall shield
Analog Output	18 AWG without shield
Digital Input	18 AWG without shield
Digital Output	18 AWG without shield
Management Level LAN	24 AWG Category 6
Management Level LAN - Link between Level 2 and Level 62	Quad Bundle Fiber Optic Cabling
Field Level LAN	22 AWG without shield
Modbus Software Interface	22 AWG with overall shielded
BACnet TCP/IP Interface	24 AWG Category 6
BACnet MS/TP Interface	22 AWG without shield
LONWorks Software Interface	22 AWG without shield

2. Cable shielding shall be as indicated above unless the manufacturer of the instrumentation or component recommends against the use of shielded cable. Shield shall be grounded at the DCP, UC, or control panel. Ground at one end only to avoid ground loops.
3. Conductors shall be 98 percent minimum conductivity stranded copper.
4. Proper impedance for the application as recommended by the BMCS component manufacturer.
5. Continuous runs without splices.
6. Identification of each end at the termination point. Identification should be indicated on and correspond to the record drawings.
7. All cabling installed without conduit in plenum spaces shall be suitably rated for the

application and the cable jacket shall meet the following:

- a. Unique color to the job. Color to be coordinated with all other trades.
- B. 120 VAC power wiring shall be of #12 AWG solid conductor or larger as required and shall meet the requirements of the Electrical specifications.
- C. Terminations shall be mechanically and electrically secure. Twist type wire nuts shall not be acceptable.
- D. Cable within panels or enclosures shall be installed in wiring guides.
- E. All wiring terminations within field panels shall be terminated at terminal stripes and shall be identification tagged on both sides of the terminal strip.

## 2.11 FIBER OPTIC CABLE

- A. Fiber optic cable shall be utilized, at minimum, to interconnect the Level 2 Central Cooling Plant and Level 62 Pump Room MLAN switches. Additional fiber optic cable may be utilized for data communication at the BMCS subcontractor's option.
- B. Fiber optic cable (data transmission) shall meet, at minimum, the following requirements:
  1. 62.5 micron core (multi-mode fiber).
  2. 850 nm or 1300 nm LED compatible operation, as required.
  3. Minimum 125 micron cladding.
  4. Maximum attenuation of 4.5 db/km (850 nm).
  5. Outdoor and below grade fibers shall be within gel filled tube to protect against moisture and micro-bending.
  6. Cable shall contain 400% more fibers than required for a single point-to-point communications connection.
  7. Outdoor fiber shall be equipped with a central non-conducting member for long pull applications.
- C. Fiber optic cable and associated equipment shall be selected such that the manufacturer's recommended optical budget loss requirements are satisfied for each application.

## 2.12 PANELS

- A. Provide panels and enclosures for all components of the BMCS, which are susceptible to physical or environmental damage.
- B. Interior panels and enclosures shall meet, at minimum, the following requirements:
  1. NEMA 1 rated painted steel panels with locking door.
  2. Ventilated to prevent excessive heat build-up, where required.
  3. Field cabling shall be terminated on a terminal strip fixed within the enclosure. Provide strain relief as necessary.
  4. Internal components shall be installed to allow easy access for diagnostics, maintenance, removal or replacement of any component within the enclosure.
  5. Cabling shall be neatly installed within wire guides with removable covers for easy access.
- C. Exterior and garage mounted panels and enclosures shall meet, at minimum, the following requirements:
  1. NEMA 4 painted steel panels with locking door.
  2. Field cabling shall be terminated on a terminal strip. Provide strain relief as necessary.
  3. Internal components shall be installed to allow easy access for diagnostics, maintenance, removal or replacement of any component within the enclosure.
  4. Cabling shall be within wire guides with removable covers for easy access.
- D. Panels and enclosures shall be located as follows:
  1. Chilled water Plant.
  2. Boiler Plant.
  3. Heat Exchanger Rooms.
  4. Level 62 Pump Room.

