FAA
Air Traffic Organization

Technical Specifications

MAJOR MECHANICAL SUSTAIN
DENVER, CO ARTCC

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SECTION 01 10 00 - SUMMARY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Project information.
2. Work covered by Contract Documents.
3. Work under separate contracts.
4. Access to site.
5. Coordination with occupants.
6. Work restrictions.
7. Specification and Drawing conventions.
8. Miscellaneous provisions.

B. Related Requirements:

1. Section 015000 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

1.3 PROJECT INFORMATION

A. Project Identification: Chiller/Cooling Tower Modernization.

1. Facility: Air Route Traffic Control Center (ARTCC)
2. Project Location: 2211 17th Avenue, Longmont, CO 80501

B. Owner: U.S. Department of Transportation, Federal Aviation Administration (FAA).

1. Owner's Representative: Contracting Officer.

1.4 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of Project is defined by the Contract Documents and consists of, but is not limited to, the following:

1. Mechanical

a. Chiller Plant

(i) Remove& replace Chillers 100 and 200.

(ii) Remove & replace all related control points.

(iii) Demolish and replace all associated piping to isolation valves.

(iv) Retain parts to be used by chillers 300 and 400.

(v) Flow, temperature, pressure, and any other related sensors for all chillers and Purge Units shall be replaced.

(vi) Provide and install new flat plate heat exchangers.

(vii) Remove & replace condenser and chilled water pumps and motors.

(viii) All pumps for chilled water (P1A, P1B, P1C, P1D) and all pumps for condenser water (P3A, P3B, P3C).

(ix) Replace DDC panel. Upgrade to Schneider Electric StruxureWare.

(x) Add/ replace isolation valves where necessary.

(xi) Provide, install, and maintain temporary chiller units and other associated equipment as needed, in coordination with FAA facility personnel.

b. EF 310

(i) Verify code compliance of fan, and ducting for new refrigerant of chillers.

(ii) Demolish and install new damper actuators.

(iii) Remove and replace exhaust fan EF-310.

c. Condensing Plant

(i) Remove & replace Cooling Towers.

(ii) Includes all associated piping.

(iii) Redoing the trough guard outside and inside the pump house.

(iv) New trough level sensors.

(v) New insulation to protect from freezing.

(vi) Upgrade all controls to Schneider Electric StruxureWare.

(vii) Provide, install, and maintain temporary cooling tower units and other associated equipment as needed, in coordination with FAA facility personnel.

d. Pump House

(i) New unit heater.

(ii) New trough guard that will seal better than existing.

(iii) Isolation valve on header.

(iv) New Flat Plate Heat Exchanger (New Free-Cooling method).

e. Control Wing Basement (CWB)

(i) Remove and replace CRAC units: AHU-22, AHU-104 through 109 and

associated ductwork

(ii) Remove & replace all piping, insulation, sensors and appurtenances up to branch isolation valve. Turn over old sensors to facility as spare parts; including, but not limited to, Temperature and Pressure sensors, Humidity and Freeze sensors.

(iii) Remove & replace all actuators and dampers for each CRAC.

(iv) Remove & replace humidifiers and condensate piping for AHU-22 and AHU-106 only.

(v) Run new conductors for each CRAC from their respective power panels.

(vi) Remove and replace AHU-400 and ducting as necessary.

(vii) Remove & replace smoke detectors.

(viii) Remove & replace humidifier, hose and its associated hardware.

(ix) Remove & replace condensate booster pump with permanent drain.

(x) Remove & replace all control and isolation valves, including actuators.

(xi) Remove & replace inlet damper and actuator.

(xii) Remove & replace all piping, insulation, sensors and appurtenances up to branch isolation valve, turn over old sensors to facility as spare parts, this includes, but is not limited to Temperature and Pressure sensors, Humidity and Freeze sensors, Strainer blowoffs, Automatic Air vents, and Pressure differentials.

(xiii) Add balancing valves to HWR and CWR piping.

(xiv) Convert as-built shop drawings to FAA standard baseline drawings.

f. Building Automation Controls

(i) Restore existing Schneider Electric controls, including appropriate modifications as required, to achieve full operational status.

(ii) Remove and replace any existing non-Schneider Electric controls systems for equipment impacted by the other work described herein. New control systems shall consist of equipment manufactured by Schneider Electric.

(iii) Coordinate the installation of all building automation controls with the Schneider Electric / FAA ARTCC Program Office. This may include utilization of a local subcontractor to be designated by the SE Program office.

(iv) Communications for the new and existing Building Automation Control Systems shall conform to BACnet protocols.

2. Architectural

a. Fire Stopping

(i) Inspect and augment fire-stopping as follows:

(ii) Walls/ceiling openings in B120A, B134, and B119.

(iii) Ramp at column line 11/C-C.

(iv) DSR floor.

(v) Wall/ceiling openings in rooms B115, B116 and B118.

(vi) Room B102.

b. Stairway 3

(i) Install swing gate at the first floor.

(ii) Install Emergency Light with battery backup at basement level.

c. HOST Mechanical Room

(i) Remove drop ceiling and acoustical wall panels.

(ii) Refit sprinkler heads and smoke detectors to fixed ceiling.

(iii) Add or remove smoke detectors and re-program fire panel if needed.

(iv) Remove wall panels and support structures and address wiring issues or equipment attached to panel structure, if required.

d. HOST Computer Room

(i) Clean existing neutral-colored panels.

(ii) Remove & replace red/orange panels with approved panels.

(iii) Remove and replace ceiling tiles.

(iv) Remove & replace existing ceiling tile grid and tiles.

(v) Provide support system for removable section of tiles and grid system above HC power panels.

(vi) Install seismic bracing on ceiling grid.

(vii) Remove & replace water cooler with model type which allows bottle filling.

e. Chiller Room

(i) Paint Walls and attached piping.

(ii) Repair the foundation slab leaking into the chiller and boiler room.

f. Floor Finishes

(i) Remove existing VCT and replace with epoxy coating flooring material in Rooms B115 and Room B118.

(ii) Remove & replace the boiler room, chiller room, and B116 ramp area floors with new interlocking tiles. Remove and replace cove base and transitions.

g. Pump House Addition

(i) As indicated on the contract drawings.

h. Control Wing Basement (CWB)

(i) Remove and replace doors and hardware as indicated on the contract drawings. Door frames to remain.

(ii) Provide new aluminum steps, landing, and guard rail in Room B101 (TelCo Room) at door to Room B120.

3. Electrical

a. Pump House

(i) Remove & replace three pump motors, P3A, P3B, P3C.

(ii) Install Variable Frequency Drives (VFDs) for new pump motors, P3-A, P3-B, P3-C.

(iii) Remove & replace existing disconnecting switches with local disconnect switches incorporating make-before-break auxiliary contact to protect the VFD from operation with open load conductors.

(iv) Re-locate or replace sump controls and level sensors.

(v) Remove & replace freeze protection equipment.

(vi) Remove & replace lighting with LED. Reuse existing Unistrut® for new

LED lighting fixtures.

(vii) Provide electrical power circuit for new unit heater in new Electrical Room addition.

b. Condensing Plant

(i) Electrically install cooling tower fan motors CT-1A, CT-1B and CT-1C.

(ii) Install Variable Frequency Drives for fan motors, CT-1A, CT-1B, CT-1C.

(iii) Remove & replace existing "e-Stop" switches with local disconnect switches incorporating make-before-break auxiliary contact to protect the VFD from operation with open load conductors.

(iv) Install lightning protection on new cooling towers and bond to existing grounding electrode conductor (counterpoise).

(v) Install new LED lighting on and under existing access platform and on exterior of cooling towers.

(vi) Install new 110Vac receptacle convenience outlets on new cooling towers.

(vii) Bond all metal structures to existing grounding electrode conductor.

c. Chiller Room

(i) Remove and replace Chilled Water Pumps, P1-A, P1-B, P1-C, and P1-D.

(ii) Install VFDs on Chilled Water Pump motors, P1-A, P1-B, P1-C, and P1-D. Remove all four existing disconnecting switches. Extend the existing Unistrut® for new VFDs if required to do so.

(iii) Coordinate with Mechanical team to upgrade to Schneider electric controls. Re-use existing conductors to the greatest extent possible.

(iv) Remove and replace Chiller 100 and Chiller 200 with new chillers. Coordinate with Mechanical team for demo, layout, and controls. Re-use existing conductors between the Essential Buss and the new chiller units if practicable. Splice by approved method, if required.

d. Other Chiller/Control Wing Basement

(i) Replace branch circuit wiring for MCC-1A, 1B, 1C & 1D as required for the completion of this project. Re-use conductors to the greatest extent possible.

(ii) Remove and replace 1st-level MCCs as designated in the contract documents.

(iii) Provide circuit breaker coordination between 1st-level motor control centers MCC-A, B, & C with any new CBs installed in MCC-1A, 1B, & 1C.

(iv) Perform Harmonic Distortion testing at points of common connection (PCC) on feeder side of MCCs A, B, C. Install dynamic harmonic correction devices at these points, if required.

e. HOST Computer Room

(i) Install signal reference grid (SRG) under HOST computer room raised floor.

(ii) Install 4/0 grounding bare copper around the HOST room floor.

(iii) Remove/recondition the HC power panels and the transfer switches.

1. Remove existing conductors and branch circuit raceways.
2. Existing feeder raceway and enclosures are to remain.
3. Install new bus assemblies in panels HC-2 and HC-3
4. Install new Power Paragon transfer switches for panels HC-2 and HC-3.

a. Power Paragon Transfer switches will be purchased by FAA under a pre-existing contract prior to construction. Switches will be provided to contractor as Government Furnished Property (GFP).

(iv) Install new diffusion lenses in all 2'x4' lay-in trough-style luminaires.

f. B120A (Four-Channel Room)

(i) Demo all electrical work in demo area not related to general room lighting.

(ii) Provide electrical services for replacement of HVAC equipment.

g. Other Electrical

(i) Remove & replace lightning protection for AHU-400 unit.

(ii) Run new conductors for AHU-400 from power panel.

(iii) Remove and replace power conductors for AHU-22 in Room B119.

4. Other

a. Hazardous Materials

(i) Test/abate mold near the drinking fountain.

(ii) Test/abate mold in B119, HOST Mechanical Room.

(iii) EOF/NEOF area: Remove ACM by abating floor tile and mastic. ACM is trapped by walls built over floor tile and is entrapped. Demo area and build back to shell as administrative office area for RDC use. Include adding appropriate electrical for office furniture in wire duct installed in floorway. Paint area and install new floor tile and cove base.

b. Civil

(i) Test/replace underground hydronic piping.

(ii) Evaluate/modify cooling tower access platform.

(iii) Provide shelter in/at Pump House for VFD electrical enclosures:

1. Demo existing sidewalk.
2. Excavate for new foundation.
3. Construct new foundation and Electrical Room. Comply with all codes.
4. Install lightning protection system for new Electrical Room.

(iv) Non-destructive geotechnical investigation of all foundations.

(v) Code compliance.

c. Electronic Safety and Security

(i) Remove & replace refrigerant monitoring system.

(ii) Remove & replace fencing around cooling towers.

d. Fire Protection

(i) Reorient sprinkler heads in HOST room.

(ii) Reinstall smoke detectors in HOST room.

(iii) Install VESDA air sampling tubing in HOST room.

(iv) Install notification devices in Telco area.

(v) Code compliance.

e. Plumbing

(i) Remove & replace drinking fountain in HOST room with unit incorporating bottle filling feature.

f. Other

(i) Demo temporary offices in B120A.

(ii) Remove/Remove & replace wired safety glass that is no longer in compliance of code in area of B116 ramp area & CCMS room. Prime, clean, and repaint the window frames and walls in area.

(iii) Provide temporary services during demolition and reconstruction, including, but not limited to, temporary power, chillers, cooling towers, electrical panelboards, lighting, etc., as required. Temporary services will include electrical grounding and bonding in accordance with NFPA 70 (NEC) and lightning protection in compliance with NFPA 780. Lightning protection conductors, as well as grounding and bonding conductors, shall be copper. All lightning protection system materials shall be UL listed for lightning protection purposes. All temporary services/ utilities shall be subject to inspection and acceptance by the COR.

(iv) Other primary or incidental work as required by drawings, specifications or other contract documents.

5. Project Coordination

a. To facilitate trust-based team formation and early collaboration, after award, but prior to the Notice to Proceed, the contractor and major subcontractors are required to:

(i) Review the FAA 100% Chiller Plant Design package for any issues or oversights that, in their opinion may result in a less-than-optimal final product or installation, and offer suggestions for mitigation.

(ii) After the Contractor's review described in §1.4.A.5.a.(i), travel to the ZDV facility by qualified personnel of the Prime contractor, Mechanical subcontractor, and Electrical subcontractor to participate in an on-site constructability charrette of the final design. This on-site review will also include members of the FAA design engineering team and ZDV facility personnel (customers). The Constructability charrette will last four days and shall provide a thorough examination of the entire project.

(iii) After the Contractor's review described in §1.4.A.5.a.(ii), contractor shall have 60 days to assemble a submittal package, organized by discipline, Project Management, Mechanical, Electrical, Architectural, etc. Contractor shall then travel to the ZDV facility with qualified personnel of the Prime contractor, Mechanical subcontractor, and Electrical subcontractor for a second meeting to participate in an on-site review of the contractor's submittal package. This on-site review will also include members of the FAA design engineering team and ZDV facility personnel (customers). The Submittal Review meeting will last four days with a goal of reviewing and approving the majority of the contractor's submittal package.

(iv) After acceptance of the contractor's Schedule submittal by the FAA, travel to the ZDV facility by qualified personnel of the contractor's choosing, to participate in a third meeting for the development of a Project Risk Plan in compliance with FAA Order 6000.50E (attached). This on-site work group shall also include members of the FAA design engineering team, the equipment manufacturer's

team, and ZDV facility personnel (customers). The Risk Management Meeting will last for four days and shall provide a thorough examination of the project with the goal of identifying and mitigating FAA EOSH and Risk Management concerns.

Within 30 days of The Risk Management Meeting, contractor shall submit a Project Risk Plan that conforms to the template and example presented in the FAA 6000.50E order.

b. To facilitate the concepts of just-in-time delivery the contactor must commit himself and his subcontractors to off-site construction, to the greatest degree practicable. Manufacturer and suppliers used by the contractor must be willing to commit to a specific time of delivery from receipt of the Notice to Proceed at the time of the contract award.
c. The contractor must maintain the construction schedule and materiel delivery schedule on the site and update these schedules daily.
d. The contractor must participate in the commissioning process and provide normal start-up services at the completion of construction.
e. A qualified representative of the manufacturers of major equipment (chiller units, controls, cooling towers, etc.) must provide formal on-site training for ZDV facility personnel. The training shall be repeated for up to three (3) sessions to cover FAA personnel on rotating shifts.
f. Contractor must warrantee installation for a period on one year. Installation Warrantee period must start at the time the equipment is placed in service (Commissioning).

1.5 WORK BY OTHERS

A. General: Cooperate fully with Owner’s contractors so work on those contracts may be carried out smoothly, without interfering with or delaying Work under this Contract or other contracts. Coordinate the Work of this Contract with work performed under separate contracts.

B. Maintenance: Owner has awarded separate contract(s) for the following maintenance operations at Project site. Engage these entities as subcontractors to perform alterations or repairs to existing systems.

1. Dry-pipe Sprinkler Systems: To Delta Fire Systems for maintenance of sprinkler systems.
2. Direct Digital Control (DDC) Systems for HVAC: To Johnson Controls for maintenance of legacy HVAC controls.
3. Digital, Addressable Fire-Alarm System: To Alarm Control Company for maintenance of fire alarm systems.

C. Construction: Owner has awarded separate contract(s) for the following construction operations nationally. Engage these entities as subcontractors to perform New Work under this Contract.

1. Direct Digital Control (DDC) Systems for HVAC: To Schneider Electric for installation of HVAC controls at all ARTCC.

1.6 ACCESS TO SITE

A. General: Contractor shall have limited use of Project site for construction operations as indicated on Drawings by the Contract limits and as indicated by requirements of this Section.

B. Use of Site: Limit use of Project site to Work in areas indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.

1. Limits: Confine construction operations to the chiller room, pump house, cooling towers, and adjacent spaces necessary for construction operations.
2. Driveways, Walkways and Entrances: Keep driveways, loading areas, and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or for storage of materials.
    a. Schedule deliveries to minimize use of driveways and entrances by construction operations.
    b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.
    c. Dedicate deliveries to Project site to comply with Owner’s security requirements.

C. Condition of Existing Building: Maintain portions of existing building affected by construction operations in a weather tight condition throughout construction period. Repair damage caused by construction operations.

D. Condition of Existing Grounds: Maintain portions of existing grounds, landscaping, and hardscaping affected by construction operations throughout construction period. Repair damage caused by construction operations.

1.7 COORDINATION WITH OCCUPANTS

A. Full Owner Occupancy: Owner will occupy site and existing building(s) during entire construction period. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's day-to-day operations. Maintain existing exits unless otherwise indicated.

1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner.

2. Notify Owner not less than 72 hours in advance of activities that will affect Owner's operations.

1.8 WORK RESTRICTIONS

A. Work Restrictions, General: Comply with restrictions on construction operations. The work is at a critical facility that must remain operational 24 hours a day 7 days a week. The Contractor must not interfere with or disrupt air traffic operations. The work shall not discharge static electricity, damage, or interfere with other equipment at the facility, and shall not compromise security.

B. On-Site Work Hours: Limit work on Project site to normal business working hours of 6:30 a.m. to 4:30 p.m., **Monday through Friday**, unless otherwise indicated.

1. Early Morning Hours: 1:00 am to 5:30 am as directed by the Owner to prevent facility disruption.
2. Holidays: On-site work is not permitted on federal holidays.
3. Moratoriums: On-site work is not permitted the Friday before Thanksgiving through the Monday after Thanksgiving and the Friday before Christmas through the Monday after New Year’s Day.

C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated:

1. Notify Owner not less than ten days in advance of proposed utility interruptions.
2. Obtain Owner’s written permission before proceeding with utility interruptions.

D. Noise, Vibration, and Odors: Coordinate operations that may result in high levels of noise and vibration, odors, or other disruption to Owner occupancy with Owner.

1. Notify Owner not less than ten days in advance of proposed disruptive operations.
2. Obtain Owner’s written permission before proceeding with disruptive operations.

E. Restricted Substances: Use of controlled substances on Project site is not permitted. Tobacco products may be used only in designated outdoor areas.

F. Employee Identification: Owner will provide identification badges for Contractor personnel working on Project site. Require personnel to display identification badges at all times.

G. Employee Screening: Comply with Owner's requirements for background screening of Contractor personnel working on Project site.

1. Maintain list of approved screened personnel with Owner's representative.
2. Allow 30 days for screening and badging of key personnel and lead installers.
3. Un-badged personnel must be escorted at all times by badged personnel.

1.9 SPECIFICATION AND DRAWING CONVENTIONS

A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:

1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
3. All “days” are calendar days unless otherwise indicated.

B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.

C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:

1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
2. Abbreviations: Materials and products are identified by abbreviations scheduled on Drawings.

1.10 DEDUCT ALTERNATES

A. DEDUCT OPTION 1: This project’s base bid and work includes: assist in ultrasonic testing of underground piping; replacing two existing 12-inch underground condenser water mains from the cooling tower yard to inside the main building’s Chiller Room; associated excavation, and site restoration.

As an initial on-site activity, the general contractor shall coordinate with COR dates for the underground testing of the underground piping. The agreed upon date shall provide the FAA with 30-day notice, prior to the testing and associated excavation. On the approved date, the general contractor is to excavate a limited aria to allow for the ultrasonic testing of the underground water main piping. Testing shall be performed by a third-party consultant to be retained by the FAA. Immediately after completion of the testing, the general contractor shall restore the site of the excavation to pre-excavation condition.

1. The FAA will direct the general contractor within 30 days after the receipt of the test results whether to initiate the deduct alternate or continue with the base bid.
2. If Deduct Alternate 1 is exercised, the following will occur:
   a. Deduct from the work: Replacement of the 12” underground condenser water mains from the cooling tower yard to inside the exterior wall in the chiller room as indicated on the drawings;
   b. Deduct from the work: Locating existing utilities, excavation, backfill, and patching/repairing disturbances directly related to the replacement of the underground condenser water piping;

c. Add to the work: Jet-flushing of the existing 12" underground condenser water mains.

B. DEDUCT OPTION 2: This project's base price includes: doors, door frames, and door hardware replacement for nine (9) doors, as designated in the project drawings. The base price also includes three (3) doors for painting only. The FAA may not require this work. Within 30 days of issuance of the Notice to Proceed, the FAA will notify the contractor of it's intent to include or remove the work regarding these doors.

1. If deduct alternate 2 is exercised, the following will occur:
   a. Deduct from work: removal and replacement of nine (9) doors, door frames, and door hardware.
   b. Deduct from work: painting of three (3) doors.

Schedule B will show as follows:

Contract Line Item (CLIN)	**Description**	**Total**
001	1 Job	$ _____
002	Deduct Alternate 1	($ _____)
003	Deduct Alternate 2	($ _____)

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000

SECTION 01 31 00 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:

1. General coordination procedures.
2. Coordination drawings.
3. RFIs.
4. Digital project management procedures.
5. Project meetings.

B. Each contractor shall participate in coordination requirements. Certain areas of responsibility are assigned to a specific contractor.

C. Utility Service Interruptions: The Project is located at an FAA facility with 24 hour, 7 day a week operation and prohibits any interruption of electrical, natural gas or water services. For minor interruptions in these services, provide not later than 10 calendar days prior to the first planned interruption a utility service interruption plan, followed by confirmed and approved scheduled shut-down notices at least 3 calendar days prior to each interruption.

D. Submittals must be provided by the Contractor for review and approval prior to, during, and after construction. This section includes instructions for scheduling and submitting submittals as required herein, by drawing notes, or in the various sections of the specifications. Any submittal required by the contract specifications or drawings must be included on the Contractor's submittal register.

E. Related Requirements:

1. Section 013200 "Construction Progress Documentation" for preparing and submitting Contractor's construction schedule.
2. Section 017300 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
3. Section 017700 "Closeout Procedures" for coordinating closeout of the Contract.
4. Section 019113 "General Commissioning Requirements" for coordinating the Work with Owner's Commissioning Authority.

1.3 DEFINITIONS

A. RFI: Request for Information. Request from the FAA or Contractor seeking information required by or clarifications of the Contract Documents.

B. Submittals: A submittal is a contractor's or manufacturer's product information, drawing, brochure, sample, certificate, warranty, or other information that provides detail for construction and quality control of the permanent work. Submittal timetable: A tabulated list using the Submittal Register in a format approved by the COR, showing the date when the Contractor intends to submit each item. Submittal material: The information concerning each item of specified equipment or material as required for establishing conformance with the specifications, identifying a specified item of equipment or material, or supplementing the contract specifications or drawings. The Submittal Register must include, but not be limited to:

1. Manufacturer's or supplier's product data, brochures, or descriptive literature.

2. All Contractor-prepared or procured shop drawings.

3. Manufacturer’s installation instruction, including testing, which the Contractor must following unless specified otherwise.

4. Schedules.

5. Certificates of compliance.

6. Manufacturer’s operation and maintenance manuals, which the Contractor must following unless specified otherwise.

7. Warranties, including the Contractor’s one-year construction warranty.

8. Submittal Register

1.4 INFORMATIONAL SUBMITTALS

A. Utility Service Interruptions: The Project is located at an FAA facility with 24 hour, 7 day a week operation and prohibits any interruption of electrical, natural gas or water services. For minor interruptions in these services, provide not later than 10 calendar days prior to the first planned interruption a utility service interruption plan, followed by confirmed and approved scheduled shut-down notices at least 3 calendar days prior to each interruption.

B. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:

1. Name, address, telephone number, and email address of entity performing subcontract or supplying products.
2. Number and title of related Specification Section(s) covered by subcontract.
3. Drawing number and detail references, as appropriate, covered by subcontract.

C. Key Personnel Names: Within 15 days of contract award submit a list of key personnel and their project assignments, including superintendent and other personnel planned to perform duties at

the Project site. Identify individuals and their duties and responsibilities; list addresses, telephone numbers and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.

1. Post copies of list in project meeting room, in temporary field office, and in prominent location in each built facility. Keep list current at all times.

1.5 GENERAL COORDINATION PROCEDURES

A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations included in different Sections that depend on each other for proper installation, connection, and operation.

1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
3. Make adequate provisions to accommodate items scheduled for later installation.

B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.

1. Prepare similar memoranda for the COR and separate contractors if coordination of their Work is required.

C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

1. Preparation of Contractor's construction schedule.
2. Preparation of the schedule of values.
3. Installation and removal of temporary facilities and controls.
4. Delivery and processing of submittals.
5. Progress meetings.
6. Pre-installation conferences.
7. Project closeout activities.
8. Startup and adjustment of systems.

1.6 COORDINATION DRAWINGS

A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely indicated on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.

1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:

    a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
    b. Coordinate the addition of trade-specific information to coordination drawings in a sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.
    c. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
    d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
    e. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
    f. Indicate required installation sequences.
    g. Indicate dimensions shown on Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternative sketches to Owner indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

B. Coordination Drawing Organization: Organize coordination drawings as follows:

1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Supplement plan drawings with section drawings where required to adequately represent the Work.
2. Plenum Space: Indicate sub-framing for support of ceiling, raised access floor, and wall systems, mechanical and electrical equipment, and related Work. Locate components within plenums to accommodate layout of light fixtures and other components indicated on Drawings. Indicate areas of conflict between light fixtures and other components.
3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, curbs and housekeeping pads, and similar items.
6. Mechanical and Plumbing Work: Show the following:

    a. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
    b. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.
    c. Fire-rated enclosures around ductwork.

7. Electrical Work: Show the following:

    a. Runs of vertical and horizontal conduit 1 inches in diameter and larger.

b. Light fixture, exit light, emergency battery pack, smoke detector, and other fire-alarm locations.
c. Panel board, switch board, switchgear, transformer, busway, generator, and motor-control center locations.
d. Location of pull boxes and junction boxes dimensioned from column center lines.

8. Fire-Protection System: Show the following:

a. Locations of standpipes, mains piping, branch lines, pipe drops, and sprinkler heads.

9. Review: COR will review coordination drawings to confirm that in general the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If COR determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, COR will so inform Contractor, who shall make suitable modifications and resubmit.
10. Coordination Drawing Prints: Prepare coordination drawing prints according to requirements in Section 013300 "Submittal Procedures."

1.7 REQUEST FOR INFORMATION (RFI)

A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.

1. Owner will return without response those RFIs submitted to COR by other entities controlled by Contractor.
2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.

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. RFI number, numbered sequentially.
6. RFI subject.
7. Specification Section number and title and related paragraphs, as appropriate.
8. Drawing number and detail references, as appropriate.
9. Field dimensions and conditions, as appropriate.
10. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
11. Contractor's signature.
12. 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. RFI Forms: Software-generated form with substantially the same content as indicated above, acceptable to Owner.

1. Attachments shall be electronic files in PDF format.

D. COR's Action: COR will review each RFI, determine action required, and respond. Allow ten working days for CORs response for each RFI. RFIs received by COR 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. Requests for approval of submittals.
b. Requests for approval of substitutions.
c. Requests for approval of Contractor's means and methods.
d. Requests for coordination information already indicated in the Contract Documents.
e. Requests for adjustments in the Contract Time or the Contract Sum.
f. Requests for interpretation of Owner's actions on submittals.
g. Incomplete RFIs or inaccurately prepared RFIs.

2. Owner's action may include a request for additional information, in which case Owner's time for response will date from time of receipt by Owner of additional information.

E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Software-generated form with not less than the following:

1. Project name.
2. Name and address of Contractor.
3. Name and address of FAA facility/Project site.
4. RFI number including RFIs that were returned without action or withdrawn.
5. RFI description.
6. Date the RFI was submitted.
7. Date COR's response was received.

F. On receipt of COR's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify COR within seven days if Contractor disagrees with response.

1.8 DIGITAL PROJECT MANAGEMENT PROCEDURES

A. Use of FAA Digital Data Files: Digital data files of FAA CAD drawings will be provided by COR for Contractor's use during construction.

1. Digital data files may be used by Contractor in preparing coordination drawings and Shop Drawings.
2. FAA makes no representations as to the accuracy or completeness of digital data files as they relate to Contract Drawings.

3. Digital Drawing Software Program: Contract Drawings are available in DGN format.

B. PDF Document Preparation: Where PDFs are required to be submitted to COR, prepare as follows:

1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
2. Name file with submittal number or other unique identifier, including revision identifier.
3. Certifications: Where digitally submitted certificates and certifications are required, provide a digital signature with digital certificate on where indicated.

1.9 PROJECT MEETINGS

A. General: Schedule and conduct meetings and conferences at Project site unless otherwise indicated.

1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify COR of scheduled meeting dates and times a minimum of 10 working days prior to meeting.
2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including COR within three days of the meeting.

B. Pre-Construction Conference: The COR will schedule and conduct a preconstruction conference before the approved construction start date, at a time convenient to the FAA, but no less than 10 working days prior to the COR approved construction start date.

1. Attendees: Authorized representatives of FAA, the FAA Commissioning Authority, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
2. Agenda: Discuss items of significance that could affect progress, including the following:

a. Responsibilities and personnel assignments.
b. Tentative construction schedule.
c. Phasing.
d. Critical work sequencing and long lead items.
e. Designation of key personnel and their duties.
f. Lines of communications.
g. Use of web-based Project software.
h. Procedures for processing field decisions and Change Orders.
i. Procedures for RFIs.
j. Procedures for testing and inspecting.
k. Procedures for processing Applications for Payment.
l. Distribution of the Contract Documents.
m. Submittal procedures.
n. Sustainable design requirements.
o. Preparation of Record Documents.

p. Use of the premises and existing buildings.
q. Work restrictions.
r. Working hours.
s. Owner's occupancy requirements.
t. Responsibility for temporary facilities and controls.
u. Procedures for moisture and mold control.
v. Procedures for disruptions and shutdowns.
w. Construction waste management and recycling.
x. Parking availability.
y. Office, work, and storage areas.
z. Equipment deliveries and priorities.
aa. First aid.
bb. Security.
cc. Progress cleaning.

3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.

C. Pre-installation Conferences: Conduct a pre-installation conference at Project site before each construction activity when required by other sections and when required for coordination with other construction.

1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise COR and FAA's Commissioning Authority of scheduled meeting dates.
2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:

a. Contract Documents.
b. Options.
c. Related RFIs.
d. Related Change Orders.
e. Purchases.
f. Deliveries.
g. Submittals.
h. Sustainable design requirements.
i. Review of mockups.
j. Possible conflicts.
k. Compatibility requirements.
l. Time schedules.
m. Weather limitations.
n. Manufacturer's written instructions.
o. Warranty requirements.
p. Compatibility of materials.
q. Acceptability of substrates.
r. Temporary facilities and controls.
s. Space and access limitations.
t. Regulations of Owner.
u. Testing and inspecting requirements.
v. Installation procedures.

w. Coordination with other work.
x. Required performance results.
y. Protection of adjacent work.
z. Protection of construction and personnel.

3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

D. Project Closeout Conference: Schedule and conduct a project closeout conference, at a time convenient to the FAA, but no later than 30 calendar days prior to the scheduled date of Substantial Completion.

1. Conduct the conference to review requirements and responsibilities related to Project closeout.
2. Attendees: Authorized representatives of the FAA, the FAA’s Commissioning Authority, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:

a. Preparation of Record Documents.
b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
c. Submittal of written warranties.
d. Requirements for preparing operations and maintenance data.
e. Requirements for delivery of material samples, attic stock, and spare parts.
f. Requirements for demonstration and training.
g. Preparation of Contractor's punch list.
h. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
i. Responsibility for removing temporary facilities and controls.

4. Minutes: Entity conducting meeting will record and distribute meeting minutes.

E. Progress Meetings: Conduct progress meetings at weekly intervals.

1. Attendees: In addition to representatives of the FAA, the FAA's Commissioning Authority, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
2. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.

a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.

1) Review schedule for next work period.

2) Provide 3-week look-ahead

b. Review present and future needs of each entity present, including the following:

1) Interface requirements.
2) Sequence of operations.
3) Status of submittals.
4) Status of sustainable design documentation.
5) Deliveries.
6) Off-site fabrication.
7) Access.
8) Site use.
9) Temporary facilities and controls.
10) Progress cleaning.
11) Quality and work standards.
12) Status of correction of deficient items.
13) Field observations.
14) Status of RFIs.
15) Status of Proposal Requests.
16) Pending changes.
17) Status of Change Orders.
18) Pending claims and disputes.
19) Documentation of information for payment requests.
20) Activity Hazard Analysis (Forms)

3. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.

a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meetiRetain "Coordination Meetings" Paragraph below if Project is constructed under multiple contracts or if some unusual circumstance requires tighter control than normal. Under multiple contracts, Owner often assigns responsibility for scheduling and conducting meetings to Project coordinator, who prepares the combined contractors' construction schedule. Insert special intervals such as "every third Tuesday" to suit special circumstances.

PART 2 -)

END OF SECTION 013100

SECTION 013200 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:

1. Contractor's Project Schedule.
2. CPM schedule requirements.
3. Daily construction reports.
4. Material location reports.
5. Site condition reports.
6. Schedule of Values

1.3 DEFINITIONS

A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction Project. Activities included in a construction schedule consume time and resources.

1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
2. Predecessor Activity: An activity that precedes another activity in the network.
3. Successor Activity: An activity that follows another activity in the network.

B. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.

C. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.

D. Event: The starting or ending point of an activity.

E. Float: The measure of leeway in starting and completing an activity.

1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.

2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.

F. Resource Loading: The allocation of manpower and equipment necessary for completing an activity as scheduled.

G. Schedule of Values: A statement furnished by Contractor allocating portions of the Contract Sum to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

1.4 INFORMATIONAL SUBMITTALS

A. Format for Submittals: Submit required submittals in the following format:

1. Working electronic copy of schedule file, where indicated.
2. PDF file.

B. Contractor's Project Schedule: Provide schedule of size required to display entire schedule for entire project period.

1. Submit an initial project schedule within 30 calendar days from contract award.
   a. Provide a working digital copy of schedule, using software indicated, and labeled to comply with requirements for submittals.
   b. Indicate applicable specification sections as part of the schedule.
2. Provide a baseline project schedule within 45 calendar days of contract award.
   a. Provide a working digital copy of schedule, using software indicated, and labeled to comply with requirements for submittals.
   b. Indicate applicable specification sections as part of the schedule.

C. CPM Reports: Concurrent with CPM schedule, submit each of the following reports. Format for each activity in reports shall contain activity number, activity description, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.

1. Activity Report: List of activities sorted by activity number and then early start date, or actual start date if known.
2. Logic Report: List of preceding and succeeding activities for each activity, sorted in ascending order by activity number and then by early start date, or actual start date if known.
3. Total Float Report: List of activities sorted in ascending order of total float.

D. Daily Construction Reports: Submit daily to COR and copy to Contracting Officer.

E. Material Location Reports: Submit at weekly intervals.

F. Site Condition Reports: Submit at time of discovery of differing conditions.

G. Qualification Data: For scheduling consultant.

H. Schedule of Values

1.5 QUALITY ASSURANCE

A. Scheduling Consultant Qualifications: An experienced specialist in CPM scheduling and reporting, with capability of producing CPM reports and diagrams within 24 hours of FAA's request.

B. Pre-Scheduling Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to the preliminary Project schedule and Contractor's Project Schedule, including, but not limited to, the following:

1. Review software limitations and content and format for reports.
2. Verify availability of qualified personnel needed to develop and update schedule.
3. Discuss constraints, including work restrictions, phasing, distances between work areas, and full Owner occupancy.
4. Review schedule for work by others.
5. Review submittal requirements and procedures.
6. Review time required for review of submittals and resubmittals.
7. Review requirements for tests and inspections by independent testing and inspecting agencies.
8. Review time required for Project closeout and Owner startup procedures, including commissioning activities.
9. Review and finalize list of construction activities to be included in schedule.
10. Review procedures for updating schedule.

1.6 COORDINATION

A. Coordinate Contractor's Project Schedule with the schedule of values, submittal schedule, progress reports, payment requests, and other required schedules and reports.

1. Secure time commitments for performing critical elements of the Work from entities involved.
2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.
3. On a weekly basis provide a Two-Week Look-Ahead Schedule for review by all parties involved in upcoming activities.

1.7 CONTRACTOR'S PROJECT SCHEDULE, GENERAL

A. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.

B. Scheduling Consultant: Engage a consultant to provide planning, evaluation, and reporting using CPM scheduling.

1. In-House Option: Owner may waive requirement to retain a consultant if Contractor employs skilled personnel with experience in CPM scheduling and reporting techniques. Submit qualifications.
2. Meetings: Scheduling consultant shall attend all meetings related to Project progress.

C. Time Frame: Extend schedule from date established for the Notice to Proceed to date of final completion.

1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Contract Modification.

D. Activities: Treat each floor or separate area as a separate numbered activity for each main element of the Work. Comply with the following:

1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Owner.
2. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.

    a. Flow control valves.

    b. Controls for HVAC.

    c. Pumps.

    d. Chillers.

    e. Cooling towers.

    f. Air handlers.

    g. Motor control center(s).

    h. Variable frequency drives.

3. Submittal Review Time: Include review and resubmittal times indicated in Section 013300 "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Project Schedule with submittal schedule.
4. Startup and Testing Time: Include no fewer than 15 days for startup and testing.
5. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Owner’s administrative procedures necessary for certification of Substantial Completion.
6. Punch List and Final Completion: Include not more than 30 days for completion of punch list items and final completion.

E. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.

1. Construction Sequence: Arrange list of activities on schedule by construction sequence as indicated.
2. Work Restrictions: Show the effect of the following items on the schedule:

    a. Coordination with existing construction.
    b. Limitations of continued occupancies.
    c. Uninterruptible services.
    d. Use-of-premises restrictions.
    e. Seasonal variations.
    f. Environmental control.

3. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:

    a. Subcontract awards.
    b. Submittals.
    c. Purchases.
    d. Fabrication.
    e. Sample testing.
    f. Deliveries.
    g. Installation.
    h. Tests and inspections.
    i. Adjusting.
    j. Curing.
    k. Building flush-out.
    l. Startup and placement into final use and operation.
    m. Commissioning.

F. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:

1. Unresolved issues.
2. Unanswered Requests for Information.
3. Rejected or unreturned submittals.
4. Notations on returned submittals.
5. Pending modifications affecting the Work and the Contract Time.

G. Contractor's Project Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.

1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
3. As the Work progresses, indicate final completion percentage for each activity.

H. Distribution: Distribute copies of approved schedule to the COR, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.

1. Post copies in Project meeting rooms and temporary field offices.
2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

1.8 CPM SCHEDULE REQUIREMENTS

A. CPM Schedule: Prepare Contractor's Project Schedule using a time-scaled CPM network analysis diagram for the Work.

1. Develop network diagram in sufficient time to submit CPM schedule so it can be accepted for use no later than 60 days after date established for the Notice of Award.

    a. Failure to include any work item required for performance of this Contract shall not excuse Contractor from completing all work within applicable completion dates.

2. Conduct educational workshops to train and inform key Project personnel, including subcontractors' personnel, in proper methods of providing data and using CPM schedule information.
3. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.
4. Use "one workday" as the unit of time for individual activities. Indicate nonworking days and holidays incorporated into the schedule to coordinate with the Contract Time.

B. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the startup network diagram, prepare a skeleton network to identify probable critical paths.

1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:

    a. Preparation and processing of submittals.
    b. Mobilization and demobilization.
    c. Purchase of materials.
    d. Delivery.
    e. Fabrication.
    f. Utility interruptions.
    g. Installation.
    h. Work by Owner that may affect or be affected by Contractor's activities.
    i. Testing and inspection.
    j. Commissioning.
    k. Punch list and final completion.
    l. Activities occurring following final completion.

2. Critical Path Activities: Identify critical path activities, including those for interim completion dates. Scheduled start and completion dates shall be consistent with Contract milestone dates.

3. Processing: Process data to produce output data on a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.
4. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.

    a. Subnetworks on separate sheets are permissible for activities clearly off the critical path.

C. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using a network fragment to demonstrate the effect of the proposed change on the overall Project schedule.

D. Initial Issue of Schedule: Prepare initial network diagram from a sorted activity list indicating straight "early start-total float." Identify critical activities. Prepare tabulated reports showing the following:

1. Contractor or subcontractor and the Work or activity.
2. Description of activity.
3. Main events of activity.
4. Immediate preceding and succeeding activities.
5. Early and late start dates.
6. Early and late finish dates.
7. Activity duration in workdays.
8. Total float or slack time.
9. Average size of workforce.
10. Dollar value of activity (coordinated with the schedule of values).

1.9 REPORTS

A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:

1. List of subcontractors at Project site.
2. List of separate contractors at Project site.
3. Approximate count of personnel at Project site.
4. Equipment at Project site.
5. Material deliveries.
6. High and low temperatures and general weather conditions, including presence of rain or snow.
7. Testing and inspection.
8. Accidents.
9. Meetings and significant decisions.
10. Unusual events.
11. Stoppages, delays, shortages, and losses.
12. Meter readings and similar recordings.
13. Emergency procedures.
14. Change Orders received and implemented.
15. RFIs returned by Owner that require action.
16. Services connected and disconnected.

17. Equipment or system tests and startups.
18. Partial completions and occupancies.
19. Substantial Completions authorized.

B. Material Location Reports: At weekly intervals, prepare and submit a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site. Indicate the following categories for stored materials:

1. Material stored prior to previous report and remaining in storage.
2. Material stored prior to previous report and since removed from storage and installed.
3. Material stored following previous report and remaining in storage.

C. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

D. Special reports: Submit reports to COR for incidents, such as employee injuries, damage to FAA property, or near misses.

1.10 SCHEDULE OF VALUES

A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule.

1. Coordinate line items in the schedule of values with items required to be indicated as separate activities in Contractor's construction schedule.
2. Submit the schedule of values to Owner at earliest possible date, but no later than seven days before the date scheduled for submittal of initial Applications for Payment.
3. Progress schedule of values shall be agreed to by COR in advance of pay request.

B. Format and Content: Use Project Specifications table of contents as a guide to establish line items for the schedule of values. Provide at least one-line item for each Specification Section.

1. Arrange the schedule of values in tabular form, with separate columns to indicate the following for each item listed:

a. Related Specification Section or Division.
b. Description of the Work.
c. Name of subcontractor.
d. Name of manufacturer or fabricator.
e. Name of supplier.
f. Dollar value of the following, as a percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent. Round dollar amounts to whole dollars, with total equal to Contract Sum.

1) Labor.
2) Materials.

3) Equipment.

2. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Provide multiple line items for principal subcontract amounts in excess of five percent of the Contract Sum.
3. Provide a separate line item in the schedule of values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
4. Overhead Costs: Show cost of temporary facilities and other major cost items that are not direct cost of actual work-in-place as separate line items.
5. Closeout Costs. Include separate line items under Contractor and principal subcontracts for Project closeout requirements in an amount totaling five percent of the Contract Sum and subcontract amount.
6. Schedule of Values Revisions: Revise the schedule of values when Contract Modifications result in a change in the Contract Sum. Include at least one separate line item for each Contract Modification.

END OF SECTION 013200

SECTION 01 33 00 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

B. Submittals must be provided by the Contractor for review and approval prior to, during, and after construction. This section includes instructions for scheduling and submitting submittals as required herein, by drawing notes, or in the various sections of the specifications. Any submittal required by the contract specifications or drawings must be included on the Contractor's submittal register.

1.2 SUMMARY

A. Section Includes:

1. Submittal Schedule requirements.
2. Administrative and procedural requirements for submittals.

B. Related Requirements:

1. Section 013100 "Project Management and Coordination" for submitting coordination drawings and subcontract list and for requirements for web-based Project software.
2. Section 013200 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
3. Section 014000 "Quality Requirements" for submitting test and inspection reports, and schedule of tests and inspections.
4. Section 017700 "Closeout Procedures" for submitting closeout submittals and maintenance material submittals.
5. Section 017823 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
6. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
7. Section 017900 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.
8. Section 019113 "General Commissioning Requirements" for submitting commissioning plans, qualifications, and test reports.

1.3 DEFINITIONS

A. Submittals: A submittal is a contractor's or manufacturer's product information, drawing, brochure, sample, certificate, warranty, or other information that provides detail for construction and quality control of the permanent work.

B. Submittal material: The information concerning each item of specified equipment or material as required for establishing conformance with the specifications, identifying a specified item of equipment or material, or supplementing the contract specifications or drawings.

C. Submittal Schedule or Schedule of Submittals: A tabulated list using the Submittal Register in a format approved by the COR, showing the date when the Contractor intends to submit each item.

D. Submittal Register: Submittal tracking document prepared and maintained by the Contractor (see Submittal Register).

E. Action Submittals: Written and graphic information and physical samples that require FAA's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."

F. Informational Submittals: Written and graphic information and physical samples that do not require FAA's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."

1.4 SUBMITTAL SCHEDULE

A. Submittal Schedule: Submit, as an action submittal, a list of submittals, arranged in chronological order by dates required by project schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by COR and additional time for handling and reviewing submittals required by those corrections.

1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's Project schedule.
2. Initial or Critical Submittal: Submit concurrently with startup project schedule. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's project schedule.

    a. Submit revised submittal schedule to reflect changes in current status and timing for submittals.

4. Format: Arrange the following information in a tabular format:

    a. Scheduled date for first submittal.
    b. Specification Section number and title.
    c. Submittal Category: Action; informational.
    d. Name of subcontractor.
    e. Description of the Work covered.
    f. Scheduled date for Owner's final release or approval.
    g. Scheduled dates for purchasing.
    h. Scheduled date of fabrication.

i. Scheduled dates for installation.
j. Activity or event number.

1.5 SUBMITTAL REGISTER:

A. Initial Submittal Register: Within fourteen calendar days after contract award, and before providing any submittals or starting installation of any materials and/or equipment, the Contractor must furnish an electronic copy of the initial submittal register to the COR for review and approval.

B. The Contractor must submit, track and maintain the submittal register by filling-in the submittal transmittal numbers, Contractor, and Government actions as the submittals progress, and provide updated submittal registers with each monthly pay request.