5. OAHU and AHU Rooms.
  6. Generator Room.
  7. Pump Rooms.
  8. Main Electrical Rooms.
  9. Stairwell pressurization fans.
  10. Garage electrical Rooms.
- E. All panels shall be lockable with the same key, which shall be unique to the building. Provide the Owner with ten keys.
- F. Panels and enclosures shall be wall mounted or freestanding as required by the location and available space. Provide miscellaneous metals and uni-strut supports as necessary to support freestanding panel locations.

### 2.13 LABELING

- A. Provide labeling for all CCP, DCP, UC, panels and enclosures. Labeling shall meet, at minimum, the following requirements:
1. Plastic laminated label, which shall be affixed to the DCP, UC, panel or enclosure with rivets or permanent adhesive.
  2. Lettering 6mm (0.25 inch) high, which sharply contrast the background color.
  3. Consistent throughout the project.
  4. Indicated and cross referenced in the record documentation.
- B. Provide labeling of all cables. Labeling shall meet, at minimum, the following requirements:
1. Each cable shall be identified with a permanent tag or self-adhesive label within the panel.
  2. Cable identification shall be cross-referenced on the associated record documentation and a copy of the drawing(s) mounted within the panel enclosure.
  3. Cabling shall be machine generated. Hand written labels shall not be permitted.

### 2.14 WARNING NOTICES

- A. Provide warning notices at all equipment controlled by the BMCS and at all associated motor starters. Warning labels shall be installed, at minimum, at the following locations:
1. AHU plenum doors.
  2. AHU motor starter, MCC and/or VSD.
  3. Pump motors.
  4. Pump motor starter, MCC and/or VSD.
  5. Fan enclosure or access panel.
  6. Fan motor starter, MCC and/or VSD.
  7. Chilling unit control panel.
  8. Chilling unit disconnect/power panel.
  9. Cooling tower starter, MCC and/or VSD.
  10. Boiler unit control panel.
  11. Boiler unit disconnect/power panel.
- B. The warning notices shall be 3 inches by 5 inches minimum, with yellow background and black lettering. The notices shall state the following:

<p><b>CAUTION</b> THIS EQUIPMENT STARTS AND STOPS AUTOMATICALLY</p>
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- C. The warning notices shall be securely attached to the equipment at a location approved by the Owner and shall be highly visible. Submit a sample with the shop drawing submittal.

### 2.15 ENGINEERING OIW DESK

- A. Provide two operator desks within the Engineering Office and one operator desk within the Level 62 Pump Room. Install all required system equipment as detailed within these documents.

- B. The desk shall meet the following additional requirements:
  - 1. Six feet wide.
  - 2. PC storage self below the work surface.
  - 3. Paper storage shall be below the work surface with feed slots to above alarm printer as necessary.
  - 4. Laminate top and edge front.
  - 5. Keyboard pull out tray.
  - 6. One shallow pullout pencil drawer.
- C. Desk shall be manufactured by Winsted or approved equal.

### **PART 3 - EXECUTION**

#### **3.1 BORING**

- A. Provide all cutting, boring and patching of work as required for a complete BMCS. Boring and patching shall meet, at minimum, the following requirements:
  - 1. Prior to boring any structural components, obtain the Owner's approval.
  - 2. Perform x-rays of the respective areas prior to boring. Coordinate x-rays with the Owner.
  - 3. Bores shall have clean, square and smooth edges. Patches shall be inconspicuous in covered areas and visually undetectable in areas normally accessible to the tenants.
  - 4. Restore fire ratings if boring has violated the fire rated assemblies.
  - 5. Boring and cutting shall be kept to a minimum and conducted in a neat and workmanlike manner. Provide reinforcing and fastening materials as necessary.
  - 6. Boring and patching that has become necessary due to improperly installed sleeves shall be done at no additional cost to the Owner.