C. The Submittal Register: Includes, but is not be limited to:
1. Manufacturer's or supplier's product data, brochures, or descriptive literature.
2. All Contractor-prepared or procured shop drawings.
3. Manufacturer’s installation instruction, including testing, which the Contractor must following unless specified otherwise.
4. Schedules.
5. Certificates of compliance.
6. Manufacturer’s operation and maintenance manuals, which the Contractor must following unless specified otherwise.
7. Warranties, including the Contractor’s one-year construction warranty.
8. The submittal register shall include Project Title and Location, Date, Contractor Name, and Contract Number

D. Format the submittal register to include transmittal number column, item numbers, specification paragraph number, type of submittal, classification, contractor scheduled dates, contractor and Gov't action columns.

1.6 SUBMITTAL FORMATS

A. Submittal Information: Include the following information in each submittal:

1. Project name.
2. Date.
3. Name of Owner.
4. Name of Construction Manager.
5. Name of Contractor.
6. Name of firm or entity that prepared submittal.
7. Names of subcontractor, manufacturer, and supplier.
8. Unique submittal number, including revision identifier. Include Specification Section number with sequential alphanumeric identifier; and alphanumeric suffix for resubmittals.
9. Category and type of submittal.
10. Submittal purpose and description.
11. Number and title of Specification Section, with paragraph number and generic name for each of multiple items.

12. Drawing number and detail references, as appropriate.
13. Indication of full or partial submittal.
14. Location(s) where product is to be installed, as appropriate.
15. Other necessary identification.
16. Remarks.
17. Signature of transmitter.

B. Options: Identify options requiring selection by FAA.

C. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by COR on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.

D. PDF Submittals: Prepare submittals as PDF package, incorporating complete information into each PDF file. Name PDF file with submittal number.

1.7 SUBMITTAL PROCEDURES

A. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.

1. Email: Prepare submittals as PDF package, and transmit to COR by sending via email. Include PDF transmittal form. Include information in email subject line as requested by COR.

    a. COR will return annotated file. Annotate and retain one copy of file as a digital Project Record Document file.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
4. Coordinate transmittal of submittals for related parts of the Work specified in different Sections so processing will not be delayed because of need to review submittals concurrently for coordination.

    a. COR reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on COR’s receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.

1. Initial Review: Allow 15 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. COR will advise Contractor when a submittal being processed must be delayed for coordination.
2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
3. Resubmittal Review: Allow 15 days for review of each resubmittal.
4. Sequential Review: Where sequential review of submittals by FAA's consultants, FAA, or other parties is indicated, allow 21 days for initial review of each submittal.
    a. Structural Steel Framing.
    b. Fire Suppression Systems.
    c. Vibration and Seismic Controls for HVAC Piping and Equipment.
    d. Testing, Adjusting, and Balancing.
    e. Hydronic Pumps.
    f. Centrifugal Water Chillers.
    g. Asbestos Abatement.
    h. Modular Indoor Central Station Air Handling Units
    i. Seismic Controls for Electrical Systems.
    j. Motor Control Centers.
    k. Variable Frequency Drives.
    l. Fire Detection and Alarm.
5. Concurrent Consultant Review: Where the Contract Documents indicate that submittals may be transmitted simultaneously to COR and to FAA's consultants, allow 15 days for review of each submittal. Submittal will be returned to COR before being returned to Contractor.
    a. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to COR.

D. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.

1. Note date and content of previous submittal.
2. Note date and content of revision in label or title block and clearly indicate extent of revision.
3. Resubmit submittals until they are marked with approval notation from Owner’s action stamp.

E. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

F. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from COR’s action stamp.

1.8 SUBMITTAL REQUIREMENTS

A. Contractor shall include submittals that are complete with all required information, samples, drawings, other graphical information, etc. Delays due to inadequate submittals are the Contractor's responsibility.

B. The Contracting Officer may issue an order stopping any work for which the prescribed submittals have not been submitted and processed as required. No part of the time lost due to any such stop orders will be made the subject of a claim by the Contractor for extension of performance time, for excess costs, or damages.

C. Any item purchased and/or installed by the Contractor that does not comply with the contract specifications are subject to rejection and replacement with conforming items without additional cost to the Government and without any extension of performance time.

D. Approval by the Contracting Officer must not be construed as assuming responsibility for the Contractor's work. The Contracting Officer will rely upon the Contractor's certification on the submittal that a complete check has been made and conformance with the contract has been met.

E. Substitutions: Requests for material substitutions subsequent to approvals shall be through submittal clearly stating "substitution" and the justification for the request, and shall include all pertinent technical and material data for evaluation for approval.

F. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.

1. If information must be specially prepared for submittal because standard published data are unsuitable for use, submit as Shop Drawings, not as Product Data.
2. Mark each copy of each submittal to show which products and options are applicable.
3. Include the following information, as applicable:

    a. Manufacturer's catalog cuts.
    b. Manufacturer's product specifications.
    c. Standard color charts.
    d. Statement of compliance with specified referenced standards.
    e. Testing by recognized testing agency.
    f. Application of testing agency labels and seals.
    g. Notation of coordination requirements.
    h. Availability and delivery time information.

4. For equipment, include the following in addition to the above, as applicable:

    a. Wiring diagrams that show factory-installed wiring.
    b. Printed performance curves.
    c. Operational range diagrams.
    d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.

5. Submit Product Data before Shop Drawings, and before or concurrent with Samples.

G. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data unless submittal based on Owner's digital data drawing files is otherwise permitted.

1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:

a. Identification of products.
b. Schedules.
c. Compliance with specified standards.
d. Notation of coordination requirements.
e. Notation of dimensions established by field measurement.
f. Relationship and attachment to adjoining construction clearly indicated.
g. Seal and signature of professional engineer if specified.

2. Paper Sheet Size: Except for templates, patterns, and similar full-size Drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches, but no larger than 24 by 36 inches.

a. Four paper copies of each submittal. Owner will return one copy.

H. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other materials.

1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
2. Identification: Permanently attach label on unexposed side of Samples that includes the following:

a. Project name and submittal number.
b. Generic description of Sample.
c. Product name and name of manufacturer.
d. Sample source.
e. Number and title of applicable Specification Section.
f. Specification paragraph number and generic name of each item.

3. Paper Transmittal: Include paper transmittal including complete submittal information indicated.
4. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.

a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
b. Samples not incorporated into the Work, or otherwise designated as FAA's property, are the property of Contractor.

5. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.

a. Number of Samples: Submit one full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. COR will return submittal with options selected.

6. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.

a. Number of Samples: Submit three sets of Samples. COR will retain two Sample sets; remainder will be returned. Mark up and retain one returned Sample set as a project record Sample.

1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.

I. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:

1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
2. Manufacturer and product name, and model number if applicable.
3. Number and name of room or space.
4. Location within room or space.

J. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of Owners and owners, and other information specified.

K. Design Data: Prepare and submit written and graphic information indicating compliance with indicated performance and design criteria in individual Specification Sections. Include list of assumptions and summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Number each page of submittal.

L. Certificates:

1. Certificates and Certifications Submittals: Submit a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity. Provide a notarized signature where indicated.
2. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.

3. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
4. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
5. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
6. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.

M. Operations and Maintenance (O & M) Manual: Submit per applicable specification.

N. Warranty and Guarantee: Submit per applicable specification.

O. Asbestos Free Certificate: Submit per applicable specification.

P. Test and Research Reports:

1. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
2. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
3. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
4. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
5. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
6. Research Reports: Submit written evidence, from a model code organization acceptable to the FAA, that product complies with building code in effect for Project. Include the following information:

    a. Name of evaluation organization.
    b. Date of evaluation.
    c. Time period when report is in effect.
    d. Product and manufacturers' names.
    e. Description of product.
    f. Test procedures and results.
    g. Limitations of use.

1.9 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are insufficient to perform services or certification required, submit a written request for additional information to COR.

B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit PDF copy of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.

1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

1.10 CONTRACTOR'S REVIEW

A. Action Submittals and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to COR.

B. Contractor's Approval: Indicate Contractor's approval for each submittal with a uniform approval stamp. Include name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

1. Owner will not review submittals received from Contractor that do not have Contractor's review and approval.

1.11 FAA’S REVIEW

A. Action Submittals: COR will review each submittal, indicate corrections or revisions required, and return it. COR will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action, as follows:

1. “APPROVED” will be noted with an “A” accepted without comments.
2. “APPROVED AS NOTED” will be noted with a “B” – May require follow-up action or response by Contractor to satisfy the FAA and receive acceptance.
3. “RESUBMIT” will be noted with a “C” – Resubmit per comments.
4. “DISAPPROVED” will be noted with a “D” – Rejected, with or without comments. Resubmittal required.

B. Informational Submittals: COR will review each submittal and will not return it, or will return it if it does not comply with requirements. COR will forward each submittal to appropriate party.

C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from COR.

D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review

E. Owner will return without review submittals received from sources other than Contractor.

F. Submittals not required by the Contract Documents will be returned by Owner without action.

END OF SECTION 013300

SECTION 013529 – HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General provisions of the Contract, including General and Supplementary Conditions and Division 01 Specifications, apply to this Section.

B. FAA Oder 3900.19B – FAA Occupational Safety and Health Program applies to this Section.

1. Some Chapters of the Order apply in their entirety to Contractors as indicated in Part 3 of this Section.

1.2 SUMMARY

A. Section Includes:

1. Accident prevention plan.
2. Site safety and health officer.
3. FAA safety and health requirements.
4. Additional safety and health requirements.

B. RELATED REQUIREMENTS

1. Section 02 41 19 “Selective Demolition” for hot work and hot work permits.
2. Section 02 82 00 “Asbestos Abatement and LCC Demolition” for protection of Owner’s and Contractor’s personnel from exposure to hazardous materials.

C. Contractor shall be responsible for producing and maintaining a Safety Plan compliant with CFR codes, OSH Article 53 (Sections 1-12) and 77 (Sections 1-15).

D. Comply with 29 CFR 1910.95 and 29 CFR 1926.52.

1.3 DEFINITIONS

A. JHA: Job hazard analysis.

B. OSH: Occupational safety and health.

C. PPE: Personal protective equipment.

1.4 ACTION SUBMITTALS

A. Hearing Conservation Program: Must be approved by Owner’s hearing conservation program Administrator.

1.5 INFORMATION SUBMITTALS

A. Safety and Health Program.

1. Contractor's written overall safety and health program(s).

B. Accident Prevention plan.

C. Permits, accident reporting, proposed locations for Hard Hat signs, and type and location of on-site fire extinguishers and 1st aid equipment/supplies.

1.6 ACCIDENT PREVENTION PLAN (APP)

A. Use qualified persons to write a Project specific APP. Address all safety and health requirements not already addressed in the overall safety and health program.

1. Provide Project specific information including access to emergency medical treatment.
2. Maintain up to date copies in Owner's and Contractor's field office.

1.7 SITE SAFETY AND HEALTH OFFICER (SSHO)

A. Provide an SSHO that meets the following requirements:

1. Must have completed the 30-hour OSHA Construction safety class or as an equivalent 30 hours of formal construction safety and health training covering the subjects of the OSHA 30-hour course.
2. Must have five years' construction industry safety experience or three years when combined with a Certified Safety Professional certificate or safety and health degree.

B. SSHO must be on-site during working hours to implement, administer, and enforce Contractor's safety and health program and APP.

1. SSHO may not be the Contractor's superintendent.
2. SSHO may be the Contractor's quality control manager and must report to a senior Project or corporate official.
3. Assure at least one worker with current CPR/First Aid is onsite when any work is performed.
4. Must have an equally qualified designee to cover absences.

C. Duties and responsibilities.

1. Conduct daily safety and health inspections.
2. Maintain written log including operations inspected, hazards, corrective actions, estimated corrective action date, and actual corrective action date. Logs must be submitted with Contractor's daily construction reports at the same interval specified in Section 01 32 00 "Construction Progress Documentation".
3. Investigate and report mishaps.
4. Maintain safety and health reference materials on Project site.
5. Implement and enforce JHA.
6. Ensure subcontractor compliance with Project safety and health requirements.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 FAA SAFETY AND HEALTH REQUIREMENTS

A. OSH Training and Awareness.

1. Comply with all applicable federal, state, and local OSH regulations.
2. Conduct OSH compliance training for each employee.

B. MISHAP PREVENTION

1. Work may be suspended immediately if there is an imminent threat to personnel safety or the environment.
2. Enhanced personnel protection by fencing, barricades, signage or any other means necessary shall be provided in vehicular areas including driveways and parking areas and ingress and egress routes, and any other occupied areas.
3. Do not store or allow accumulation of materials, tools, equipment, refuse or debris that would interfere with safe occupancy or passage of personnel.

C. MISHAP REPORTING

1. Provide FAA with written report on all incidents involving property damage or OSHA recordable employee injuries within 24 hours.

D. FALL PROTECTION

1. Submit written fall protection program.
2. Provide fall protection equipment to each affected employee.

E. CONFINED SPACE ENTRY

1. Comply with the requirements of Chapter 11 of the Order.

F. HAZARDOUS ENERGY CONTROL

1. Comply with the requirements of Chapter 13 of the Order.

G. ASBESTOS CONTROL PROGRAM

1. Class I and II work must be performed by qualified abatement workers.
2. Submit written asbestos abatement plan.

H. BLOOD BORNE PATHOGENS

1. Submit written blood borne pathogens program.

I. HAZARD COMMUNICATION

1. Submit written hazard communication program.
2. When hazardous chemicals are brought onto the Project site provide Owner with copies of MSDS.
3. Provide information regarding precautionary measures to avoid excessive exposure.
4. Post copies of MSDS adjacent to work.
5. Contractor shall bring to the attention of the COR any material encountered during execution of the Work that the Contractor suspects is hazardous.
6. Before commencement of construction or any significant portion thereof, hold safety meeting with representatives from Contractor, COR, (and other parties) to review contract's health and safety requirements.

J. RESPIRATORY PROTECTION

1. Provide respiratory equipment to each affected employee.

K. HEARING CONSERVATION

1. Submit written hearing conservation program to FAA for approval.
2. Provide appropriate audiometric testing, PPE, and training.
3. Wear PPE where required.

L. FIRST AID

1. Provide medical services and first aid.
2. Provide facilities for quick drenching or flushing of eyes and body.

M. JOB HAZARD ANALYSIS

1. Perform job hazard analysis in accordance with Chapter 23.
2. Use the Job Hazard Analysis Worksheet at the end of Chapter 23, or approved equivalent.
3. Maintain copies of signed worksheets on Project site for Owner’s inspection.

N. FIRE PREVENTION

1. Comply with the minimum requirements of Chapter 24.
2. Provide briefings to all employees on FAA’s emergency response procedures.

O. PERSONAL PROTECTIVE EQUIPMENT

1. Comply with the minimum requirements of Chapter 25.

P. TOXIC AND HAZARDOUS SUBSTANCES EXPOSURE

1. Comply with “Hazard Communication” Article in this Section.

Q. ELECTRICAL SAFETY

1. FAA’s electrical safety programs apply to Contractor’s personnel.
2. Employ safety related work practices to prevent electrical shock.
3. While working in areas with potential electric hazards use protective clothing and equipment.
4. Provide protective clothing and equipment to each affected employee.

3.2 ADDITIONAL SAFETY AND HEALTH REQUIREMENTS

1. Submit additional written safety and health programs required for this Project or address in APP:

    a. Scaffolds.
    b. Excavations.
    c. Cranes and Derricks in Construction.

END OF SECTION 013529

SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.

1. Specific quality-assurance and quality-control requirements for individual work results are specified in their respective Specification Sections. Requirements in individual Sections may also cover production of standard products.
2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.
3. Requirements for Contractor to provide quality-assurance and quality-control services required by Owner are not limited by provisions of this Section.
4. Specific test and inspection requirements are not specified in this Section.

1.3 DEFINITIONS

A. Experienced: When used with an entity or individual, "experienced" unless otherwise further described means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

B. Field Quality-Control Tests: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

C. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations. Retain one or more of three subparagraphs below if applicable to Project.

D. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.

E. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) according to 29 CFR 1910.7, by a testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency qualified to conduct product testing, to establish product performance and compliance with specified requirements.

F. Source Quality-Control Tests: Tests and inspections that are performed at the source; for example, plant, mill, factory, or shop.

G. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

H. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

I. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Contractor's quality-control services do not include contract administration activities performed by Owner.

1.4 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Owner.

1.5 CONFLICTING REQUIREMENTS

A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements are specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to COR for direction before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to COR for a decision before proceeding.

1.6 ACTION SUBMITTALS

A. Delegated-Design Services Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit a statement signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1.7 INFORMATIONAL SUBMITTALS

A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities, and key personnel and their responsibilities.

B. Qualification Data: For Contractor's quality-control personnel.

C. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

D. Permits, Licenses, and Certificates: For Owner's record, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with standards and regulations bearing on performance of the Work.

1.8 CONTRACTOR'S QUALITY-CONTROL PLAN

A. Quality-Control Plan, General: Submit quality-control plan within 10 days from Notice of Award, and not less than fifteen calendar days prior to preconstruction conference. Submit in format acceptable to COR. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities. Coordinate with Contractor's Project Schedule.

B. Quality-Control Personnel Qualifications: Engage qualified personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.

1. Project quality-control manager shall not have other Project responsibilities.

C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.

D. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:

1. Contractor-performed tests and inspections including Subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and

inspections. Distinguish source quality-control tests and inspections from field quality-control tests and inspections.

2. Owner-performed tests and inspections indicated in the Contract Documents, including tests and inspections indicated to be performed by Commissioning Authority.

E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring work into compliance with standards of workmanship established by Contract requirements.

F. Monitoring and Documentation: Maintain testing and inspection reports including log of approved and rejected results. Include work COR has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming work into compliance with requirements.

1.9 REPORTS AND DOCUMENTS

A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:

1. Date of issue.
2. Project title and number.
3. Name, address, telephone number, and email address of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Record of temperature and weather conditions at time of sample taking and testing and inspection.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and re-inspecting.

B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, telephone number, and email address of technical representative making report.
2. Statement on condition of substrates and their acceptability for installation of product.
3. Statement that products at Project site comply with requirements.
4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
6. Statement whether conditions, products, and installation will affect warranty.
7. Other required items indicated in individual Specification Sections.

C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, telephone number, and email address of factory-authorized service representative making report.
2. Statement that equipment complies with requirements.
3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
4. Statement whether conditions, products, and installation will affect warranty.
5. Other required items indicated in individual Specification Sections.

1.10 QUALITY ASSURANCE

A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.

C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Installer Qualifications: A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or products that are similar in material, design, and extent to those indicated for this Project.

F. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.

G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspection indicated, as documented according to ASTM E 329; and with additional qualifications specified in individual Sections.

H. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

I. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

J. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:

1. Contractor responsibilities include the following:

a. Provide test specimens representative of proposed products and construction.
b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
c. Provide sizes and configurations of test assemblies to adequately demonstrate capability of products to comply with performance requirements.
d. Build site-assembled test assemblies using installers who will perform same tasks for Project.
e. When testing is complete, remove test specimens and test assemblies; do not reuse products on Project.

2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to COR and Commissioning Authority, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

1.11 QUALITY CONTROL

A. Contractor Responsibilities: Tests and inspections not explicitly assigned to the FAA are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.

1. Engage a qualified testing agency to perform quality-control services.

a. Contractor shall not employ same entity engaged by the FAA, unless agreed to in writing by the FAA.

2. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspection will be performed.
3. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
4. Testing and inspection requested by Contractor and not required by the Contract Documents are Contractor's responsibility.

B. Retesting/Re-inspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and re-inspecting, for construction that replaced Work that failed to comply with the Contract Documents.

C. Testing Agency Responsibilities: Cooperate with COR, Commissioning Authority, and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.

1. Notify COR, Commissioning Authority, and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
2. Determine the locations from which test samples will be taken and in which in-situ tests are conducted.
3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
5. Do not release or revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
6. Do not perform duties of Contractor.

D. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."

E. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in pre-installation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.

F. Associated Contractor Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:

1. Access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
4. Facilities for storage and field curing of test samples.
5. Delivery of samples to testing agencies.
6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
7. Security and protection for samples and for testing and inspection equipment at Project site.

G. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspection.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

PART 2 - EXECUTION

2.1 TEST AND INSPECTION LOG

A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:

1. Date and time test or inspection was conducted.
2. Description of the Work tested or inspected.
3. Date test or inspection results were transmitted to COR.
4. Identification of testing agency or special inspector conducting test or inspection.

B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for FAA's Commissioning Authority's reference during normal working hours.

1. Submit log at Project closeout as part of Project Record Documents.

2.2 REPAIR AND PROTECTION

A. General: On completion of testing, inspection, sample taking, and similar services, repair damaged construction and restore substrates and finishes.

1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 017300 "Execution."

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 014000

SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.

B. Related Requirements:

1. Section 011000 "Summary" for work restrictions and limitations on utility interruptions.

1.3 USE CHARGES

A. General: The FAA will provide "reasonable" amounts of water, electricity and sewer service. Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities engaged in the Project to use temporary services and facilities without cost, including, but not limited to, FAA and testing agencies.

B. Water and Sewer Service from Existing System: Water from FAA's existing water system is available for use without metering and without payment of use charges, with the exception of fire protection water through direct connection to hydrants. Provide connections and extensions of services as required for construction operations. Obtain permission to use water through hydrants, for which there is metering required and extra costs charged.

C. Electric Power Service from Existing System: Electric power from FAA's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

1.4 INFORMATIONAL SUBMITTALS

A. Site Utilization Plan: Show temporary facilities, temporary utility lines and connections, staging areas, construction site entrances, vehicle circulation, and parking areas for construction personnel.

B. Implementation and Termination Schedule: A minimum of 15 working days prior to the date established for commencement of the Work on site, submit schedule indicating implementation and termination dates of each temporary utility.

C. Fire-Safety Program: Show compliance with requirements of NFPA 241 and Safety Hazard Risk Management (SHRM). Indicate Contractor personnel responsible for management of fire-prevention program.

D. Moisture- and Mold-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage and mold.

E. Dust- and HVAC-Control Plan: Submit coordination drawing and narrative that indicates the dust- and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Include the following:

1. Locations of dust-control partitions at each phase of work.
2. HVAC system isolation schematic drawing.
3. Location of proposed air-filtration system discharge.
4. Waste-handling procedures.
5. Other dust-control measures.

1.5 QUALITY ASSURANCE

A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

B. Tests and Inspections: Arrange for Owner to test and inspect each temporary utility before use.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Polyethylene Sheet: Reinforced, fire-resistive sheet, 10-mil minimum thickness, with flame-spread rating of 15 or less per ASTM E 84 and passing NFPA 701 Test Method 2.

B. Dust-Control Adhesive-Surface Walk-Off Mats: Provide mats minimum 36 by 60 inches.

C. Insulation: Un-faced mineral-fiber blanket, manufactured from glass, slag wool, or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.

2.2 TEMPORARY FACILITIES

A. Comply with Safety Hazard Risk Management for temporary power and fire protection. Skilled tradesmen must perform temporary work in accordance with all applicable codes and FAA Standards.

B. The Contractor is responsible for securing their equipment, vehicles, tools, materials, and supplies. The FAA is not responsible for any losses due to theft from vehicles or the work or staging areas.