#### **3.2 SLEEVES, CUTTING, PATCHING AND FIRE STOPPING**

- A. The Subcontractor shall be responsible for the timely placing of sleeves as detailed on the Drawings and the Coordination Drawings for all piping and conduit through walls and partitions, beams, floors and roofs as noted below, while the same are under construction:
  - 1. All concrete or masonry construction.
  - 2. Wall construction where the penetration must be sealed air tight. Patches for penetrations through walls for Work installed prior to finish application shall be provided by others.
  - 3. Fire rated wall construction.
  - 4. Where indicated on the Drawings.
- B. Sleeves shall be at least one size larger than the size of conduit or pipe, including the insulation where applicable; it serves except where "Link Seal" casing seals are used in sleeves through walls below grade. Sleeves shall be sized such that the annular space between the sleeve and the conduit shall not be less than 1/2 inch. All conduits passing through concrete or masonry walls above grade shall be at least 18 gauge galvanized steel sleeves. Sleeves shall be set flush with finished wall. All sleeves in floors shall extend a minimum of 2 inches above the finished floor. Sleeves installed in fire rated construction shall be of suitable length and diameter to accommodate the firesafing system used. Sleeves set in concrete floor construction shall be at least 16 gauge galvanized steel. Where the conduit passes through a sleeve, no point of the conduit shall touch the sleeve and the conduit shall be centered in the sleeve.
- C. Seal all penetrations in fire rated construction with factory built devices or with manufactured fill, void or cavity materials "Classified" by Underwriters Laboratories, Inc. for use as a Through Penetration Firestop. All firestop devices and systems shall be approved for such use by the authorities having jurisdiction. The firestop system used shall maintain the fire resistance rating of the building component that is penetrated. Firestop systems and devices shall comply with ASTM E 814 (UL 1479) for all types of penetrations being sealed. Submittal data for firestop systems shall include the applicable UL System Numbers. Excessive shrinkage of the firestop materials, which would permit the transmission of smoke or water prior to exposure to a fire condition, is unacceptable. Where a mastic coating is used to seal the surface of the firestop, the mastic shall be non-hardening. The firestop manufacturer's representatives shall instruct the Subcontractor's representatives in the proper installation procedures so that the penetrations on the Project shall be

installed in accordance with the UL listing and the manufacturer's recommendations. If it complies with these Specifications, firestop sealing component/system as manufactured by one of the following manufacturers shall be acceptable:

1. Tremco Fire Resistive Joint System using Dymeric sealant and Cerablanket-FS mineral filler.
  2. Specified Technologies, Inc. SpecSeal Systems.
  3. 3M Fire Barrier Penetration Sealing Systems.
  4. GE Pensil Firestop Sealant by General Electric.
  5. International Protective Coatings Corp. Flame Safe Systems.
  6. Thermal Ceramics Fire Master Firestop Fire Protection Systems.
  7. Hilti FS-601 Systems.
- D. Sleeves penetrating walls below grade shall be standard weight galvanized steel pipe with 1/4 inches thick steel plate water seal secured to the pipe with continuous fillet weld. The water seal plate shall be located in the middle of the wall and shall be 2 inches wider all around than the sleeve it encircles. The entire assembly shall be hot dipped galvanized after fabrication. Seal off annular opening between pipe and sleeve with "Link Seal" type casing seal as manufactured by Thunderline Corporation or Innerlynx. The pipe sleeve shall be sized to accommodate the Thunderline casing seal. Casing seals shall be Series 300 for pipe size 3/4 inches through 4 inches and Series 400 for pipe sizes 5 inches and larger.
- E. If holes and/or sleeves are not properly installed and cutting and patching becomes necessary, it shall be done at no additional expense to the Owner. The Subcontractor shall undertake no cutting or patching without first securing the Architect's written approval.
- F. All unused sleeves shall be sealed with firestop devices and systems to maintain the fire rating of the construction penetrated.

### 3.3 HANGING AND SUPPORTING

- A. Install all equipment, devices, materials and components in compliance with the manufacturers' recommendations. Supports shall be suitable for the environment within which the component is to be installed. Coordinate all hanging and supporting of components with all trades.
- B. Structural support members shall be galvanized.

### 3.4 EXCAVATION AND BACKFILL

- A. Make all necessary excavations, cutting of paving, concrete and etc., removal of unusable spoil material, do all backfilling with stabilized with stabilized fill and do temporary patch type paving repairs necessary for the proper execution of the Work. Remove all dirt and debris out of and away from the building as directed. Backfill shall be mechanically compacted to a density of ninety-five percent of the maximum dry density at optimum moisture content as determined by the Standard Proctor Compaction Test.
- B. Backfill shall be compacted and repairs to paving or concrete shall be accomplished to the satisfaction of the Architect and the local authorities having jurisdiction.
- C. See the various sections of the Specifications for additional excavation and backfill requirements.

### 3.5 TUBING AND PIPING

- A. Provide tubing and piping as required for the field instrumentation specified in the BCMS Field Devices - Air section of these specifications.
- B. Tubing within mechanical rooms, vertical risers, and penetrations to ductwork shall be either copper pipe or shall be plastic tubing within conduit. Identify the type of tubing proposed in the shop drawing submittal.
- C. Provide suitable bulk head fittings for duct and panel penetrations.
- D. Tubing in plenum rated areas shall be plastic tubing. Plastic tubing shall meet, at minimum, the



following requirements:

1. Flame retardant.
2. Crack resistant.
3. Polyethylene tubing.
4. 300 psi burst pressure.

### 3.6 STATIC PRESSURE REFERENCE RISER

- A. Provide a pipe riser located in the East Mechanical Room from level two to the roof of the building to serve as the static pressure reference point for each floor.
- B. The pipe riser shall be copper and shall meet the following requirements:
  1. Type "L" copper pipe.
  2. Copper pipe shall be manufactured in the United States by Cerro, Halstead, Mueller, Wolverine or approved equal.
  3. Copper pipe fittings shall be Arco, Elkhart, Grinnell, Mueller, Nibco or approved equal, wrought copper joint fittings.
  4. Copper fittings shall be soldered with ASTM B 32-76 Grade 95TA tin antimony solder. Solder or brazing alloys that contain lead will not be acceptable.
  5. Subcontractor may use a "T-Drill" joining system with brazed joints at the "T-Drill" connections in lieu of copper fittings for copper branch piping.
  6. Provide one-quarter inch tap and manual isolation valve on each floor for floor static pressure reference point connection.
  7. Riser shall be open at the top of the building (penthouse) and at the bottom of the building (level 2 outside air intake). Provide a full line size manual isolation valve at level 30 such that if the valve is closed, the upper riser is completely isolated from the lower riser.
  8. Provide dampening pots at the top and bottom of the where it is open to atmosphere.
  9. Provide suitable support members for riser.
  10. Minimum size shall be 2 inches.
- C. Pipe riser shall be run adjacent to the mechanical pipe risers. Refer to Mechanical Documents for identified location.

### 3.7 CONDUIT INSTALLATION

- A. Nonflexible Metal Conduit shall be installed in accordance with the following requirements:
  1. Nonflexible metal conduit shall be sized in accordance with the percent fill requirements of the National Electrical Code and as indicated on the Drawings and shall be of ample size to permit the ready insertion and withdrawal of conductors without abrasion. No nonflexible metal conduit shall be smaller than 1/2 inches. Grouping of "home runs" is acceptable only where the number of conductors indicated on the Drawings is maintained and the proper National Electrical Code derating factors are applied.
  2. Nonflexible conduit, including both rigid conduit and nonmetallic (PVC) conduit, shall not be embedded in any structural slabs, unless specifically noted on the Drawings. The specifically noted nonflexible conduit to be embedded in any structural slab shall be installed strictly in accordance with the Project Structural Engineer's specific written instructions. Forward two copies of the Project Structural Engineer's written approval and instructions for installation to the Engineer for his file prior to proceeding with the installation. Nonflexible conduits embedded in structural slabs shall have watertight joints.
  3. Conduit in finished portions of the building, except in mechanical and electrical equipment rooms or where otherwise indicated on the Drawings, shall be concealed. Concealed nonflexible metal conduits shall be run in as direct a manner and with as long a bend as possible. Exposed nonflexible metal conduit shall be run parallel to or at right angles with the lines of the building. All bends shall be made with screw jointed conduit fittings or with standard ells in which the conduit is bent to a radius not less than that shown in Table 346-10 of the National Electrical Code. All bends shall be free from dents or flattening. Not more than the equivalent of four-quarter bends shall be used in any run between terminals and cabinets or between outlets and junction or pull boxes.
  4. Nonflexible metal conduit shall be continuous from outlet to outlet and from outlet to cabinets, junction or pull boxes and shall enter and be secured at all boxes in such a manner that each system shall be electrically continuous throughout.