C. Staging Area:
   1. Area size and location will be determined in coordination with COR prior to on-site mobilization.
   2. Contractor is responsible for keeping the staging area clean.
      a. If area is not maintained in safe and clean condition, the Contracting Officer may have the area cleaned by others with the costs being deducted from the Contractor's progress payment.
   3. Snow removal in the staging area is the responsibility of the Contractor.

D. The Contractor may provide a temporary security fence around their staging area, provided the fence posts do not penetrate or otherwise damage the ground or paving. Underground locates shall be performed prior to installing the fence posts. If fence/gates are utilized, provide the COR with two keys or combination to lock(s).

E. For purposes of personnel safety, isolation fencing shall, in coordination with the COR be installed for the purpose of enclosing portions of the Project site to prevent unauthorized personnel from easily entering site except by entrance gates approved for use.

F. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.

   1. FAA will provide conditioned interior space for the Contractor's superintendent for the duration of the project.

G. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.

   1. Store combustible materials apart from building.

2.3 EQUIPMENT

A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.

B. HVAC Equipment: Unless FAA authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.

   1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
   2. Heating Units: Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.
   3. Permanent HVAC System: If Owner authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return-air grille in system and remove at end of construction and clean HVAC system as required in Section 017700 "Closeout Procedures."

C. Air-Filtration Units: Primary and secondary HEPA-filter-equipped portable units with four-stage filtration. Provide single switch for emergency shutoff. Configure to run continuously.

PART 3 - EXECUTION

3.1 TEMPORARY FACILITIES, GENERAL

A. Conservation: Coordinate construction and use of temporary facilities with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.

1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as FAA's property.

3.2 INSTALLATION, GENERAL

A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.

1. Locate facilities to limit site disturbance as specified in Section 011000 "Summary."

B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.3 TEMPORARY UTILITY INSTALLATION

A. General: Install temporary service or connect to existing service.

1. Arrange with utility company, COR, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.

B. Water Service: Connect to FAA's existing water service facilities. Clean and maintain water service facilities in a condition acceptable to COR. At Substantial Completion, restore these facilities to condition existing before initial use.

C. Sanitary Facilities: Provide a minimum of two temporary toilets, and provide wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.

D. Temporary Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures. Select equipment that will not have a harmful effect on completed installations or elements being installed.

E. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.

1. Prior to commencing work, isolate the HVAC system in area where work is to be performed according to coordination drawings.

a. Disconnect supply and return ductwork in work area from HVAC systems servicing occupied areas.
b. Maintain negative air pressure within work area using HEPA-equipped air-filtration units, starting with commencement of temporary partition construction, and continuing until removal of temporary partitions is complete.

2. Maintain dust partitions during the Work. Use vacuum collection attachments on dust-producing equipment. Isolate limited work within occupied areas using portable dust-containment devices.
3. Perform daily construction cleanup and final cleanup using approved, HEPA-filter-equipped vacuum equipment.

F. Electric Power Service: Connect to FAA's existing electric power service. Maintain equipment in a condition acceptable to COR.

G. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.

1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.

3.4 SUPPORT FACILITIES INSTALLATION

A. General: Comply with the following:

1. Provide construction for shops and sheds located within construction area or within 30 feet of building lines that is noncombustible according to ASTM E 136. Comply with NFPA 241.
2. Maintain support facilities until COR schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to COR.

B. Traffic Controls: Comply with requirements of authorities having jurisdiction.

1. Protect existing site improvements to remain including curbs, pavement, and utilities.
2. Maintain access for fire-fighting equipment and access to fire hydrants.

C. Parking: Use designated areas of FAA's existing parking areas for construction personnel.

D. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.

1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
2. Remove snow and ice as required minimizing accumulations.
3. Protect catch basins from entry and accumulation of mud and other debris.

E. Tree and Plant Protection: Protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.

F. Waste Disposal Facilities: Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."

G. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with progress cleaning requirements in Section 017300 "Execution."

H. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.

1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

I. Existing Elevator Use: Use of FAA's existing elevators will be permitted, provided elevators are cleaned and maintained in a condition acceptable to COR. Elevator use by Contractor shall be coordinated with the COR and shall at all times consider access required for and use required by FAA personnel. Conflicts during use that may compromise personnel safety shall be avoided at all times.

1. Do not load elevators beyond their rated weight capacity.
2. Provide protective coverings, barriers, devices, signs, or other procedures to protect elevator car and entrance doors and frame. If, despite such protection, elevators become damaged, engage elevator Installer to restore damaged work so no evidence remains of correction work. Return items that cannot be refinished in field to the shop, make required repairs and refinish entire unit, or provide new units as required.
3. At Substantial Completion, restore elevators to condition existing before initial use, including replacing worn cables, guide shoes, and similar items of limited life.

J. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate.

K. Existing Stair Usage: Use of FAA's existing stairs will be permitted, provided stairs are cleaned and maintained in a condition acceptable to COR. Stair use by Contractor shall be coordinated with the COR and shall at all times consider access required for and use required by FAA personnel. Conflicts during use that may compromise personnel safety shall be avoided at all times.

1. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If stairs become damaged, restore damaged areas so no evidence remains of correction work.
2. At Substantial Completion, restore stairs to condition existing before initial use.

L. Temporary Use of Permanent Stairs: Use of new stairs for construction traffic will be permitted, provided stairs are protected and finishes restored to new condition at time of Substantial Completion.

3.5 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.

1. Where access to adjacent properties is required in order to affect protection of existing facilities, obtain written permission from adjacent property owner to access property for that purpose.

B. Environmental Protection:
1. Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
2. Storm water Control:
Comply with requirements of FAA. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of storm water from heavy rains. Protect catch basins from entry and accumulation of mud and other debris.

C. Barricades, Warning Signs, and Lights: Comply with requirements of FAA through the COR for erecting structurally adequate barricades, including warning signs and lighting.

D. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by the FAA.

E. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weather tight enclosure for building exterior.

1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.

3.6 OPERATION, TERMINATION, AND REMOVAL

A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.

B. Maintenance: Maintain facilities in good operating condition until removal.

1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.

C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.

D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

1. Materials and facilities that constitute temporary facilities are property of Contractor.
2. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace sod, street paving, curbs, and sidewalks, as required by Owner.

3. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 017700 "Closeout Procedures."

END OF SECTION 015000

SECTION 01 57 19 - TEMPORARY ENVIRONMENTAL CONTROLS

PART 1 - GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications listed below are referenced as the latest edition published as of the date of this document. The publications are referred to within the text by the basic designation only.

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 530/F-93/004	Test Methods for Evaluating Solid Waste (Vol IA, IB, IC, and II) (SW-846)
EPA 832-R-92-005	Storm Water Management for Construction Activities Developing Pollution Preventions and Plans and Best Management Practices

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards
29 CFR 1910.120	Hazardous Waste Operations and Emergency Response
29 CFR 1926	Construction Safety
40 CFR 112	Oil Pollution Prevention
40 CFR 122.26	Storm Water Discharges
40 CFR 136-143	Water Programs
40 CFR 173	Procedure Governing the Rescission of State Primary Enforcement Responsibility for Pesticide Use Violations
40 CFR 204	Noise Emission Standards for Construction Equipment
40 CFR 241	Guidelines for Disposal of Solid Waste
40 CFR 243	Guidelines for the Storage and Collection of Residential, Commercial, and Institutional Solid Waste
40 CFR 258	Subtitle D Landfill Requirements
40 CFR 260	Hazardous Waste Management System: General
40 CFR 261	Identification and Listing of Hazardous Waste

40 CFR 262	Standards Applicable to Generators of Hazardous Waste
40 CFR 263	Standards Applicable to Transporters of Hazardous Waste
40 CFR 264	Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 265	Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 266	Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities
40 CFR 268	Land Disposal Restrictions
40 CFR 270	EPA Administered Permit Programs: The Hazardous Waste Permit Program
40 CFR 271	Requirements for Authorization of State Hazardous Waste Programs
40 CFR 272	Approved State Hazardous Waste Management Programs
40 CFR 273	Standards For Universal Waste Management
40 CFR 279	Standards for the Management of Used Oil
40 CFR 280	Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (UST)
40 CFR 300	National Oil and Hazardous Substances Pollution Contingency Plan
40 CFR 311-374	Worker Right-to-Know
40 CFR 355	Emergency Planning and Notification
40 CFR 372-SUBPART D	Specific Toxic Chemical Listings
40 CFR 716	Health and Safety Data Reporting
40 CFR 761	Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions
49 CFR 171	General Information, Regulations, and Definitions

49 CFR 172	Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements
49 CFR 173	Shippers - General Requirements for Shipments and Packaging
49 CFR 178	Specifications for Packaging

FEDERAL AVIATION ADMINISTRATION (FAA) ORDERS

Order 1050.17	Airway Facilities Environmental and Safety Compliance Program
Order 1050.14B	Polychlorinated Biphenyl’s (PCBs) in the National Airspace System

1.2 DEFINITIONS

1.2.1 Sediment

Soil and other debris that have eroded and have been transported by runoff water or wind.

1.2.2 Solid Waste

Garbage, refuse, debris, sludge, or other discharged material (except hazardous waste as defined in paragraph entitled "Hazardous Waste" or hazardous debris as defined in paragraph entitled "Hazardous Debris"), including solid, liquid, semisolid, or contained gaseous materials resulting from domestic, industrial, commercial, mining, or agricultural operations. Material not regulated as solid waste are: nuclear source or byproduct materials regulated under the Federal Atomic Energy Act of 1954 as amended; suspended or dissolved materials in domestic sewage effluent or irrigation return flows, or other regulated point source discharges; regulated air emissions; and fluids or wastes associated with natural gas or crude oil exploration or production.

a. Green waste: The vegetative matter from landscaping, land clearing and grubbing, including, but not limited to, grass, bushes, scrubs, small trees and saplings, tree stumps and plant roots. Marketable trees, grasses and plants that are indicated to remain, be re-located, or be re-used are not included.

b. Surplus soil: Existing soil that is in excess of what is required for this work, including aggregates intended, but not used, for on-site mixing of concrete, mortars and paving. Contaminated soil meeting the definition of hazardous material or hazardous waste is not included.

c. Inert construction and demolition debris: Broken or removed concrete, masonry, and rock asphalt paving; ceramics; roofing paper and shingles. Inert materials may be reinforced with or contain ferrous wire, rods, accessories and weldments.

d. Wood: Dimension and non-dimension lumber, plywood, chipboard, hardboard. Treated and/or painted wood that meets the definition of lead contaminated or lead based contaminated paint is not included.

e. Scrap metal: Scrap and excess ferrous and non-ferrous metals such as reinforcing steel, structural shapes, pipe and wire that are recovered or collected and disposed of as scrap. Scrap metal meeting the definition of hazardous material or hazardous waste is not included.

f. Paint cans: Metal cans that are empty of paints, solvents, thinners and adhesives. If permitted by the paint can label, a thin dry film may remain in the can.

g. Recyclables: Materials, equipment and assemblies such as doors, windows, door and window frames, plumbing fixtures, glazing and mirrors that are recovered and sold as recyclable. Metal meeting the definition of lead contaminated or lead based paint contaminated may be included as recyclable if sold to a scrap metal company. Paint cans may be included as recyclable if sold to a scrap metal company.

1.2.3 Debris

Non-hazardous solid material generated during the construction, demolition, or renovation of a structure which exceeds 2.5-inch particle size that is: a manufactured object; plant or animal matter; or natural geologic material (e.g. cobbles and boulders). A mixture of debris and other material such as soil or sludge is also subject to regulation as debris if the mixture is comprised primarily of debris by volume, based on visual inspection.

1.2.4 Hazardous Debris

As defined in paragraph entitled "Debris" of this section, debris that contains listed hazardous waste (either on the debris surface, or in its interstices, such as pore structure) per 40 CFR 261; or debris that exhibits a characteristic of hazardous waste per 40 CFR 261.

1.2.5 Chemical Wastes

This includes salts, acids, alkalis, herbicides, pesticides, and organic chemicals.

1.2.6 Garbage

Refuse and scraps resulting from preparation, cooking, dispensing, and consumption of food.

1.2.7 Hazardous Waste

Any discarded material, liquid, solid, or gas, which meets the definition of hazardous material or is designated hazardous waste by the Environmental Protection Agency or State Hazardous Control Authority as defined in 40 CFR 260, 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, 40 CFR 265, 40 CFR 266, 40 CFR 268, 40 CFR 270, 40 CFR 271, 40 CFR 272, 40 CFR 273, 40 CFR 279, and 40 CFR 280.

1.2.8 Oily Waste

Petroleum products and bituminous materials.

1.2.9 Regulated Waste

Those solid waste that have specific additional federal, state, or local controls for handling, storage, or disposal.

1.2.10 Class I Ozone Depleting Substance (ODS)

Class I ODS is defined in Section 602(a) of The Clean Air Act and includes the following chemicals:

chlorofluorocarbon-11 (CFC-11)
chlorofluorocarbon-12 (CFC-12)
chlorofluorocarbon-13 (CFC-13)
chlorofluorocarbon-111 (CFC-111)
chlorofluorocarbon-112 (CFC-112)
chlorofluorocarbon-113 (CFC-113)
chlorofluorocarbon-114 (CFC-114)
chlorofluorocarbon-115 (CFC-115)
chlorofluorocarbon-212 (CFC-212)
chlorofluorocarbon-213 (CFC-213)
chlorofluorocarbon-214 (CFC-214)
chlorofluorocarbon-215 (CFC-215)
chlorofluorocarbon-216 (CFC-216)
chlorofluorocarbon-217 (CFC-217)
halon-1211
halon-1301
carbon tetrachloride
methyl chloroform

1.2.11 Hazardous Materials

Any material that is defined in 49 CFR 171, listed in 49 CFR 172, and regulated as a hazardous material in accordance with 49 CFR 173, requires a Safety Data Sheet (SDS) in accordance with 29 CFR 1910.120, or which during end use, treatment, handling, storage, transportation or disposal meets or has components which meet or have the potential to meet the definition of a Hazardous Waste in accordance with 40 CFR 261. Throughout this specification, hazardous material includes hazardous chemicals.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 PROTECTION OF NATURAL RESOURCES

Preserve the natural resources within the project boundaries and outside the limits of permanent work. Restore to an equivalent or improved condition upon completion of work. Confine construction activities to within the limits of the work indicated or specified.

3.1.1 Land Resources

Except in areas to be cleared, do not remove, cut, deface, injure, or destroy trees or shrubs without the Contracting Officer Representative’s (COR's) permission. Do not fasten or attach ropes, cables, or guys to existing nearby trees for anchorages unless authorized by the COR. Where such use of attached ropes, cables, or guys is authorized, the Contractor will be responsible for any resultant damage.

3.1.1.1 Protection of Trees

Protect existing trees which are to remain and which may be injured, bruised, defaced, or otherwise damaged by construction operations. Remove displaced rocks from un-cleared areas. By approved excavation, remove trees with 30 percent or more of their root systems destroyed.

3.1.1.2 Replacement

Remove trees and other landscape features scarred or damaged by equipment operations, and replace with equivalent, undamaged trees and landscape features. Obtain The COR's approval before replacement.

3.1.2 Water Resources

3.1.2.1 Stream Crossings

The COR's approval is required before any equipment will be permitted to ford live streams. In areas where frequent crossings are required, install temporary culverts or bridges. Obtain the COR's approval prior to installation. Remove temporary culverts or bridges upon completion of work, and repair the area.

3.1.2.2 Releases/Spills of Oil and Hazardous Substances

Take precautions to prevent releases/spills of oil and hazardous substances. Maintain adequate and appropriate spill kits at construction site in order to properly respond to a release. In the event of any releases of oil and hazardous substances, chemicals, or gases; immediately notify the COR. Contain and clean up these spills without cost to the Government. If Government assistance is requested or required, the Contractor shall reimburse the Government for such assistance.

3.1.2.3 Storm Water Controls During Construction

a) Construction site sediment runoff shall be prevented from entering any storm drains, and prevented from degrading areas adjacent to the construction due to siltation and sedimentation, by the use of appropriate erosion and sediment controls. Contractor shall provide erosion protection of the surrounding soils.

b) There shall be no discharge of excavation ground water to the sanitary sewer, storm drains, or bodies of water without appropriate permits and prior specific authorization of the COR in writing. Discharge of hazardous substances will not be permitted under any circumstances.

c) Contractor shall comply with all state and federal regulatory agencies governing construction runoff controls.

3.2 CLASS I AND II ODS PROHIBITION

Class I and II ODS as defined and identified herein will not be used in the performance of this contract, nor be provided as part of the equipment. This prohibition will be considered to prevail over any other provision, specification, drawing, or referenced documents.

3.3 TEMPORARY FUELING AND FUEL TANKS

A. Conduct fueling and lubricating operations of equipment and motor vehicles in a manner that protects against spills and evaporation. Appropriate spill kits shall be provided at construction site. All used oil generated on site shall be managed in accordance with 40 CFR 279.

B. Where possible, minimize the capacity of aboveground storage tanks (ASTs) placed on-site for the purpose of storing petroleum products. Prior to placing storage tanks on-site, the contractor shall verify any state requirements for temporary tank registration, prepare any registration documents, and abide by all applicable regulations. All temporary ASTs shall have built-in/integrated secondary weatherproof containment designed to hold the total capacity of the AST.

3.4 CONTROL AND DISPOSAL OF SOLID WASTES

Pick up solid wastes, and place in covered containers which are regularly emptied. Do not prepare or cook food on the project site. Prevent contamination of the site or other areas when handling and disposing of wastes. At project completion, leave the areas clean. Recycling is encouraged and can be coordinated with the FAA facility representative. Remove all solid waste (including non-hazardous debris) from Government property and dispose off-site at an approved landfill. Solid waste disposal off-site must comply with most stringent local, state, and federal requirements including 40 CFR 241, 40 CFR 243, and 40 CFR 258.

3.5 CONTROL AND DISPOSAL OF HAZARDOUS WASTE AND UNIVERSAL WASTES

3.5.1 Hazardous Waste/Debris Management

The Contractor will identify all construction activities which will generate hazardous waste/debris. The Contractor must provide a documented waste determination for all resultant waste streams. Hazardous waste/debris will be identified, labeled, handled, stored, and disposed of in accordance with all Federal, State, and local regulations including 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, 40 CFR 265, 40 CFR 266, and 40 CFR 268. Store hazardous wastes in approved containers in accordance with 49 CFR 173 and 49 CFR 178. Hazardous waste generated within the confines of the facility will be identified as being generated by the FAA. This will require coordination with local FAA representative (the Safety and Environmental Compliance Manager, or SECM) to determine shipping manifest information. Under no circumstances shall hazardous waste be brought onto Government property. For hazardous wastes spills, verbally notify the COR immediately.

3.5.2 Mercury Materials

Mercury is prohibited in the construction of this facility, unless specified otherwise, and with the exception of mercury vapor lamps and fluorescent lamps. Dumping of mercury-containing materials and devices such as mercury vapor lamps, fluorescent lamps, and mercury switches, in rubbish containers is prohibited. Removed lamps and other mercury-containing equipment as Universal Waste pursuant to 40 CFR 273. Remove without breaking, pack to prevent breakage, and transport out off site in an unbroken condition for recycling/disposal.

3.5.3 PCB-Containing Light Ballasts

a) Perform removal of PCB-containing light fixture ballasts in conjunction with other work. All unlabeled light fixture ballasts shall be considered PCB-containing.

b) Contractor shall ensure that all electrical fixtures are disabled and de-energized prior to removing light fixtures and ballasts. A qualified and trained electrician is required to verify that all light fixtures are de-energized prior to initiating work.

c) Remove PCB-containing light fixture ballasts from light fixtures. Exercise caution to avoid both skin and respiratory exposures.

d) If PCB-containing light fixture ballast has leaked, scrape and wipe up residue with appropriate solvent. Dispose of contaminated cleaning materials with PCB-containing light fixture ballasts.

e) Place non-leaking PCB-containing light fixture ballasts in an impermeable container (such as a DOT 17R closed top drum) in layers. Place leaking PCB-containing light fixture ballasts in a separate container and label it as such. The Contractor shall label and mark the PCB storage containers (leading and non-leaking) with EPA-approved PCB labels.

f) Temporarily store all containers inside an established temporary storage area. The storage area with must be marked signs, marks and lines to meet applicable regulations. Inform the COR of the location of stored containers. Coordinate with the local FAA representative (the Safety and Environmental Compliance Manager, or SECM) to determine shipping manifest information.

END OF SECTION 01 57 19

SECTION 017300 - EXECUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:

1. Construction layout.
2. Installation of the Work.
3. Cutting and patching.
4. Progress cleaning.
5. Starting and adjusting.
6. Protection of installed construction.

B. Related Requirements:

1. Section 011000 "Summary" for limits on use of Project site.

2. Section 017419 “Construction Waste Management” for control and disposal of waste.
3. Section 017700 "Closeout Procedures" for replacing defective work and final cleaning.
4. Section 024119 "Selective Demolition" for demolition and removal of selected portions of the building.
5. Section 078413 "Penetration Firestopping" for patching penetrations in fire-rated construction.

1.3 DEFINITIONS

A. Cutting: Removal of in-place construction necessary to permit installation or performance of subsequent work.

B. Patching: Fitting and repair work required to restore construction to original conditions after installation of subsequent work.

1.4 PREINSTALLATION MEETINGS

A. Cutting and Patching Conference: Conduct conference at Project site.

1. Prior to commencing work requiring cutting and patching, review extent of cutting and patching anticipated and examine procedures for ensuring satisfactory result from cutting

and patching work. Require representatives of each entity directly concerned with cutting and patching to attend, including the following:

a. Contractor's superintendent.
b. Trade supervisor responsible for cutting operations.
c. Trade supervisor(s) responsible for patching of each type of substrate.
d. Mechanical, electrical, and utilities subcontractors' supervisors, to the extent each trade is affecting by cutting and patching operations.

2. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

1.5 INFORMATIONAL SUBMITTALS

A. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous and solid waste disposal.

1.6 QUALITY ASSURANCE

A. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.

1. Structural Elements: When cutting and patching structural elements, notify Owner of locations and details of cutting and await directions from Owner before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that result in increased maintenance or decreased operational life or safety. Operational elements include the following:

a. Primary operational systems and equipment.
b. Fire separation assemblies.
c. Air or smoke barriers.
d. Fire-suppression systems.
e. Plumbing piping systems.
f. Mechanical systems piping and ducts.
g. Control systems.
h. Communication systems.
i. Fire-detection and -alarm systems.
j. Electrical wiring systems.

3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity that results in reducing their capacity to perform as intended, or that result in increased maintenance or decreased operational life or safety. Other construction elements include but are not limited to the following:

a. Water, moisture, or vapor barriers.
b. Membranes and flashings.
c. Sprayed fire-resistive material.
d. Equipment supports.
e. Noise- and vibration-control elements and systems.

4. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Owner's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

B. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Comply with requirements specified in other Sections.

B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.

1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Owner for the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning site work, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.

1. Before construction, verify the location and elevation at points of connection for underground hydronic piping and water-service piping.
2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.

B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.

1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

C. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:

1. Description of the Work.
2. List of detrimental conditions, including substrates.
3. List of unacceptable installation tolerances.
4. Recommended corrections.

D. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

B. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

C. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information (RFI)to COR according to requirements in Section 013100 "Project Management and Coordination”.

D. Existing Utility Information:
1. Furnish information to local utility and FAA if it is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, etc. affected by construction.

E. Existing Utility Interruptions:
1. Do not interrupt utilities serving facilities occupied by FAA or others without COR’s written permission. Contractor may have to provide temporary utilities during outage. Submit any outage requests to COR a minimum of 10 working days prior to the requested date of outage.

3.3 CONSTRUCTION LAYOUT

A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to existing construction and benchmarks. If discrepancies are discovered, notify COR promptly.

1. Locate and layout underground hydronic piping and water storage tank, including elevations, slopes and grades.

3.4 INSTALLATION

A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.

1. Make vertical work plumb and make horizontal work level.
2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
4. Maintain minimum headroom clearance of 96 inches in occupied spaces and 90 inches in unoccupied spaces.

B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.

D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.

E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.

F. Tools and Equipment: Where possible, select tools or equipment that minimize production of excessive noise levels.

G. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other portions of the Work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.

H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.

1. Mounting Heights: Where mounting heights are not indicated, mount components at heights in coordination with the COR.
2. Allow for building movement, including thermal expansion and contraction.
3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

I. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.

J. Repair or remove and replace damaged, defective, or nonconforming Work.

1. Comply with Section 017700 "Closeout Procedures" for repairing or removing and replacing defective Work.

K. Hazardous Materials: Products, cleaners, and installation materials shall be asbestos and lead free.

3.5 CUTTING AND PATCHING

A. Submittals:
Submit a written request through the COR in advance of any cutting or alteration which affects work of the FAA or any separate Contractor or the integrity of weather-exposed or moisture-resistant elements or systems. Request shall include items such as justification, alternatives to cutting and patching, and written concurrence of any separate contractor whose work will be affected.

B. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.

1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

C. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.

D. Temporary Support: Provide temporary support of work to be cut.

E. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

F. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching according to requirements in Section 011000 "Summary."

G. Cutting: Cut in-place construction by sawing, drilling, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction.

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chipping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.

4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
6. Proceed with patching after construction operations requiring cutting are complete.

H. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.

1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize evidence of patching and refinishing.

    a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
    b. Restore damaged pipe covering to its original condition.

3. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
4. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weather tight condition and ensures thermal and moisture integrity of building enclosure.

I. Defective Work: Contractor is responsible for cutting and patching necessary to remove and replace defective work, work not conforming to requirements, removal of samples of installed work as specified for testing, and uncovering portions of the work to provide for installation of items omitted during earlier portions of the construction.

J. Materials: Use materials and products that are similar or identical (to the fullest extent possible) to existing materials unless otherwise called out on the drawings. If identical materials are not available and Contractor cannot create an end result that is visually indistinguishable from the original, Contractor may be required to replace the complete system as directed by the Contracting Officer.

K. Inspection: Upon inspecting, report unsatisfactory or questionable conditions to COR in writing. Do not proceed with additional work until COR has provided approval of revised cutting and patching methods.

L. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.6 PROGRESS CLEANING

A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.

1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris. Contractor must store volatile materials and waste in containers in a location approved by COR.
2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg. F.
3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.

    a. Use containers intended for holding waste materials of type to be stored.

B. Site: Maintain Project site free of waste materials and debris. Remove tools, equipment and materials not required for work in progress. Contractor must provide and maintain cleaning supplies and equipment, provide and maintain containers on site for the collection of waste materials, debris, and rubbish, and must haul all project waste off site for proper disposal. Disposal of volatile, harmful, or dangerous materials on the ground or in storm or sanitary sewer systems or drainages is prohibited.

C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.

1. Remove liquid spills promptly.
2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Section 015000 "Temporary Facilities and Controls" and Section 017419 "Construction Waste Management and Disposal." Use of the Government's existing trash containers on site for the work is prohibited.

H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

J. Limiting Exposures: Supervise construction operations to ensure that no part of the construction completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.7 STARTING AND ADJUSTING

A. Coordinate startup and adjusting of equipment and operating components with requirements in Section 019113 "General Commissioning Requirements."

B. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.

C. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.

D. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Manufacturer's Field Service: Comply with qualification requirements in Section 014000 "Quality Requirements."

3.8 PROTECTION OF INSTALLED CONSTRUCTION

A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.

B. Protection of Existing Items: Provide protection and ensure that existing items to remain undisturbed by construction are maintained in condition that existed at commencement of the Work.

C. Comply with manufacturer's written instructions for temperature and relative humidity.

END OF SECTION 017300

SECTION 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for the following:

1. Salvaging nonhazardous demolition waste.
2. Recycling nonhazardous demolition and construction waste.
3. Disposing of nonhazardous demolition and construction waste.

B. Related Requirements:

1. Section 024119 "Selective Demolition" for disposition of waste resulting from partial demolition of buildings, structures, and site improvements, and for disposition of hazardous waste.

1.3 DEFINITIONS

A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.

B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.

C. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.

D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.

E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.

F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

G. Reference ASTM E2114 for additional definitions applicable to sustainable development.

1.4 PERFORMANCE REQUIREMENTS

A. General: Achieve end-of-Project rates for salvage/recycling of 75 percent by weight of total non-hazardous solid waste generated by the Work. Practice efficient waste management in the use of materials in the course of the Work. Use all reasonable means to divert construction and demolition waste from landfills and incinerators. Maximize use of source reduction and recycling procedures outlined in ASTM D5834. Facilitate recycling and salvage of materials, including the following:

1. Demolition Waste:

a. Structural and miscellaneous steel.
b. Rough Hardware.
c. Doors and frames.
d. Door hardware.
e. Acoustical tile and panels.
f. Wood-core raised access floor panels.
g. Carpet.
h. Demountable partitions.
i. Piping.
j. Supports and hangers.
k. Valves.
l. Mechanical equipment.
m. Refrigerants.
n. Electrical conduit.
o. Copper wiring.
p. Lighting fixtures.
q. Lamps.
r. Electrical devices.
s. Electrical equipment.

2. Construction Waste:

a. Insulation.
b. Piping.
c. Electrical conduit.
d. Packaging: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle 100 percent of the following uncontaminated packaging materials:

1) Paper.
2) Cardboard.
3) Boxes.
4) Plastic sheet and film.
5) Polystyrene packaging.
6) Wood crates.
7) Plastic pails.

1.5 ACTION SUBMITTALS

A. Waste Management Plan: – Submit Plan to the COR a minimum of 15 calendar days prior to the scheduled date of the Waste Management Conference on site. Approval of the Plan must be received from the COR prior to the Conference. Identify materials that cannot be recycled or reused and include an explanation to the COR as to why they cannot be recycled or reused.

1.6 INFORMATIONAL SUBMITTALS

A. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit report. Use form acceptable to COR. Include the following information:

1. Material category.
2. Generation point of waste.
3. Total quantity of waste in pounds.
4. Quantity of waste salvaged, both estimated and actual in pounds.
5. Quantity of waste recycled, both estimated and actual in pounds.
6. Total quantity of waste recovered (salvaged plus recycled) in pounds.
7. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.

B. Waste Reduction Calculations: Before request for Substantial Completion, submit calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.

C. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.

D. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.

E. Recycling and Processing Facility Records: Provide a list of each certified recycling facility and a copy of the facility's permit or license. Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

F. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

G. Qualification Data: For refrigerant recovery technician.

H. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

1.7 QUALITY ASSURANCE

A. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.

B. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.

C. Waste Management Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to waste management including, but not limited to, the following:

1. Review and discuss waste management plan including responsibilities of waste management coordinator.
2. Review requirements for documenting quantities of each type of waste and its disposition.
3. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
4. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
5. Review waste management requirements for each trade.

1.8 WASTE MANAGEMENT PLAN

A. General: Develop a waste management plan according to ASTM E 1609 and requirements in this Section. Plan shall consist of waste identification, waste reduction work plan, and cost/revenue analysis. Distinguish between demolition and construction waste. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.

B. Waste Identification: Indicate anticipated types and quantities of demolition and construction waste generated by the Work. Use form acceptable to Owner. Include estimated quantities and assumptions for estimates.

C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Use form acceptable to COR. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.

1. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work.
2. Salvaged Materials for Sale: For materials that will be sold to individuals and organizations, include list of their names, addresses, and telephone numbers.
3. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
4. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
5. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.

6. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location where materials separation will be performed.

D. Cost/Revenue Analysis: Indicate total cost of waste disposal as if there was no waste management plan and net additional cost or net savings resulting from implementing waste management plan. Use form acceptable to COR. Include the following:

1. Total quantity of waste.
2. Estimated cost of disposal (cost per unit). Include hauling and tipping fees and cost of collection containers for each type of waste.
3. Total cost of disposal (with no waste management).
4. Revenue from salvaged materials.
5. Revenue from recycled materials.
6. Savings in hauling and tipping fees by donating materials.
7. Savings in hauling and tipping fees that are avoided.
8. Handling and transportation costs. Include cost of collection containers for each type of waste.
9. Net additional cost or net savings from waste management plan.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.

1. Comply with operation, termination, and removal requirements in Section 015000 "Temporary Facilities and Controls."

B. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.

1. Distribute waste management plan to everyone concerned within three days of submittal return.
2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.

C. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.

2. Comply with Section 015000 "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

3.2 SALVAGING DEMOLITION WASTE

A. Salvaged Items for Reuse in the Work: Not permitted.

B. Salvaged Items for Sale and Donation: Not permitted on Project site.

C. Salvaged Items for FAA's Use: Salvage items for Owner's use and handle as follows:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
3. Store items in a secure area until delivery to FAA.
4. Transport items to FAA's storage area on-site.
5. Protect items from damage during transport and storage.

D. Doors and Hardware: Brace open end of door frames. Except for removing door closers, leave door hardware attached to doors.

E. Equipment: Drain tanks, piping, and fixtures. Seal openings with caps or plugs. Protect equipment from exposure to weather.

F. Lighting Fixtures: Separate lamps by type and protect from breakage.

G. Electrical Devices: Separate switches, receptacles, switchgear, transformers, meters, panelboards, circuit breakers, and other devices by type.

3.3 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

A. General: Recycle paper and beverage containers used by on-site workers.

B. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Contractor.

C. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.

D. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical according to approved construction waste management plan.

1. Provide appropriately marked containers or bins for controlling recyclable waste until removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.

a. Inspect containers and bins for contamination and remove contaminated materials if found.

2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
4. Store components off the ground and protect from the weather.
5. Remove recyclable waste from Owner's property and transport to recycling receiver or processor.

3.4 RECYCLING DEMOLITION WASTE

A. Metals: Separate metals by type.

1. Structural Steel: Stack members according to size, type of member, and length.
2. Remove and dispose of bolts, nuts, washers, and other rough hardware.

B. Acoustical Ceiling Panels and Tile: Stack large clean pieces on wood pallets and store in a dry location.

C. Metal Suspension System: Separate metal members including trim, and other metals from acoustical panels and tile and sort with other metals.

D. Carpet Tile: Remove debris, trash, and adhesive.

1. Stack tile on pallet and store clean, dry carpet in a closed container or trailer provided by Carpet Reclamation Agency or carpet recycler.

E. Piping: Reduce piping to straight lengths and store by type and size. Separate supports, hangers, valves, sprinklers, and other components by type and size.

F. Conduit: Reduce conduit to straight lengths and store by type and size.

3.5 RECYCLING CONSTRUCTION WASTE

A. Packaging:

1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
2. Polystyrene Packaging: Separate and bag materials.
3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site salvage for reuse.
4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.

B. Wood Materials:

1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
2. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.

3.6 DISPOSAL OF WASTE

A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.

1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Burning: Do not burn waste materials.

3.7 ATTACHMENTS

A. Form CWM-1 for construction waste identification.

B. Form CWM-2 for demolition waste identification.

C. Form CWM-3 for construction waste reduction work plan.

D. Form CWM-4 for demolition waste reduction work plan.

E. Form CWM-5 cost/revenue analysis of construction waste reduction work plan.

F. Form CWM-6 cost/revenue analysis of demolition waste reduction work plan.

G. Form CWM-7 for construction waste

H. Form CWM-8 for demolition waste.

END OF SECTION 017419

SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:

1. Substantial Completion procedures.
2. Final completion procedures.
3. Warranties.
4. Final cleaning.
5. Repair of the Work.

B. Related Requirements:

1. Section 017823 "Operation and Maintenance Data" for additional operation and maintenance manual requirements.
2. Section 017839 "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
3. Section 017900 "Demonstration and Training" for requirements to train the FAA's maintenance personnel to adjust, operate, and maintain products, equipment, and systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of cleaning agent.

B. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.

C. Certified List of Incomplete Items: Final submittal at final completion.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Schedule of Maintenance Material Items: For maintenance material submittal items specified in other Sections.

1.5 SUBSTANTIAL COMPLETION PROCEDURES

A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's punch list), indicating the value of each item on the list and reasons why the Work is incomplete.

B. Submittals Prior to Substantial Completion: Complete the following a minimum of 10 working days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, damage or settlement surveys, property surveys, and similar final record information.
2. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
3. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by COR. Label with manufacturer's name and model number.

    a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain COR's signature for receipt of submittals.

4. Submit testing, adjusting, and balancing records.

C. Procedures Prior to Substantial Completion: Complete the following a minimum of 10 working days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Complete startup and testing of systems and equipment.
2. Perform preventive maintenance on equipment used prior to Substantial Completion.
3. Instruct FAA's personnel in operation, adjustment, and maintenance of products, equipment, and systems.
4. Terminate and remove temporary facilities from Project site, along with construction tools and similar elements.
5. Complete final cleaning requirements.
6. Touch up paint and otherwise repair and restore marred exposed finishes to eliminate visual defects.

D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 working days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, COR will either proceed with inspection or notify Contractor of unfulfilled requirements. COR will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by COR, that must be completed or corrected before certificate will be issued.

1. Request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected.

2. Results of completed inspection will form the basis of requirements for final completion.

E. Final Acceptance of Substantial Completion: Contractor must submit a written Completion Certification to the Contracting Officer (CO) with concurrent copy(s) to the COR certifying contract documents have been reviewed, O&M manuals, maintenance schedule, as-builts, warranties, parts lists, project records have been submitted, and required instruction and training of facility operations and maintenance personnel have been performed.

1.6 FINAL COMPLETION PROCEDURES

A. Submittals Prior to Final Completion: Before requesting final inspection for determining final completion, complete the following:

1. Certified List of Incomplete Items: Submit certified copy of COR's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by COR. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.

B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 working days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, COR will either proceed with inspection or notify Contractor of unfulfilled requirements. COR will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1. Request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.7 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.

1. Organize list of spaces in sequential order.
2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
3. Include the following information at the top of each page:

    a. Project name.
    b. Date.
    c. Name of Owner.
    d. Name of Contractor.
    e. Page number.

4. Submit list of incomplete items in the following format:

    a. MS Excel electronic file. CORwill return annotated file.

1.8 SUBMITTAL OF PROJECT WARRANTIES

A. Time of Submittal: Submit written warranties on request of COR for designated portions of the Work where warranties are indicated to commence on dates other than date of Substantial Completion, or when delay in submittal of warranties might limit FAA's rights under warranty.

B. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.

C. Warranties in Paper Form:

1. Bind warranties in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.1 FINAL CLEANING

A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.

1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:

a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.

c. Rake grounds that are not planted, mulched, or paved to a smooth, even-textured surface.
d. Remove tools, construction equipment, machinery, and surplus material from Project site.
e. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces.
f. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
g. Sweep concrete floors broom clean in unoccupied spaces.
h. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
i. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials.
j. Remove labels that are not permanent.
k. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
l. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
m. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter on inspection.
n. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.
o. All vacuums and air filtering devices shall use HEPA filters and shall be cleaned or replaced prior to each use.
p. Clean floor, wall surfaces, tile and painted surfaces and inspect for damage. Clean resilient flooring with manufacturer approved cleaner. Vacuum carpets with powered floor sweepers to remove dirt and dust. Remove glue or other substances from nap of carpet. Replace cracked, dirty or damaged tiles with new tiles. If spot-painting does not blend into the existing color and texture of the surrounding surfaces, repaint wall from inside corner to inside corner. In mechanical rooms; remove shipping labels, tape, tape residue, dirt and dust from equipment and apparatus with vacuum or compressed air. Remove oil, grease and other contaminants from floors and equipment. Remove and clean screens at strainers in piping systems. Clean insects, debris, and dust from louver screens.
q. Provide “Care and Use Instructions” for finish materials along with a list of the finish materials and cleaning products recommended by the manufacturer. Provide “Care and Use Instructions” separately to the COR immediately upon completion of a specific finish, and provide in Project O&M manual.
r. Leave Project clean and ready for occupancy.

C. Construction Waste Disposal: Comply with waste disposal requirements in Section 015000 "Temporary Facilities and Controls" and Section 017419 "Construction Waste Management and Disposal."

3.2 REPAIR OF THE WORK

A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.

B. Repair, or remove and replace, defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.

1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.
2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that already show evidence of repair or restoration.

    a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.

3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
4. Replace burned-out bulbs or LED modules, bulbs noticeably dimmed by hours of use, LED modules with one or more unlit LED, defective and noisy starters in fluorescent and mercury vapor luminaires, and defective drivers in LED luminaries to comply with requirements for new fixtures.

END OF SECTION 017700

SECTION 017823 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:

1. Emergency manuals.
2. Systems and equipment operation manuals.
3. Systems and equipment maintenance manuals.
4. Product maintenance manuals.

B. Related Requirements:

1. Section 013300 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
2. Section 019113 "General Commissioning Requirements" for verification and compilation of data into operation and maintenance manuals.

1.3 DEFINITIONS

A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.

B. Subsystem: A portion of a system with characteristics similar to a system.

1.4 CLOSEOUT SUBMITTALS

A. Provide to the COR an inventory of each component and piece of equipment requiring operations and maintenance documentation as identified in the Contract Documents.
1. Provide an Attachment 1 to identify systems and sub-systems.
2. Provide Attachment 2 to document O&M equipment inventory information.

B. Submit operation and maintenance manuals indicated. Provide content for each manual as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.

1. FAA and FAA's Commissioning Authority will comment on whether content of operation and maintenance submittals is acceptable.
2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.

C. Format: Submit operation and maintenance manuals in the following format:
1. Submit bound paper copies.
2. Submit copies using electronic media. Provide electronic information on CD-ROM, flash drive or similar electronic media.

D. Initial Manual Submittal: Submit four (4) draft copies of each manual at least 30 days before commencing demonstration and training. COR and FAA's Commissioning Authority will comment on whether general scope and content of manual are acceptable. COR will return two (2) annotated copies to the Contractor.

E. Final Manual Submittal: Submit five (5) copies of each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. COR will return two (2) copies with comments to the Contractor.

1. Correct or revise each manual to comply with FAA's and FAA's Commissioning Authority's comments. Submit five (5) copies of each corrected manual within 15 days of receipt of COR's and Commissioning Authority's comments and prior to commencing demonstration and training.

F. Payment Deduction: Timely submission of draft and final O&M documents is critical to successful commissioning and turnover of O&M to the FAA. For O&M documentation not submitted in accordance with the submission schedule listed herein, the FAA may utilize services from others to obtain the required O&M information. The Contractor's price may be reduced by an amount commensurate with the cost to the FAA to obtain the required information by alternate means.

G. Comply with Section 017700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

1.5 FORMAT OF OPERATION AND MAINTENANCE MANUALS

A. Manuals, Paper Copy: Submit manuals in the form of hard-copy, bound and labeled volumes.

1. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.

a. If two or more binders are necessary to accommodate data of a system, organize data in each binder (Data Package) into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents. Indicate Data Package number for multiple-volume sets.

2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment. Enclose title pages and directories in clear plastic sleeves.
4. Supplementary Text: Prepared on 8-1/2-by-11-inch white bond paper.
5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.

    a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
    b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

1.6 ORGANIZATION AND CONTENT OF MAINTENANCE MANUALS

A. Manuals shall be organized into Data Packages or, if multiple volumes are not necessary, Data Sections as follows:
    1. Data Package or Data Section 1: General building materials and components such as sealants, light fixtures, door hardware, etc.
    2. Data Package or Data Section 2: Simple operating components such as valves, hatches, louvers, plumbing fixtures.
    3. Data Package or Data Section 3: Minor equipment such as small pumps and fans.
    4. Data Package or Data Section 4: Major and complex equipment such as AHU's, package AC units, large pumps and motors, chillers, boilers, switch gear, elevators, control systems, engine generators, harmonic cancellation systems, fire alarm and suppression systems, TAB reports, etc.

B. Suggested O&M Manual Sections by Building System (Table of Contents):
    1. General Building Information
    2. Grounds & Pavements
    3. Roofing
    4. Interior Construction
    5. Interior Finishes
    6. Conveying Systems
    7. Plumbing Systems
    8. HVAC Systems
    9. Life/Safety
    10. Electrical Systems
    11. Communication Systems
    12. Building Automation Systems
    13. Security Systems

C. Prior to submittal of the Manual(s) to the COR at the initial and final stage, Contractor shall review and approve the manuals for quality to assure compliance with all requirements pertaining to format and content.

D. Organization of Manuals: Unless otherwise indicated, organize each Data Package or Data Section into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:

1. Title page.
2. Table of contents.
3. Manual contents.

E. Title Page: Include the following information:

1. Subject matter included in manual.
2. Name and address of Project.
3. Name and address of Owner.
4. Date of submittal.
5. Name and contact information for Contractor.
6. Name and contact information for Commissioning Authority.
7. Cross-reference to related systems in other operation and maintenance manuals.

F. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the Data Package or Data Section, and cross-referenced to Specification Section number in Project Manual.

1. If operation or maintenance documentation requires more than one data package to accommodate data, include comprehensive table of contents for all data in each package of the set.

G. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.

H. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

1.7 EMERGENCY CONTENT

A. Emergency Information: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by FAA's operating personnel for types of emergencies indicated.

B. Content: Organize manual into a separate section for each of the following:

1. Type of emergency.
2. Emergency instructions.
3. Emergency procedures.

C. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:

1. Fire.
2. Refrigerant leak.
3. Water leak.
4. Power failure.
5. Water outage.
6. System, subsystem, or equipment failure.
7. Chemical release or spill.

D. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.

E. Emergency Procedures: Include the following, as applicable:

1. Instructions on stopping.
2. Shutdown instructions for each type of emergency.
3. Operating instructions for conditions outside normal operating limits.
4. Required sequences for electric or electronic systems.
5. Special operating instructions and procedures.

1.8 SYSTEMS AND EQUIPMENT OPERATION CONTENT

A. Systems and Equipment Operation Information: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

B. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:

1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
2. Performance and design criteria if Contractor has delegated design responsibility.
3. Operating standards.
4. Operating procedures.
5. Operating logs.
6. Wiring diagrams.
7. Control diagrams.
8. Piped system diagrams.
9. Precautions against improper use.
10. License requirements including inspection and renewal dates.

C. Descriptions: Include the following:

1. Product name and model number. Use designations for products indicated on Contract Documents.
2. Manufacturer's name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

D. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

F. Piped Systems: Diagram piping as installed, and identify color coding where required for identification.

1.9 SYSTEMS AND EQUIPMENT MAINTENANCE CONTENT

A. Systems and Equipment Maintenance Information: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

B. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranties as described below.

C. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product,

list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

D. Manufacturers' Maintenance Documentation: Include the following information for each component part or piece of equipment:

1. Standard maintenance instructions and bulletins; include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

    a. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

E. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:

1. Test and inspection instructions.
2. Troubleshooting guide.
3. Precautions against improper maintenance.
4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
5. Aligning, adjusting, and checking instructions.
6. Demonstration and training video recording, if available.

F. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.

1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.

G. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

H. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

I. Warranties: Include copies of warranties and lists of circumstances and conditions that would affect validity of warranties.

1. Include procedures to follow and required notifications for warranty claims.

J. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.

1. Do not use original project record documents as part of maintenance manuals.

1.10 PRODUCT MAINTENANCE CONTENT

A. Product Maintenance Information:
1. Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
2. Care and Use Instructions shall be provided to the COR immediately upon completion of a distinct portion of the work or area that will be substantially occupied.

B. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties, as described below.

C. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

D. Product Information: Include the following, as applicable:

1. Product name and model number.
2. Manufacturer's name.
3. Color, pattern, and texture.
4. Material and chemical composition.
5. Reordering information for specially manufactured products.

E. Maintenance Procedures: Include manufacturer's written recommendations and the following:

1. Inspection procedures.
2. Types of cleaning agents to be used and methods of cleaning.
3. List of cleaning agents and methods of cleaning detrimental to product.
4. Schedule for routine cleaning and maintenance.
5. Repair instructions.

F. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

G. Warranties: Include copies of warranties and lists of circumstances and conditions that would affect validity of warranties.

1. Include procedures to follow and required notifications for warranty claims.

2.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 017823

SECTION 017839 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for project record documents, including the following:

1. Record Drawings.
2. Miscellaneous record submittals.

B. Related Requirements:

1. Section 017300 "Execution" for final property survey.
2. Section 017700 "Closeout Procedures" for general closeout procedures.
3. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.

1.3 CLOSEOUT SUBMITTALS

A. Record Drawings: Comply with the following:

1. Number of Copies: Submit copies of record Drawings as follows:

a. Initial Submittal:

1) Submit one paper-copy set(s) of marked-up record prints.
2) Owner will indicate whether general scope of changes, additional information recorded, and quality of marked-up record prints are acceptable.

b. Final Submittal:

1) Submit one paper-copy set of marked-up record prints.
2) Submit two additional color copies of scanned marked-up record prints.
3) Print each drawing, whether or not changes and additional information were recorded.

1.4 RECORD DRAWINGS

A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued. The Contractor must make the record drawings available to the Contracting Officer at all times.

1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.

a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
b. Accurately record information in an acceptable drawing technique.
c. Record data as soon as possible after obtaining it.
d. Record and check the markup before enclosing concealed installations.

2. Content: Types of items requiring marking include, but are not limited to, the following:

a. Dimensional changes to Drawings.
b. Revisions to details shown on Drawings.
c. Depths of foundations.
d. Locations and depths of underground utilities.
e. Revisions to routing of piping and conduits.
f. Revisions to electrical circuitry.
g. Actual equipment locations.
h. Duct size and routing.
i. Locations of concealed internal utilities.
j. Changes made by Contract Change or RFI.
k. Changes made following Owner's written orders.
l. Details not on the original Contract Drawings.
m. Field records for variable and concealed conditions.

3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
4. Mark record sets with erasable colored pencils and highlighters to distinguish between types of change:

a. Red-colored pencil for additions.
b. Green highlighter for deletions.
c. Blue-colored pencil for notes to drafter.

5. Mark important additional information that was either shown schematically or omitted from original Drawings.

B. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.

1. Record Prints: Organize record prints into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.

2. Identification: As follows:

a. Project name.
b. Date.
c. Designation "PROJECT RECORD DRAWINGS."
d. Name of Owner.
e. Name of Contractor.

1.5 MISCELLANEOUS RECORD SUBMITTALS

A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

B. Format: Submit miscellaneous record submittals as one paper copy and PDF electronic file.

1. Include miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of miscellaneous record submittals.

1.6 MAINTENANCE OF RECORD DOCUMENTS

A. Maintenance of Record Documents:
1. Store full set(s) of record documents in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss.
2. Provide access to project record documents for COR’s reference at all times. The Contractor shall update record drawings daily, and the drawings must be current as of the previous work day’s changes.
3. On a weekly basis the Contractor must update a set of construction drawings within the Government’s COR site office. They will be inspected for accuracy and completeness by the COR. Failure to keep the as-built field data current shall be sufficient justification to withhold a retainage percentage from the monthly pay application.

PART 2 - PRODUCTS

PART 3 - EXECUTION

END OF SECTION 017839

SECTION 017900 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for instructing FAA's personnel, including the following:

1. Instruction in operation and maintenance of systems, subsystems, and equipment.

1.3 INFORMATIONAL SUBMITTALS

A. Instruction Program: A minimum of fifteen (15) calendar days prior to start of personnel instruction, submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module. Copies and distribution of the outline shall be in such a form as to accommodate up to twenty (20) training attendees.
1. Indicate proposed training modules using manufacturer-produced demonstration . Provide video recordings for systems, equipment, and products in lieu of live instructional module.

B. Qualification Data: For instructor.

C. Attendance Record: For each training module, submit list of participants and length of instruction time.

1.4 CLOSEOUT SUBMITTALS

A. At completion of training, submit complete training manual(s) for FAA's use prepared in same paper format required for operation and maintenance manuals specified in Section 017823 "Operation and Maintenance Data."

B. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test, and student evaluations of training.

1.5 QUALITY ASSURANCE

A. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 014000 "Quality Requirements," experienced in operation and maintenance procedures to train maintenance personnel.

B. Pre-instruction Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to demonstration and training including, but not limited to, the following:

1. Inspect and discuss locations and other facilities required for instruction.
2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
3. Review required content of instruction.
4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

1.6 COORDINATION

A. Coordinate instruction schedule with FAA's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of FAA's personnel.

B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.

C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data have been reviewed and approved by COR.

1.7 INSTRUCTION PROGRAM

A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.

B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:

1. Basis of System Design, Operational Requirements, and Criteria: Include the following:

a. System, subsystem, and equipment descriptions.
b. Performance and design criteria if Contractor is delegated design responsibility.
c. Operating standards.
d. Regulatory requirements.
e. Equipment function.
f. Operating characteristics.
g. Limiting conditions.

h. Performance curves.

2. Documentation: Review the following items in detail:

a. Emergency manuals.
b. Systems and equipment operation manuals.
c. Systems and equipment maintenance manuals.
d. Product maintenance manuals.
e. Project Record Documents.
f. Identification systems.
g. Warranties.
h. Maintenance service agreements and similar continuing commitments.

3. Emergencies: Include the following, as applicable:

a. Instructions on meaning of warnings, trouble indications, and error messages.
b. Instructions on stopping.
c. Shutdown instructions for each type of emergency.
d. Operating instructions for conditions outside of normal operating limits.
e. Sequences for electric or electronic systems.
f. Special operating instructions and procedures.

4. Operations: Include the following, as applicable:

a. Startup procedures.
b. Equipment or system break-in procedures.
c. Routine and normal operating instructions.
d. Regulation and control procedures.
e. Control sequences.
f. Safety procedures, including lockout/tag out requirements
g. Instructions on stopping.
h. Normal shutdown and re-start instructions.
i. Operating procedures for emergencies.
j. Operating procedures for system, subsystem, or equipment failure.
k. Seasonal and weekend operating instructions.
l. Required sequences for electric or electronic systems.
m. Special operating instructions and procedures.

5. Adjustments: Include the following:

a. Alignments.
b. Checking adjustments.
c. Noise and vibration adjustments.
d. Economy and efficiency adjustments.

6. Troubleshooting: Include the following:

a. Diagnostic instructions.
b. Test and inspection procedures.
c. Frequently asked questions.

7. Maintenance: Include the following:

    a. Inspection procedures.
    b. Types of cleaning agents to be used and methods of cleaning.
    c. List of cleaning agents and methods of cleaning detrimental to product.
    d. Procedures for routine cleaning.
    e. Procedures for preventive maintenance.
    f. Procedures for routine maintenance.
    g. Instruction on use of special tools.

8. Repairs: Include the following:

    a. Diagnosis instructions.
    b. Repair instructions.
    c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
    d. Instructions for identifying parts and components.
    e. Review of spare parts needed for operation and maintenance.

1.8 PREPARATION

A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 017823 "Operation and Maintenance Data."

B. Set up instructional equipment at instruction location.

1.9 INSTRUCTION

A. Engage qualified instructors to instruct FAA's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

B. Scheduling: Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.

    1. Schedule training with COR with at least 30 calendar days' advance notice.

    2. Training will be required across multiple shifts of personnel.

C. Training Location and Reference Material: To extent practical, conduct training on-site in completed and fully operational facility using actual equipment in-place and final operation and maintenance data submittals.

D. Evaluation: At the conclusion of each training module, assess and document training via a pre-printed survey form approved by the COR.

E. Provide record of training to COR. Record shall include list of attendees, student evaluation of training, evaluation of student comprehension at end of training and recommendations for follow-on training.

F. Cleanup: Collect used and leftover educational materials. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

PART 2 - PRODUCTS

PART 3 - EXECUTION

3.1 LENGTH OF INSTRUCTION

A. As a minimum, provide 32 hours of demonstration and training for each of the following systems, subsystems, and equipment:
   1. Boilers
   2. Chiller plant controls.
   3. Chillers.
   4. Cooling towers.

B. As a minimum, provide 2 hours of demonstration and training for each of the following systems, subsystems, and equipment:

   1. Flow control valves.
   2. Pumps.
   3. Water treatment.
   4. Air handling units.
   5. Motor control center(s).
   6. Variable frequency drives.

END OF SECTION 017900

SECTION 01 91 13 – GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes general requirements that apply to implementation of commissioning without regard to specific systems, assemblies, or components.

B. Commissioning is a team-oriented, systematic process to verify, and document performance of selected facility systems, and assemblies, in accordance with defined objectives, criteria, the design intent and Owner's operational needs and that they can be maintained to perform as intended throughout the building life cycle.

C. The Commissioning Process is a quality based method that is adopted by Owner to achieve a successful construction project and is not an additional layer of construction or project management. Commissioning does not remove or reduce the responsibility of the contractor or it's subcontractors to provide a finished and fully functional product.

D. Refer to the separate Commissioning Plan for specifics regarding the Commissioning Process and procedures, systems and equipment to be commissioned, and roles and responsibilities for all Commissioning Team members. The Commissioning Plan is part of the contract documents. The Commissioning Plan is a working document and is updated as additional information concerning systems to be commissioned is obtained. As checklists and test documents are developed, updated and completed; each become a part of the Commissioning Plan.

E. Related Divisions and Sections:

1. Section 01 33 00, "Submittal Procedures."
2. Section 01 78 23, "Operation and Maintenance Data."
3. Section 01 79 00, "Demonstration and Training."
4. Division 23 "Heating, Ventilating, and Air Conditioning (HVAC)"

1.3 DEFINITIONS

A. Acceptance: A formal action, taken by a person with appropriate authority (which may or may not be contractually defined) to declare that some aspect of the project meets defined requirements, thus permitting subsequent activities to proceed.

B. Checklists: Verification checklists that are developed and used during all phases of the commissioning process to verify that the design intent and DDH are being achieved. This includes checklists for general verification, testing and other specific requirements.

C. Commissioning (Cx): A systematic process of ensuring that equipment or systems have been properly installed and function in tested modes according to Contract Documents. It shall also verify that building systems perform interactively according to DDH and Owner's operational needs. The Commissioning process shall encompass and coordinate traditionally separate functions of system documentation, equipment Startup, Control System calibration, testing and balancing and performance testing.

D. Commissioning Authority (CxA): Identified by the owner. Leads, plans, schedules and coordinates the commissioning team to implement the Commissioning Process. The process is based on the structure developed and presented in ASHRAE Guideline 0-2005.

E. Commissioning Plan: A written plan of how the commissioning process will be accomplished. The plan describes how the Commissioning Team will accomplish commissioning responsibilities.

F. Commissioning Process: A quality-focused process for enhancing the delivery of a project. The process focuses upon verifying and documenting that the facility and its systems and assemblies are planned, designed, installed and tested to meet the design intent.

G. Commissioning Team (CxT): The individuals, who through coordinated actions are responsible for implementing the commissioning process.

H. Construction Documents: These include a wide range of documents that will vary from project to project and with Owner's needs and with regulations, and laws. Construction Documents usually include the project manual (specifications), plans (drawings), and general terms and conditions of the contract.

I. Contract Documents: These include a wide range of documents that will vary from project to project with Owner's needs, regulations, and laws. Contract Documents frequently include price agreements, construction management process, subcontractor agreements, and/or requirements, requirements and procedures for submittals, changes, other construction requirements, timeline for completion, and the Construction Documents.

J. Coordination Drawings: Drawings showing the work of all trades to illustrate that equipment can be installed in the space allocated without compromising equipment function or access for maintenance and replacement. These drawings graphically illustrate and dimension manufacturers' recommended maintenance clearances.

K. Deficiency: An issue that prohibits the successful passing of any step in the installation or function of a component, piece of equipment, or system that is not in compliance with design intent, DDH, or contract documents.

L. Design Intent: A document that details the functional requirements of a project and the expectations of how it will be used and operated. These include project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information. The design intent is translated into the construction documents. The design intent is the ultimate measure of the project's technical success.

M. Factory Testing: Testing of equipment at the factory or on-site by a factory representative with Design Manager or other Owner representative present.

N. Functional Performance Test(s) (FPT): A procedure authored by the CxA designed to verify the functional performance of equipment or systems under a full range of operating conditions and loads, as specified by contract documents. The contractor and/or subcontractors perform the FPT and provide necessary test equipment to complete the tests. The CxA directs, witnesses, and documents the FPT.

1. Functional performance testing shall not be performed until Pre-Functional Verification Checklists and Startups are completed, and verified.

O. General Contractor (GC): The contractor, subcontractor, suppliers and vendors who perform the construction activities and comply with the contract documents.

P. Issues Log: A formal and ongoing vehicle to track commissioning issues concerns, deficiencies, their status and resolution of each item.

Q. Occupancy and Operations Phase Commissioning: May include tests performed after Substantial Completion, due to partial occupancy, equipment, design requirements, or other site conditions that prohibit tests from being performed during construction phase. May also include, problem resolution, design evaluation, site visits, updated drawings and specifications, or other requirements performed during the occupancy and initial operations period defined for the project.

R. Owner’s Witness: Owner authorized witness designated to sign completed Commissioning Test Data Forms to authenticate reported test data.

S. Pre-Functional Verification Checklist(s) (PFVC): Activities that must be performed for the proper storage, handling and installation of building components and equipment. Pre-functional verification checklists must be completed by the GC prior to Functional Performance Testing.

T. Simulated Condition: Condition created for purpose of testing response of system.

U. Startup: Initial starting or activating of dynamic equipment, including executing Pre-Functional Verification Checklists. Startup must be completed prior to Functional Performance Testing.

V. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

W. TAB: Testing, Adjusting, and Balancing.

X. Test Procedure: A written protocol that defines methods, personnel, and expectations for tests conducted on components, equipment, assemblies, systems, and interfaces among systems.

Y. Verification: The process by which specific documents, components, equipment, assemblies, systems, and interfaces among systems are confirmed to comply with the criteria described in the design intent and DDH.

1.4 COMMISSIONING TEAM

A. Members of the commissioning team shall include the following and their representatives:

1. Owner

2. Commissioning Authority (CxA)
3. General Contractor (GC)

B. Membership: Team members shall be appointed, each having the authority to act on behalf of the entity he or she represents, to implement the commissioning process through coordinated action.

1.5 OWNER RESPONSIBILITIES

A. Owner defines the overall vision for the use of the area, establishes the Design Intent and Commissioning objectives, establishes the construction budget, and ultimately accepts and operates the finished facility.

B. Owner's responsibilities include:

1. Assembles the Commissioning Team (CxT).
2. Attends design, construction, and commissioning related meetings.
3. Coordinates site visits and testing with the CxA.
4. Monitors/reviews PFVC to ensure the results are documented as the checklists are completed.
5. Monitors control system point-to-point checks performed by the controls contractor and ensure the results are documented as the checks are completed.
6. Oversees all or part of testing of the control system and approves it for use by TAB, before TAB is executed.
7. Receives TAB plans and reports and coordinates their review.
8. Participates at their discretion in Functional Performance Testing.
9. Coordinates training with the General Contractor and approves training plans.
10. Reviews and approves Operations and Maintenance documentation.
11. Reviews and approves GC maintenance schedules for equipment operated by the GC prior to acceptance.
12. Review and approve the preparation of the final Operation and Maintenance manuals. Ensure required Operation and Maintenance manuals, instructions and demonstrations are provided to Owner's designated operating staff.

C. Appoints the Design Manager (DM). The DM has the overall responsibility to execute the design in accordance with the Design Intent.

The DM shall:

1. Translates Owner's requirement into technical design intent.
2. Prepares thorough, accurate, and clear contract documents.
3. Develops/updates the Design Data Handbook (DDH).
4. Incorporates commissioning specifications and related information into construction specifications.
5. Supports and advises the Commissioning Authority (CxA) in developing testing documents.
6. Issues clarifications or interpretations of Design Intent as required.
7. Provides the CxA one copy of all approved technical submittals.
8. Provides the CxA one copy of correspondence regarding all RFI's.
9. Consults and resolves any design related issues/problems that arise during the construction.

10. Copies the CxA on changes relating to systems and equipment to be commissioned.

1.6 COMMISSIONING AUTHORITY (CxA) RESPONSIBILITIES

A. The CxA implements and facilitates overall Commissioning activities. The primary role of the CxA is to develop, coordinate and execute testing plans, document performance and confirm proper system functionality and interactions in accordance with the Design Intent, DDH, and Contract Documents.

B. The CxA functions interdependently with the design and construction teams and is Owner's representative throughout the construction process.

C. The CxA is not responsible for design concept, design criteria, compliance with codes, design or general construction scheduling, cost estimating, or construction management. These are responsibilities of Owner, Design Manager, and General Contractor.

D. The CxA shall assist with problem solving, and resolving non-conformance or deficiency issues; however, responsibility remains that of the designer and contractor.

E. Specific responsibilities of the Commissioning Authority include:

1. Develops a Commissioning Plan, which describes in general the extent of the Commissioning process to accomplish the design intent and coordinate with the construction schedule.
2. Coordinates Commissioning activities in a logical, sequential and efficient manner.
3. Kicks off the commissioning effort. Conducts an initial CxT meeting to describe the process, review roles and responsibilities, set expectations, establish communication and coordinate the work.
4. Schedule and lead commissioning meetings as needed with the Commissioning Team.
5. Develops PFVC and FPT based on the Contract Documents, manufacturers O&M information, and accessibility requirements for O&M. Brings to the attention of Owner, DM, and GC identified deficiencies and coordination problems with HVAC systems/equipment to be commissioned.
6. Reviews completed PFVC to ensure the results are documented properly as the checklists are completed and to evaluate any issues which are documented in the PFVC.
7. Tracks testing non-conformance. Participates in re-testing as necessary until satisfactory performance is achieved as requested by Owner.
8. Compile and maintain organized and complete commissioning records.
9. Review approved submittals applicable to the systems being commissioned to assist in development of testing checklists.
10. Review requests for information and change orders for impact on commissioning.
11. Establishes test plans and cooperates with schedules set up by CxT.
12. Coordinate with Owner and GC to monitor Functional Performance Testing for commissioned systems and assemblies. Witness and document Functional Performance Tests performed by the Contractor for all commissioned HVAC systems and assemblies.
13. The Functional Performance Testing will include operating the system and components through each of the written sequences of operation, and other significant modes and sequences, including start-up, shutdown, unoccupied mode, manual mode, staging, miscellaneous alarms, power failure and interlocks with other systems or equipment. Sensors and actuators shall be calibrated by the installing contractors, and spot-checked

by the commissioning provider during Functional Performance Testing. Coordinate retesting as necessary until satisfactory performance is achieved. Tests on respective HVAC equipment shall be executed, if possible, during both the heating and cooling seasons. However, some overwriting of control values to simulate conditions may be required. Functional Performance Testing shall be done using conventional manual methods and readouts, to provide a high level of confidence in proper system function, as deemed appropriate by Owner.

14. Maintain a master issues log and a separate record of Functional Performance Testing. Report all issues to Owner as they occur. Provide written progress reports and test results with recommended actions.
15. If requested by the CxT attend selected planning and job-site meetings to obtain information on construction progress.
16. Reviews TAB execution plan and reports.
17. As a part of the FPT, monitors control point-to-point checks performed by the controls contractor and ensures the results are documented as the checks are completed.
18. Reviews FPT and analyze data to verify performance.
19. Document design non-compliance and deficiencies identified in all phases of Commissioning.
20. Recommends acceptance of tested systems and equipment commissioned to Owner.
21. Provides a final Commissioning Report that will include:

    a. An Executive Summary
    b. List of participants and roles
    c. Brief project description
    d. Overview of Commissioning and testing scope
    e. General description of testing and verification methods.
    f. For each piece of commissioned equipment, the report will contain the disposition of the Commissioning Authority regarding the adequacy of the equipment. Outstanding non-compliance and deficiencies shall be specifically listed. Appendices shall contain acquired documentation of all completed PFVC, FPT, deficiency lists, site visit reports, general findings and unresolved issues.

1.7 GENERAL CONTRACTOR (GC) RESPONSIBILITIES.

A. The GC has overall responsibility and authority to procure the construction materials and work force and manage the construction to ensure compliance with and coordination of the Contract Documents.

B. Specific responsibilities of the GC include:

1. Include cost of support for the Commissioning process in the total Contract Sum.
2. Cooperate with the CxA and other Commissioning Team members, to facilitate the successful completion of the Commissioning process.
3. Facilitate coordination of Commissioning by Commissioning Authority and shall include commissioning activities in Construction Schedule.
4. Assign a GC representative to the Commissioning Team within one month of the Award of the Contract. The representative shall have the authority to make decisions on behalf of the GC as those decisions relate to the organization and scheduling of commissioning activities.

5. Coordinate construction meetings, schedules and Commissioning activities with Owner and CxA. Coordination shall include, but not be limited to the following:

    a. Commissioning Team meetings
    b. Planning
    c. Scheduling Documentation
    d. Provide the CxA with pertinent information (RFI, submittals, changes) relative to systems and equipment to be commissioned.

6. Attend Commissioning Team meetings; respond to action items from these meetings to allow the Commissioning activities to proceed on schedule.
7. Ensure cooperation and participation of specialty sub-contractors.
8. Submit Commissioning milestones for incorporation into the overall construction schedule, in cooperation with the CxA and Owner. As a minimum, the following commissioning related activities shall be included in the project schedule:

    a. Completed installation of systems and assemblies to be commissioned.
    b. Completed Pre-Functional Verification Checklists.
    c. Functional Performance Testing.
    d. Substantial completions.