5. Terminals of all nonflexible metal conduits shall be furnished with bushings, locknuts, connectors, etc., as specified herein. All joints shall be cut square, reamed smooth and drawn up tight.
  6. So far as is practicable, all exposed nonflexible metal conduit shall be run without traps. Where traps or dips are unavoidable, a junction or pull box shall be placed at each low point.
  7. Nonflexible metal conduit hangers and fasteners shall be of the type appropriate in design and in dimensions for the particular applications and shall be securely fastened in place as specified herein.
  8. Each entire nonflexible metal conduit system shall be installed complete before any conductors are drawn in. To guard against obstructions and omissions, each run of conduit shall be finished before gypsum board is installed. All nonflexible metal conduits shall be swabbed after plaster is finished and dry.
  9. As soon as nonflexible metal conduit has been permanently installed in place, conduit ends shall be capped or plugged with standard accessories.
  10. Nonflexible metal conduit shall be provided with pull boxes of approved sizes after two right angle bends and at intervals not exceeding 125 feet in addition to those shown on the Drawings. Boxes shall be in accessible locations.
  11. A 1/8 inches braided polypropylene rope or #14 galvanized iron fish wire shall be left in all empty nonflexible metal conduit systems. At least 12 inches of properly secured rope or wire shall be folded back into each end of the empty nonflexible metal conduits.
  12. Furnish and install OZ/Gedney Company expansion fittings, Type DX for rigid metal conduit, Type EX for rigid metal conduit exposed to the weather and Type TX for electrical metallic tubing (EMT) or equivalent manufactured by Appleton, Crouse-Hinds or Steel City, where nonflexible metal conduits cross building expansion joints. Refer to the Electrical Grounding specifications in the Electrical division.
  13. Nonflexible metal conduit installed in the ground shall have watertight joints and shall be painted the entire length with two coats of protective finish. All coating shall be applied in accordance with the manufacturer's recommendations. The entire length of nonflexible metal conduit, including fittings, in contact with the ground, to a point 6 inches above the ground (or concrete slab) shall be completely coated subject to the Engineer's approval.
  14. In areas designated as Class I, Division 2 hazardous areas, rigid metal conduit (or liquid tight flexible metal conduit for motor terminations) with approved terminations and fittings shall be used. The Class I, Division 2 hazardous areas shall be as defined by the authorities having jurisdiction for this Project.
  15. Prior to the installation of any plastic coated nonflexible metal conduit, the Subcontractor shall submit a 12 inches Sample of the proposed conduit and miscellaneous materials for review by the Consultant. Samples of standard galvanized conduits are not required.
  16. Submit review a list of the proposed manufacturers of nonflexible metal conduit and fittings selected from the manufacturers listed herein. The Subcontractor may install nonflexible metal conduit and fittings furnished by any manufacturer listed on the submittal.
- B. Flexible Metal Conduit shall be installed in accordance with the following requirements:
1. Continuity of the equipment ground across flexible metal conduit connections shall be maintained for all systems that are over 150 volts to ground. The continuity shall be maintained by installing a grounding conductor sized in accordance with the current National Electrical Code. The grounding conductor shall be inside the flexible conduit and shall be connected on one end of the flexible metal conduit by a suitable binding post and similarly connected on the opposite end with another suitable binding post. All grounding conductors shall be solid copper conductors.
  2. For flexible metal conduit sizes 1-1/4 inches and smaller and lengths of 6 feet or less, UL listed liquid tight flexible conduit with grounding provisions and watertight fittings may be used in lieu of a flexible metal conduit and separate grounding conductor described above in accordance with Article 351 of the National Electrical Code, "Liquid Tight Flexible Conduit".
  3. Flexible metal conduit shall be secured with Midwest Catalog Nos. 1708-1715 or approved equal insulated throat clamps. Liquid tight flexible metal conduit shall be secured with Midwest Catalog Nos. LTB-38 through LTB-300 or approved equal insulated throat watertight fittings and shall be used where subject to weather or moisture conditions. Connectors shall be steel type. Die cast connectors shall not be acceptable.