9. Inspect, check and confirm the correct and complete installation of all systems, sub-systems and component start-up for each system. Coordinate with all trades to document the results of inspections on the checklists and sign them. If deficient or incomplete work is discovered, ensure corrective action is taken and re-check until the results are satisfactory and the system is ready for safe start-up.
10. Notify Owner seven days in advance of scheduled on-site start-up or equipment energization procedures.
11. Assist and operate equipment during systems testing as required.
12. Provide any special tools and/or instruments specific to the piece of equipment or system that is required for testing. Test instruments shall have verifiable certificate of calibration within the past twelve (12) months.
13. Provide O&M documentation in accordance with the construction specifications.
14. Develop and execute orientation and training in accordance with the contract documents.
15. Provide personnel to assist the CxA during system verification and FPT. Operate equipment and systems during FPT in accordance with the Commissioning Plan and as directed by the CxA. If improper functionality, incomplete work, or other deficiencies affecting system performance are discovered, the CxA will stop the FPT. Those responsible for deficient or incomplete work will be equally responsible to ensure necessary corrections are completed for full system operation as specified.
16. In the event the deficiencies cannot be completed within one (1) re-test, the GC shall pay the cost to retest plus any additional cost incurred for travel expenses for subsequent tests.
17. Execute Commissioning responsibilities according to Contract Documents and Construction Schedule.
18. Attend Commissioning meetings.
19. Coordinate training of Owner personnel.
20. Complete PFVC and submit them to Owner. PFVC shall be completed as the equipment delivery, installation and start up progresses. PFVC shall be complete and verified before functional testing is performed.

21. Analyze functional performance trend logs and monitoring data to verify performance of installed equipment.
22. Provide requested Submittal data, including detailed start-up procedures and specific responsibilities of Owner required to keep warranties in force.
23. Provide information requested by Commissioning Authority regarding equipment sequence of operation and testing procedures.
24. Coordinate Test Procedures for equipment installed by factory representatives with the Commissioning Authority or Owner.
25. Comply with the Commissioning Plan.
26. Provide approved equipment documentation to Commissioning Authority, including detailed start-up procedures.

1.8 COORDINATION

A. Management: Commissioning Authority directs and coordinates Commissioning activities.

1. Members of Commissioning Team work together to fulfill their contracted responsibilities and meeting objectives of Contract Documents. The CxA facilitates the commissioning process.
2. Commissioning shall be coordinated with construction and acceptance.

B. Scheduling:

1. GC shall work with Owner and CxA in accordance with requirements of Contract Documents to schedule Commissioning activities.
2. GC shall provide not less than thirty days in advance notice to Owner and CxA for scheduling Commissioning activities. The GC shall integrate Commissioning activities into the Construction Schedule.
3. Commissioning Team and others involved in Commissioning process shall address scheduling problems and make necessary notifications in a timely manner in order to expedite Commissioning process.
4. The GC shall coordinate with Owner and CxA. Coordination shall include the following:

    a. Site visits and meetings
    b. Planning
    c. Scheduling
    d. Documentation
    e. Communication with the CxA
    f. Corrective actions

1.9 COMMISSIONING PLAN, TESTS, AND CHECKLISTS

A. Commissioning Plan. The CxA develops the Commissioning Plan to guide the commissioning process.

1. General project information.
2. Key points of contact.
3. Roles and responsibilities.

4. List of systems to be commissioned.
5. Scope Pre-Functional Verification Checklists.
6. Deficiency/non-conformance tracking format.

B. Commissioning Tests and Checklists: The CxA develops and provides Checklists to the commissioning team. Checklists will be developed utilizing the contract documents and approved submittals:

1. Pre-Functional Verification Checks (PFVC): PFVC cover the activities that must be performed for the proper storage, handling and installation of building components and equipment. PFVC shall be completed and submitted prior to startup.
2. Functional Performance Test (FPT): Functional Performance Tests cover activities associated with starting and running dynamic equipment and systems to insure proper set-up, alignment, operation and that inputs/outputs are in accordance with the design. For non-dynamic components, functional tests ensure proper function.

1.10 COMMISSIONING PROCESS

A. The Commissioning Plan is a working document and will be updated as the various checks and tests are completed and additional information concerning the systems to be commissioned is obtained.

B. Commissioning Process. The following are anticipated commissioning tasks:

1. Commissioning checklists and the equipment list will be developed and provided as specific manufacturers and models of equipment are submitted and approved for installation.
2. Specific checks and tests will be performed and documented on checklists for the PFVC and FPT. The GC shall document by initialing the specific checks on each individual PFVC. Owner and CxA will spot check for compliance.
3. The CxA will update the commissioning plan to incorporate changes in key personnel, construction modifications, schedule changes and other events that may affect the commissioning process.
4. A commissioning kick off meeting will be conducted by the CxA, to review the commissioning process with the commissioning team members.
5. Additional meetings shall be required throughout construction, scheduled by Owner and CxA with necessary parties attending, to plan scope, coordinate, schedule future activities and resolve problems. The CxA will participate in these meetings by phone.
6. Approved equipment documentation is provided to the CxA upon completion of formal submittal review, including detailed manufacturer’s installation and startup procedures.
7. The GC shall provide manufacturer’s O&M, installation and startup directions to Owner for incorporation into the process.
8. The GC executes the Pre-Functional Verification Checklists and completes according to the Commissioning Plan, and documents results. Owner will witness startup of selected and critical equipment, as identified by Owner.
9. The CxA develops required specific equipment and system functional performance test procedures.
10. The CxA oversees the FPT. The GC shall execute the tests and sign-off on these tests.
11. Items of non-compliance are noted and logged in the issues log. Corrective action by the appropriate party is noted and logged.

12. Owner reviews and verifies training plans developed and executed by the GC and Subcontractors.
13. Owner reviews the Operation and Maintenance Manual documentation.

C. The GC shall verify each item of each commissioning checklist has been checked. Non-compliance issues shall be noted on an issues log developed and provided by the CxA.

D. Various Sections of the Specifications include commissioning requirements. These requirements shall be included in the Commissioning Process, but shall not be interpreted to be the only commissioning requirements. The Commissioning Specification, tests and checklists shall take precedence, where there are conflicts.

E. Completed checklists and deficiency/non-conformance reports shall be turned in to Owner at the completion of each check or test.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 STARTUP, PRE-FUNCTIONAL VERIFICATION CHECKLISTS, AND INITIAL CHECKOUT

A. General: Pre-Functional Verification Checklists are used to check that equipment and systems are properly connected and operational. Every piece of commissioned equipment shall receive Pre-Functional Verification checkout by the GC. Pre-Functional Verification checks for a given system shall be successfully completed prior to Functional Performance Testing.

1. Only individuals who have direct knowledge and who witnessed that the line item task on the Pre-Functional Verification Checklist was performed shall initial or check the item off the checklist.
2. Pre-Functional Verification checks shall be performed concurrent with component delivery, storage, installation and start-up. Checks shall not be postponed to the last stages of component installation.

3.2 FUNCTIONAL PERFORMANCE TESTING

A. General:

1. The following applies to all Commissioning functional testing required for Project.
2. List of equipment to be commissioned is found in the commissioning plan.

B. Test Methods:

1. Functional Performance Testing and verification may be achieved by Manual Testing and/or by monitoring performance and analyzing results using Control System’s trend log capabilities or by stand-alone dataloggers.

a. The Commissioning Plan and the Specifications describe methods to be used for each test.

1) Commissioning Authority may substitute specified methods or require additional methods to be executed, with approval of Owner.
2) Commissioning Authority shall determine which method is most appropriate for tests that do not have method specified.

2. Simulated Conditions: Allowed with CxA approval, however, schedule the testing to experience actual conditions wherever practical.

a. Before simulating conditions, sensors, transducers, and devices shall be calibrated.

3. Over-Written Values:

a. Allowed with Owner and CxA approval, but shall be used with caution and avoided when possible.
b. Before overwriting values, sensors, transducers, and devices shall have been calibrated.

4. Altering Setpoints: Acceptable procedure in lieu of overwriting sensor values or simulating conditions, with Owner and CxA approval.
5. Setup:

a. Each function and test shall be performed under conditions that simulate actual conditions as close as practically possible.
b. The GC shall provide necessary materials, system modifications, etc., to produce necessary flows, pressures, temperatures, etc., necessary to execute test according to specified conditions.
c. At completion of test, the GC shall return affected building equipment and systems to pre-test condition.

6. Sampling:

a. Multiple identical pieces of non-life-safety or otherwise non-critical equipment may be functionally tested using a Sampling strategy developed by the CxA.
b. Significant application differences and significant sequence of operation differences in otherwise identical equipment will be deemed to invalidate the common identity of the equipment.
c. Small size or capacity difference, alone, does not constitute a difference in the equipment.
d. Specific recommended sampling rates are identified in the Commissioning Plan.

1) If, at any point, frequent failures occur and testing becomes more troubleshooting than verification, the Commissioning Authority may stop testing and require the GC to perform and document checkout of remaining units, prior to continuing with functional testing of the remaining units.

e. Sampling is not allowed in Pre-Functional Verification Checklist execution.

C. Coordination and Scheduling:

1. The GC shall provide sufficient notice, as specified elsewhere in this Specification Section, to Commissioning Authority regarding completion schedule for Pre-Functional Verification Checklists and Startup of equipment and systems. Schedule functional tests with Owner.

    a. Functional testing shall be executed by the GC.
    b. The Commissioning Authority shall direct, witness, and document functional testing.

2. General:

    a. Functional testing shall be conducted only after Pre-Functional Verification checks and Startup has been satisfactorily completed.
    b. Control System shall be sufficiently tested and approved by Owner prior to use for testing and balancing or to verify performance of other components or systems.
    c. Air balancing and water balancing shall be satisfactorily completed before functional testing of air-related or water-related equipment or systems.
    d. Testing shall proceed from components or subsystems to systems.
    e. When proper performance of interacting individual systems has been achieved, interface or coordinated responses between systems shall be checked.

D. Problem Solving: Commissioning Authority may participate in problem solving, however, the burden of responsibility to solve, correct, and retest problems remains with the GC and Owner.

1. Cost of Retesting:

    a. Deficiencies for which GC is responsible, the GC is responsible for costs.
    b. Government cost for more than one (1) retest in which the GC is responsible shall be reimbursed by the GC.
    c. The Commissioning Authority will track re-testing as an open item in the Commissioning Issues Log.
    d. Required retesting by GC shall not be considered justification for Claim of Delay or for time extension by GC.

3.3 OPERATION AND MAINTENANCE MANUALS

A. Specific content and format requirements for standard Operation and Maintenance Manuals are detailed in Section 01 78 23 "Operation and Maintenance Data" and in the pertinent sections of technical Specifications. Owner reviews and accepts Operation and Maintenance Manuals.

3.4 TRAINING OWNER PERSONNEL

A. Specific content and format requirements for Demonstration and Training are detailed in Section 01 79 00 "Demonstration and Training" and in the pertinent sections of technical Specifications. Owner reviews training plans and schedules and verifies that demonstration and training has been completed.

END OF SECTION 01 91 13

SECTION 02 41 19 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Demolition and removal of selected portions of building or structure.
2. Demolition and removal of selected site elements.
3. Salvage of existing items to be reused or recycled.

B. Related Requirements:

1. Section 02 82 00 “Asbestos Abatement and LCC Demolition” for demolition of hazardous materials.
2. Section 31 20 00 “Earthmoving” for excavation of underground utilities to be demolished.

1.2 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.

B. Remove and Save for Reuse: Detach items from existing construction, prepare for reuse, and reinstall where indicated.

C. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

D. Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to FAA ready for reuse. Include fasteners or brackets needed for reattachment elsewhere.

E. HEPA Filter: High Efficiency Particulate Air Filter. A filter capable of trapping and retaining at least 99.97 percent of all mono-dispersed particles of 0.3 micrometers in diameter.

1.3 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor. See Section 01 74 19 “Construction Waste Management and Disposal”

B. Any existing security system component or door hardware that is removed and not incorporated back into the work is to be protected and turned over to the Contracting Officer’s Representative (COR).

1.4 PREINSTALLATION MEETINGS

A. Pre-demolition Conference: Conduct conference at Project site.

1. Inspect and discuss condition of construction to be selectively demolished.
2. Review structural load limitations of existing structure.
3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
5. Review areas where existing construction is to remain and requires protection.
6. Review provisions for temporary power and service to maintain building security systems and components (card readers, security cameras, etc.) during demolition and construction.
7. Review demolition work with construction waste management requirements.

1.5 ACTION SUBMITTALS

A. Hot Work Permit: Prior to starting related work, prepare and submit requests for FAA Hot Work Permits. The Contractor shall coordinate all project-related Hot Work with the COR.

B. Qualification Data: For refrigerant recovery technician.

C. Proposed Protection Measures: Submit report, including drawings, that indicates the measures proposed for protecting individuals and property for dust control and for noise control. Indicate proposed locations and construction of barriers.

1. Dust Control: Provide Dust Control Plan including proposal for adequate ventilation and accompanying sketches or shop drawings.
2. Proposed Noise Control Plan.
3. Hot Work and Torch Cutting Plan: Include information requirements found in Part 3 of this Section for Hot Work and torch cutting.
4. Hot Work Plan. Include copy of permit if applicable.
5. Air Quality Plan: Submit plan for maintaining fresh air in work areas and removal of odors from work area during construction. Include list of products that will emit an air-borne odor and MSDS for each product, including, but not limited to:

a. Paints.
b. Adhesives.
c. Sealants.

D. Schedule of Selective Demolition Activities: Indicate the following:

1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure FAA's on-site operations as well as security systems and components are uninterrupted.
2. Interruption of utility services. Indicate how long utility services will be interrupted.
3. Coordination for shutoff, capping, and continuation of utility services.

4. Use of elevator and stairs.
5. Coordination of FAA's continuing occupancy of portions of existing building.

E. Inventory: Submit a list of items to be removed and delivered to FAA prior to start of demolition.\

1.6 INFORMATIONAL SUBMITTALS

A. Digital photographs, sufficiently detailed, of existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by selective demolition operations.

B. Record drawings at Project closeout.

1. Identify and accurately locate capped utilities and other subsurface structural, electrical, or mechanical conditions.

C. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

1.7 QUALITY ASSURANCE

A. Handle waste materials as specified in Section 01 74 19 “Construction Waste Management and Disposal”.

B. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

1.8 FIELD CONDITIONS

A. FAA will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so FAA's operations will not be disrupted.

B. Conditions existing at time of inspection for bidding purpose will be maintained by FAA as far as practical.

C. Notify COR of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Hazardous Materials: Hazardous materials are present in buildings and structures to be selectively demolished. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.

1. Hazardous material remediation is specified elsewhere in the Contract Documents.

E. Storage or sale of removed items or materials on-site is not permitted.

F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

1. Maintain sprinkler and fire alarm systems in service during selective demolition operations or provide approved alternate procedures such a fire watch.

2. Protect existing fire sprinkler and fire alarm components to be incorporated back into the Work.

PART 2 - PRODUCTS

2.1 PEFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Level of Standards: Comply with ANSI/ASSE A10.6 R1998 “Safety Requirements for Demolition Operations – American National Standard for Construction and Demolition Operations” and NFPA 241 “Standard for Safeguarding Construction, Alteration, and Demolition Operations,” 2013 edition.

2.2 REPAIR MATERIALS

A. Use repair materials identical to existing materials, except as required for compliance with Article B. below.

1. Where identical materials are unavailable or cannot be used for exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.
2. Use materials whose installed performance equal or surpasses that of existing materials.

B. Use low-VOC (volatile organic compound) products as specified in technical sections. Provide newer-formulated, low-voc products in place of existing products for repairs and renovation for the Work.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Review record documents of existing construction provided by FAA. FAA does not guarantee that existing conditions are same as those indicated in record documents.

C. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to COR.

E. Survey of Existing Conditions: Record existing conditions by use of measured drawings.

1. Inventory and record the condition of items to be removed and stored. Provide digital photographs of conditions that might be misconstrued as damage caused by removal operations.
2. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

F. Prior to core drilling reinforced concrete, locate reinforcing and utilities embedded within concrete with a magnetic steel locator such as one of the following:

1. "Profometer 5" manufactured by Proceq-SA, Zurich, Switzerland. (North American Sales Representative: SDS Non-Destructive Testing Equipment Inc., PO Box 844, Paso Robles, CA 93447 (Phone: 805-238-3229).
2. Ferroscan FS 10 Steel Reinforcement Detection System manufactured by Hilti, Tulsa, OK (Phone: 800-879-6000 to get a local field representative).

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. COR will arrange to shut off indicated services/systems when requested by Contractor.

C. Refrigerant: Remove refrigerant from mechanical equipment to be selectively demolished according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 PREPARATION

A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.

2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
4. Cover and protect furniture, furnishings, and equipment that have not been removed.
5. Comply with requirements for temporary enclosures and dust control as indicated herein and on the Drawings.

3.4 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
2. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
3. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.
4. Maintain adequate ventilation when using cutting torches.
5. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
6. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
7. Dispose of demolished items and materials promptly.

B. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

C. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by COR, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. Concrete: Demolish in small sections. Using power-driven saw, cut concrete to a depth of at least 3/4 inch at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete. Neatly trim openings to dimensions indicated.

B. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.

C. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.

1. Verify that no embedded utilities are within concrete. If discovered, notify COR and coordinate plan on how to proceed with the work.

3.6 HOT WORK AND CUTTING

A. Contractor shall submit a Hot Work and Torch Cutting Plan for approval prior to beginning Hot Work and cutting activities. The Plan shall identify the portions of work where Hot Work and cutting will be performed, locations of the work, types of Hot Work and cutting being proposed, schedule for the proposed Hot Work and cutting activities, and Contractor's plan for protecting the facility and its occupants, operations, and equipment during the Hot Work and cutting activities. Special attention is required for procedures and protection for Hot Work and cutting around or adjacent to existing electronic equipment.

B. Building electrical power shall not be used for arc Hot Work. Building components, including structural or miscellaneous steel shall not be used as grounding return for Hot Work activities.

C. Ventilation and exhaust to the outside shall be provided during Hot Work and cutting activities to keep the zone clear. Do not weld or cut unless ventilation and exhaust have been deemed acceptable by the COR. Provide non-flammable shields to protect persons and property. Keep cylinders upright and chained or secured to their supports.

D. Remove flammable materials from Hot Work and cutting areas prior to beginning Hot Work and cutting activities. Keep fire extinguishers in the Hot Work and cutting areas.

E. Perform Hot Work and cutting in accordance with the American Society's Specifications and Safe Practice Codes criteria, and with OSHA Safety Requirements.

F. Fire Watch: Provide Fire Watch Operations in accordance with OSHA Safety Requirements.

3.7 HOT WORK

A. Hot Work is any activity that creates heat, flame, sparks, or smoke. Examples of Hot Work include but are not limited to: Hot Work (gas or arc), Cutting, Grinding, Brazing, Soldering, use of Open Flame Heaters in Buildings, and Hot Tar Operations.

B. The Contractor shall obtain a Hot Work Permit prior to any activity involving hot work. A fire guard shall remain on station one hour following the cessation of hot work activities to extinguish any incipient stage fires that may develop.

3.8 PATCHING AND REPAIRS

A. See Section 01 73 00 “Execution.”

3.9 DISPOSAL OF DEMOLISHED MATERIALS

A. General: Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain FAA's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill and in compliance with Section 01 74 19 “Construction Waste Management and Disposal.”

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Burning: Do not burn demolished materials.

3.10 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

B. Change filters on air-handling equipment on completion of selective demolition operations.

C. Vacuum cleaning equipment shall contain HEPA filters.

D. Equipment used for ventilation of the facility shall use HEPA filtration system.

E. Coordinate final cleaning with requirements of Section 01 77 00 “Closeout Procedures.”

END OF SECTION 02 41 19

SECTION 02 82 00 - ASBESTOS ABATEMENT AND LCC DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Applicable provisions of Division 1 - General Requirements, Drawings, and other provisions and requirements of the Contract Documents apply to work of this Section. This specification is being included as part of the bid package to be followed for the removal of asbestos and lead coated components that will be disturbed during the course of the Project.

B. This Section includes the removal, control and disposal of asbestos and lead coated components (LCC), which shall be encountered during the work at the Denver ARTCC, Longmont, CO. The work may include the construction of temporary enclosures to isolate the work area, the establishment of negative-air pressure within the isolated work area, the removal of LCC from the isolated work area, and the packaging and legal disposal of the removed LCC from FAA property.

1. Observe all existing conditions prior to submitting a bid. Include in the bid, existing conditions and their impact, particularly to cost and health and safety of workers and occupants, and proper function and operation of the facility. Be aware of other work being performed. Failure to visit the site shall in no way provide relief from the necessity of furnishing materials or performing any work that may be required to complete the work in accordance with the Contract Documents without additional cost to the FAA. All site visits shall be scheduled with the FAA.

2. The quantities, locations and the extent of work indicated are only best estimates, which are limited by the physical constraints imposed by occupancy of the facility.

C. Asbestos Containing Material (ACM) and Lead paint and Lead Coated Components (LCC) Locations: Refer to the contract drawings for identification of areas and locations of materials to be abated. Coordinate abatement work with all areas of work scheduled for the Project.

D. This Project may require lead paint spot abatement and lead component removal. Structural steel component removal, mechanical demolition, architectural components demolition, and electrical demolition shall be included as part of the demolition pricing.

1.2 REFERENCE DOCUMENTS

The following documents are included for general reference and may not be inclusive of all standards applicable for this Project. The current issue of the following documents on the date of Invitation for Bids form a part of this specification and are applicable to the extent specified. Work shall conform to applicable federal, state and local government’s regulations and to the requirements specified in these Contract Documents. Whenever inconsistencies occur between the

referenced materials, the more stringent shall apply. The intent of these documents is to verify the Work is conducted at the highest level of safety.

American National Standards Institute (ANSI)

ANSI Z87.1	Occupational and Educational Eye and Face Protection
ANSI Z88.2	Respiratory Protection
ANSI Z89.1	Hard Hats
ANSI Z9.2	Fundamentals Governing the Design and Operation of Local Exhaust Systems

American Society for Testing and Materials (ASTM)

ASTM C 732	Aging Effects of Artificial Weathering on Latex Sealants
ASTM D 522	Mandrel Bend Test of Attached Organic Coatings
ASTM D 1331	Surface and Interfacial Tension of Solutions of Surface-Active Agents
ASTM D 2794	Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
ASTM D 4397	Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications
ASTM E 84	Surface Burning Characteristics of Building Materials
ASTM E 96	Water Vapor Transmission of Materials
ASTM E 119	Fire Tests of Building Construction and Materials
ASTM E 736	Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members
ASTM E 1368	Visual Inspection of Asbestos Abatement Projects
ASTM D 2986	Evaluation of Air Assay Media by the Monodisperse DOP (Dioctyl Phthalate) Smoke Test
ASTM D 4884-96	Standard Test Method for Strength of Sewn or Thermally Bonded Seams of Geotextiles

Code of Federal Regulations (CFR)

29 CFR Part 1910	Occupational Safety and Health Standards
Subpart I	Personal Protective Equipment
1910.132	General Requirements
1910.134	Respiratory Protection
Subpart J	General Environmental Controls
1910.145	Specifications for Accident Prevention Signs and Tags
Subpart Z	Toxic and Hazardous Substances
1910.1000	Air Contaminants
1910.1001	Asbestos
1910.1025	Lead
1910.1200	Hazard Communication
29 CFR Part 1926	Safety and Health Regulations for the Construction Industry
Subpart D	Occupational Health and Environmental Controls

1926.51	Sanitation
1926.52	Occupational Noise Control
1926.56	Illumination
1926.62	Lead
Subpart E	Personal Protective & Life Saving Equipment
1926.100	Head Protection
1926.101	Hearing Protection
1926.102	Eye and Face Protection
1926.103	Respiratory Protection
1926.104	Safety Belts, Lifelines, and lanyards
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Subpart M	National Emission Standard for Asbestos
Part 261	Identification and Listing of Hazardous Waste
Part 763	Asbestos
Subpart E	Asbestos-Containing Materials in Schools

	Subpart G	Asbestos Worker Protection
49 CFR	Part 173	Department of Transportation Shippers - General Requirements for Shipments and Packaging

National Institute for Occupational Safety and Health (NIOSH). Department of Health and Human Services

Method 7400	Fibers
Method 7402	Asbestos Fibers
Method 7082	Atomic Absorption; Flame
Method 7105	Atomic Absorption; Graphite Furnace

National Fire Protection Association (NFPA)

70	National Electrical Code
241	Construction and Renovations
701	Standard Method of Fire Tests for Flame-Resistant Textiles and Films.