- C. PVC Conduit shall be installed in accordance with the following requirements:
1. All types of conduit joints shall be made up using plastic couplings in accordance with the manufacturer's recommendations. The tapered ends of joints shall be swabbed with bituminous or joint sealing compound to provide a watertight joint before the coupling is applied.
  2. A 1/8 inches braided polypropylene rope or #14 galvanized iron fish wire shall be left in all empty conduit systems. At least 12 inches of properly secured rope or wire shall be folded back into each end of the empty conduits.
  3. Where PVC conduit emerges from underground or concrete, a transition from PVC to nonflexible metal conduit must occur allowing no PVC conduit to be installed within any space inside the Project.
- D. Additional requirements and installation standards (i.e. use of FS junction boxes, etc.) identified in the Electrical Documents shall also apply to the BMCS scope of work.

### 3.8 CONDUIT HANGERS AND SUPPORTS

- A. All horizontal conduits throughout the building shall be thoroughly and substantially supported with individually approved expansion ring hangers or supported in groups using Unistrut or Kindorf channels and suitable hangers. Hangers shall not be spaced more than 10 feet apart. Perforated extension bar hangers shall not be accepted in any part of the Work. All vertical conduits shall be substantially supported at floor lines to carry the weight of the conduit and cable in a satisfactory manner with allowance for expansion and contraction. Special hangers and supports shall be provided where they may be required because of any peculiarities of construction. Where exposed to weather, conduit hangers and supports shall be Robroy Industries "Plasti-Bond-Red" or approved equal. Damaged hangers and supports shall be field coated with Robroy Industries "Plasti-Bond-Red Touch Up" or approved equal. Hanger rod sizes shall be as recommended by the hanger manufacturer for the service intended.
- B. At the Subcontractor's option, subject to the approval of the local authorities having jurisdiction, conduit systems up to a maximum conduit size of 3/4 inches may be substantially and individually supported in accordance with NEC spacing using #12 AWG galvanized tie wire and other supplementary braces as required by the National Electrical Code to provide rigid support. Multiple conduits fastened to individual tie wires are not acceptable. Suspending or supporting conduits from any ceiling support system shall not be acceptable.

### 3.9 PLENUM RATED CABLE INSTALLATION

- A. All cable that is exposed within air plenum spaces shall be plenum rated cable. Plenum rated cable shall be routed parallel and perpendicular with the building column lines. Cable may follow ductwork routing and may be fixed to the top or side of the ductwork. If cabling does not follow the ductwork routing, it shall be fixed tight to the structure above. Provide cable rings and supports, at minimum, 15 feet intervals to support the cabling. Submit proposed cable routing pathways within the shop drawings.

### 3.10 BELOW RAISED FLOOR PLENUM RATED CABLE INSTALLATION

- A. All cable that is exposed within air plenum spaces shall be plenum rated cable. Plenum rated cable shall be routed parallel and perpendicular with the building column lines. Cable may be fixed to the raised floor riser supports with cable rings or hooks. Provide cable rings and supports, at minimum, 15 feet intervals to support the cabling. Submit proposed cable routing pathways within the shop drawings.

**END OF SECTION**