Compressed Gas Association (CGA)

CGA G-7	Compressed Air for Human Respirators
CGA G-7	Commodity Specifications for Air

Underwriters Laboratories (UL)

UL 586	High-Efficiency Particulate Air Filter Units

Other Standards

NSF 49	National Sanitation Foundation Class II (Laminar Flow) Biohazard Cabinetry

Federal Aviation Administration (FAA) Orders

Order 1050.20A	Airway Facilities Asbestos Control
Order 3900.19B	FAA Occupational Safety and Health Program
Local Order	Facility Asbestos Abatement Contingency Plan

1.3 DEFINITIONS

A. The following terms used in the text shall be defined as follows:

1. CIH: An Industrial Hygienist certified in the comprehensive practice of industrial hygiene by the American Board of Industrial Hygiene.

2. Class I Asbestos Work: Activities involving the removal of thermal system insulation (TSI) and surfacing ACM.
3. Class II Asbestos Work: Activities involving the removal of ACM that is not thermal system insulation or surfacing material. This includes, but is not limited to, the removal of asbestos-containing caulk.
4. Class III Asbestos Work: Repair and maintenance operations where ACM, including TSI and surfacing ACM, is likely to be disturbed. Operations may include drilling, abrading, cutting a hole, cable pulling, crawling through tunnels or attics and spaces above the ceiling, where asbestos or asbestos-containing debris is actively disturbed. Removal of small amounts of ACM that would fit into a single 60 x 60 inch glove bag or disposal bag may be classified as a Class III job.
5. Class IV Asbestos Work: Maintenance and custodial construction activities during which employees contact but do not disturb ACM and activities to clean up dust, waste and debris resulting from Class I, II, and III activities. This may include dusting surfaces where ACM waste and debris and accompanying dust exists and cleaning up loose ACM debris from TSI or surfacing ACM following construction.
6. Competent Person: On all construction work sites the contractor shall designate a competent person having the qualifications and authority for verifying worker safety and health as required by 29 CFR 1926.20 and for overseeing asbestos-related work as required by 29 CFR 1926.1101. The duties of the competent person include, but are not limited to, the following: establishing the negative pressure enclosure, verifying its integrity, controlling entry into and exit from the enclosure, and verifying workers wear required personal protective equipment and are trained in the use of hygiene facilities, work practices, and decontamination procedures specified in this specification and applicable regulations.
7. COR: Contracting Officer’s Representative
8. Critical Barrier: 2 Layers of 6-mil polyethylene sheeting sealed over the openings in the work area (or other similarly placed physical barrier) sufficient to prevent airborne fibers in the work area from migrating to an adjacent area.
9. Demarcated Area: An area that has been isolated from the remaining portions of the building by installing critical barriers and/or flapped barriers on the doorways/entrances/and other openings to the area, posting the area with OSHA approved warning signage to prevent unauthorized entry, and providing HEPA equipped ventilation equipment to filter the air and provide directed airflow out of the area.
10. Friable ACM: A term as defined in 40 CFR 61, Subpart M and EPA 340/1-90-018 that means any material containing more than one percent asbestos as determined using the method specified in 40 CFR 763, Appendix A, Subpart F, Section 1, Polarized Light Microscopy, that when dry, can be crumbled, pulverized, or reduced to powder by hand pressure.
11. High Efficiency Particulate Air (HEPA) Filter: A filter capable of trapping and retaining at least 99.97 percent of all mono-dispersed particles of 0.3 micrometers in diameter.

12. Immediately: When the contractor is on-site, immediately refers actions required to take place within 15 minutes of being notified. When the contractor is off-site, immediately refers to actions required to take place within 2 hours of being notified.
13. Monitoring Contractor (MC): contracted as a third party to the FAA, to perform inspections and air monitoring.
14. Presumed Asbestos-Containing Material (PACM): Thermal system insulation and surfacing material found in buildings constructed no later than 1980.
15. Permissible Exposure Limit (PEL): OSHA PELs are worker exposure limits regulating the concentration of a substance in air that shall not be exceeded. (1) An airborne concentration of asbestos of 0.1 fibers per cubic centimeter of air (f/cc) as an eight- (8) hour time weighted average (TWA). (2) An airborne concentration of asbestos of 1.0 f/cc as averaged over thirty- (30) minutes (Excursion Limit).
16. Time-Weighted Average (TWA): The TWA is an 8-hour time weighted average concentration of airborne asbestos fibers (longer than 5 micrometers) per cubic centimeter of air that represents the employee's 8-hour workday as determined by Appendix A of 29 CFR 1926.1101.

1.4 Not used.

1.5 PROVIDE THE FOLLOWING POST-AWARD CONTRACTOR SUBMTTALS (Provide two copies of the following):

A. Abatement Documentation:
   1. Contractor State Licenses
      a. State Business License
      b. State Asbestos Contractors License
      c. State Lead Contractors License
   2. Asbestos and Lead (as required) abatement regulatory notifications
   3. An abatement schedule in time line format shall include the following (detail each step (as necessary))
      a. Preparation Time
      b. Notification Start Date
      c. Duration of Demolition/Abatement Activities
      d. Duration of Cleaning
      e. FAA/CIH Inspection Time
      f. Encapsulation and Drying Time
      g. Final Clearance
      h. Tear Down
   4. Interface of trades involved in the construction to support the sequencing of asbestos-related work including, but limited to:
      a. Electricians: Providing electrical power for each containment.
      b. Plumbers: Providing water supply and/or sanitary sewer connections, mechanical plumbing separations, etc.
   5. Negative Pressure Calculations for each containment
   6. Disposal Requirements:

a. Asbestos Transporter Identification
b. Hazardous Waste Transporter Identification
c. Asbestos Landfill
d. Hazardous Waste Landfill

B. Prepare a Safety, Health and Accident Prevention Plan (SHAPP) for all abatement work being performed. Incorporate the requirements and procedures of the FAA Denver ARTCC Asbestos Abatement Contingency Plan into the SHAPP. At a minimum, the SHAPP shall include the following:

1. Emergency procedures shall be in written form and prominently posted on-site. Everyone, prior to entering the work area, shall be required to read and sign these procedures to acknowledge receipt and understanding of work site layout, location of emergency exits and emergency procedures. Review and designate containment area emergency exits in adequate number and location to safely exit workers. Consideration shall be given to the resultant contamination and required decontamination, but as a second priority to life safety.
2. Emergency planning shall include considerations of fire, explosion, toxic or oxygen deficient atmospheres, electrical hazards, slips, trips and falls, confined spaces and heat/cold related injury. Written procedures shall be developed and employee training in procedures shall be provided.
3. Emergency planning shall include a Hazard Communication Program (HAZCOM). A written HAZCOM program shall be established and implemented according to 29 CFR 1926.59. Copies of Safety Data Sheets (SDS) for chemicals brought on-site by the Contractor shall be attached to the written HAZCOM Program. The FAA has the option of disallowing the use of some chemicals due to high toxicity, objectionable odors, and when more suitable substitutes are available.

C. Project Personnel

1. Provide number of full-time laborers that shall be assigned to this Project.
2. Provide number of crews and shifts for this Project.
3. Provide documentation for each employee including:
   a. Documentation from a physician that employees or agents who may be exposed to airborne asbestos or airborne lead in excess of background levels have been provided with an opportunity to be medically monitored to determine whether they are physically capable of working while wearing the respirator required without suffering adverse health effects. In addition, document that personnel have received medical monitoring as required in 29 CFR 1926.62 and 1926.1101. This documentation shall be submitted for each employee entering the regulated (removal) area and must be current within the past 12 months.

b. Submit and maintain current copies of employee-accredited asbestos and lead training certificates and state licenses for asbestos and lead at the work site for the duration of the Project.

c. Provide a copy of a current (within the last 12 months) and acceptable fit test(s) for all employees with the respirator(s) that shall be used for the abatement.

d. Submit signed certificates for each employee stating that each employee has received the following:

1. Received training in the proper handling of materials that contain asbestos and lead, as applicable.
2. Understands the health implications and risks involved (including the illnesses possible from exposure to airborne asbestos fibers or to airborne lead particulate).
3. Understands the use and limits of the respiratory equipment to be used.
4. Understands the results of monitoring of airborne quantities of asbestos and lead as related to health and respiratory equipment.
5. Understands the Project scope and has been given project specific training.

D. Laboratories: Submit documentation that the laboratory(ies)) to be used for Personnel Samples on this contract is accredited.

1. For asbestos air samples the laboratory shall be accredited by the American Industrial Hygiene Association (AIHA) for Phase Contrast Microscopy and has successful completion in the last four rounds in the American Industrial Hygiene Association (AIHA) Proficiency Analytical Testing (PAT) Program. All technicians analyzing asbestos air samples shall be a current member in the Asbestos Analyst Registry (AAR).
2. For lead air samples, the laboratory shall be accredited by the American Industrial Hygiene Association (AIHA) and participates in the Environmental Lead Laboratory Accreditation Program (ELLAP).

E. Product Data: Submit Manufacturer Product Data on the following:

1. HEPA equipped Air Filtration Devices (AFDs) Product Data
2. HEPA equipped vacuum unit Product Data
3. Disposable Clothing Product Data
4. Respirator(s) Product Data
5. Portable Shower Product Data
6. Wetting Agent Product Data and SDS
7. Encapsulant Product Data and SDS
8. Chemical Stripper Product Data, SDS, and Manufacturer recommended work practices for the product
9. Spray Adhesive Product Data and SDS
10. Low Odor Mastic Remover Product Data and SDS

11. Polyethylene Sheeting Product Data
12. Waste Water Filter and Equipment Product Data
13. Airless Sprayer Product Data
14. Asbestos Disposal Bag Product Data

F. Rental Company Notification: Provide copies of written notification to any rental company concerning the intended use of rental equipment (including scaffolding), the possibility of asbestos and lead contamination, and the decontamination procedures that shall be used prior to the return of the equipment.

G. Submittal Notarization: The submittal shall be approved, signed and dated by an officer of the company and the contractors CIH indicating name and title of each person signing. This shall constitute written acceptance of the provided Asbestos Abatement Plan as the Project design plan, note any changes from the design, quantities or sequencing.

1.6 ONGOING PROJECT SUBMITTALS

A. Submit required documentation for new employees, equipment, materials or chemicals that arrive on-site at least one day prior to arrival on-site.
B. Submit on a weekly basis, previous week's daily field notes and containment sign in sheets for the Project.
C. Submit delivery manifest 48 hours in advance of delivery date.
D. Submit OSHA compliance monitoring results within 24 hours of collection date unless they are TEM results which must be forwarded for analysis to lab outside the state of Colorado.
E. Submit required Federal, State and Local documentation regarding the transportation and disposal of ACM and lead containing materials at the earliest possible time.

1.7 PROJECT CLOSEOUT SUBMITTALS

A. Closeout Submittal: Within 30 days of the completion of the work, the Abatement Contractor shall provide a closeout submittal. The closeout submittal shall consist of the following documents:
    1. Written certification on final completion of the Work that Work complies with Contract Documents.
    2. Certification that items on punch list issued at substantial completion have been completed or corrected and that tools, construction equipment and surplus materials have been removed from the site.
    3. Daily logs for abatement work.
    4. Entry/exit logs for each containment.
    5. Copies of Waste Manifests for the Project.

6. Copies of asbestos and lead worker and supervisory personnel certifications, fit test records, and physicians written opinion forms.
7. Copies of air monitoring results.
8. Clearance and testing reports.

1.8 PROJECT CONDITION

A. The work consists of the containment and removal of asbestos containing materials and lead containing coatings. Local, state, FAA Orders and federal rules, regulations and laws govern the work.

B. The FAA shall employ an independent Monitoring Contractor (MC) to verify conformance of the abatement contractor to the Contract Documents.

C. The Abatement Contractor shall cooperate with the FAA and the Monitoring Contractor. This cooperation shall include allowing access to the work areas to allow for visual and air monitoring, collecting samples, providing requested data on personnel, equipment, scheduling and facilitating FAA monitoring of the work.

D. Do not allow anyone access to the containments who are not authorized by the FAA to enter the site of work.

E. Provide warning labels in prominent locations adjacent to asbestos containing material identified in this specification to remain. The labels shall be installed before demolition or construction starts under this contract. The labels shall remain in place, after completion of abatement work, as the property of the FAA. The labels shall be printed in large, bold letters on a contrasting background and conform to the requirements of 29 CFR 1926.1101 and contain the following information:

DANGER
ASBESTOS
MAY CAUSE CANCER
CAUSES DAMAGE TO LUNGS
AUTHORIZED PERSONNEL ONLY

Where the use of respirators and protective clothing is required in the regulated area, the warning signs shall include the following:

RESPIRATORS AND PROTECTIVE CLOTHING ARE REQUIRED IN THIS AREA

F. The ARTCC facility is a 24-hour per day, 7-day per week facility, which is essential to the safe operation of air traffic in the control area. Immediately notify the FAA in the event of a breach of any regulated work areas. Coordinate construction and abatement activities with the FAA in order to prevent any disruption of FAA operations.

1. Disruption of operations for any amount of time could jeopardize the safety of the flying public and may result is criminal prosecution.
2. The FAA shall occupy the facility during construction activities. Cooperate fully with the FAA during construction operations to minimize conflicts and to facilitate FAA usage. Perform the work so as not to interfere with FAA operations. Provide FAA personnel access to equipment remaining in service. Construct containments to allow travel routes for FAA personnel and to allow moving of necessary equipment.
3. The work shall be limited to specific areas of the building and site. Unlimited access is specifically not permitted. Arrangements for use of the buildings and site shall be restricted to those areas specifically allowed by FAA. Other contractors shall be working at the site. Cooperate with other on-site contractors and prevent work by others from jeopardizing the asbestos work. Construction planning meetings shall be held once a week to discuss other projects that could adversely impact the asbestos abatement project.

1.9 WORK BY FAA

A. Environmental monitoring and sample analysis (by separate contract).
B. The shutdown, lockout/tag out and re-start of mechanical equipment, and all energized source.
C. The shutdown, lockout/tag out and re-start of electrical circuits and equipment.

1.10 NOTIFICATION

A. The Contractor is responsible for asbestos and lead related notifications, permits, and associated fees prior to and following abatement. Notify the FAA ten 15 days prior to the start of the on-site abatement operations.

1.11 HOURS OF WORK

A. The Contractor shall strictly adhere to work hours as specified in these specifications and in Division 1. Deviations shall be pre-approved, in writing by the FAA 48 hours in advance. Noisy activities may be limited to the hours of 1:00 am to 5:30 am. Work methods that result in unacceptable disturbance or rejection by the FAA shall not result in an increase to the contract sum or extension of the contract time.

B. Request to change work hours or overtime shall require the FAA written approval prior to implementing changes. The rejection of request for change shall not result in an increase to the contract sum or extending contract time.

1.12 SCHEDULE

A. Adhere to the schedule as defined in the contract documents.

1.13 PRECONSTRUCTION MEETING

A. The FAA shall schedule a preconstruction meeting after the Notice to Proceed. The minimum agenda shall consist of the following:

1. The FAA will identify the third party monitor.
2. Establishing chain of authority.
3. Abatement schedule.
4. Critical work sequencing, scheduling.
5. Processing of field decisions.
6. Distribution of Submittal Documents.
7. Review the facility Asbestos Contingency Plan.
8. Submittals: schedules, shop drawings, product data and samples, manufacturer's certifications of products, manpower reports, major equipment deliveries and priorities, procedures for maintaining record documents, use of FAA facilities by contractor (access, parking, office area, storage area, and waste load-outs), safety and first aid procedures, security procedures and housekeeping procedures.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Material and Equipment - Prior to bringing material and equipment on site it shall be clean of environmental contamination or debris.

A. Materials and products shall comply with the requirements of 29 CFR 1910.134, 29 CFR 1926.62 and 29 CFR 1926.1101.

B. Polyethylene Sheeting: ASTM D4397, 6 mils thick, flame-retardant. Sheeting shall meet flammability requirements of NFPA 701, and flame spread and smoke density requirements of ASTM E84.

C. Duct Tape: Waterproof, pressure-sensitive adhesive tape, 3 mils (min.) thick by 3 inches wide for criticals, containment seams and repairs, and decon units; 2-inch-wide may be used only on disposal bags and personnel clothing.

D. FSK Tape: Waterproof, pressure-sensitive adhesive tape, 2 mils (min) thick by 3 inches wide for criticals, containment seams, repairs, and decon units.

E. High Efficiency Particulate Air (HEPA) Filtered Vacuum: Vacuum(s) shall be:

1. Be capable of removing 99.97% of the asbestos particles (0.3 microns or greater in diameter) from the air.
2. Be portable.
3. Be equipped with hoses of sufficient length to reach areas behind pipes, ducts and other obstacles.
4. Have new filters installed at the beginning of the Project. The filters shall be changed on a regular basis for the duration of the Project.
5. Be tested and certified on-site by the Monitoring Contractor in accordance with NSF-49. Prior to testing by the Monitoring Contractor, the abatement contractor shall have all anticipated required machines for the Project available on-site for testing. Testing without cost to the abatement contractor shall occur only one time by the Monitoring Contractor. Any additional machine testing (or re-testing of failed units) cost shall be the responsibility of the abatement contractor.
6. Be removed from the FAA property immediately if they are found to be non-conforming.

F. HEPA Filtered Ventilation System: Portable ventilation system designed to exhaust and clean the air inside the enclosure prior to exhausting to the outside of the building. The units shall have at least three (3) filter stages, including readily accessible pre- and secondary filters, and a final filter, which shall be a High Efficiency Particulate Air (HEPA) filter. The units shall:

1. Be capable of capturing particles having a diameter of 0.3 micrometers or greater in size with an efficiency of 99.97%.
2. Be equipped with the automatic restart feature.
3. Have new filters installed prior to the onset of abatement activities. The filters shall be changed on a regular basis for the duration of the Project.
4. Be located as far away from the fresh air intakes as possible.
5. Be tested and certified on-site by the Monitoring Contractor in accordance with NSF-49. Prior to testing by the Monitoring Contractor, the abatement contractor shall have all anticipated required machines for the Project available on-site for testing. Testing without cost to the abatement contractor shall occur only one time by the Monitoring Contractor. Any additional machine testing (or re-testing of failed units) cost shall be the responsibility of the abatement contractor.
6. Be removed from the FAA property immediately if they are found to be non-conforming.

G. Ducts: All HEPA ventilation ducts from the negative air machines shall be constructed of new and unused two-ply polyvinyl with polyester reinforced tubing. The attachment of the ducts shall be spliced by means of sheet metal connectors and sealed in order to verify an adequate seal. The attachment of the ducts shall withstand the force from the machines for the entire duration of the Project. The construction shall be inspected and approved by the Monitoring Contractor prior to the start of abatement activities. The Abatement Contractor’s Superintendent shall have the responsibility of inspecting the

integrity of the exhaust ducts on a regular basis throughout the duration of the abatement activities.

H. Wetting Agent: Provide water to which a surfactant has been added. Use a mixture of surfactant and water which results in wetting of the asbestos-containing material and in retardation of fiber release during disturbance of the material, equal to or greater than that provided by the use of one ounce of a surfactant consisting of 50 percent polyoxyethylene ester and 50 percent polyoxyethylene ether mixed with five gallons of water.

I. Encapsulant: Provide an encapsulant/sealant, which shall be compatible with the existing surfaces, and one, which shall act as a suitable substrate for future surface coatings. Taint (or tint) the encapsulant with a contrasting color, to be approved by the FAA, so as to identify coverage.

J. Airless Sprayer: Hand-pump type, pressure-can sprayer fabricated of either metal or plastic, equipped with a wand at the end of a hose capable of delivering a stream or spray of liquid under pressure.

K. Respirators: Personal protective breathing equipment shall be in accordance with 29 CFR 1926.62 and 29 CFR 1926.1101.

L. Signs and Labels: Signs and labels shall be provided in accordance with 29 CFR 1926.62, 29 CFR 1926.1101 and 40 CFR 61 subpart M.

M. Disposal Bags: Leak-tight, 6 mil thick clear polyethylene bags with appropriate hazard warning, per EPA regulations 40 CFR 61.150 (a) (1) (v), OSHA requirement 29 CFR 1926.1101 and DOT.

N. Miscellaneous Materials: Provide tangible supplies (such as coveralls, duct tape, soap, shampoo, towels, etc.), for persons entering the removal area. This includes FAA personnel, monitoring contractor and other persons approved for entry.

O. Air Monitoring Equipment. The equipment shall include, but not be limited to:
1. Low-volume, battery powered, body-attachable, portable personal pumps with a power pack capable of sustaining the calibrated flow rate for a minimum of 10 hours.
2. Standard 25-millimeter diameter, 0.8-micron pore size filters and cassettes in accordance with 29 CFR 1926, 1101, for asbestos personal air sampling.
3. Standard 35-millimeter diameter, 0.8-micron pore size filters and cassettes in accordance with 29 CFR 1926.62, for lead personal air sampling.
4. A flow calibrator capable of calibration to within plus or minus 2 percent of reading over a temperature range of minus 20 degrees C (minus 4 degrees F) to plus 60 degrees C (140 degrees F) and traceable to a National Institute of Standards and Technology (NIST) primary standard.

PART 3 - EXECUTION

3.1 GENERAL DESCRIPTION OF WORK

A. Comply with the requirements of these Specifications and ANSI Z9.2, 29 CFR 1910.145, 29 CFR 1926.62, 29 CFR 1926.1101 and 40 CFR 61 and 763. The most stringent of codes shall apply. The following shall be considered as the typical sequence to the asbestos/lead work. Refer to the following sections for specific procedures for the Project.

B. Environmental Monitoring: Environmental monitoring for airborne asbestos fiber concentrations, airborne lead concentrations, containment pressure differential, and third party inspections shall be accomplished by the FAA's monitoring contractor, who shall be under a separate contract with the FAA. This monitoring contractor shall respond directly to the FAA.

C. Wet Removal: ACM shall be removed using an amended water wet removal method as recommended by the EPA340/1-90-019 Asbestos NESHAP Adequately Wet Guidance Document and OSHA. The Contractor shall provide for the continual prevention of excessive water accumulation throughout the duration of the Project and shall post a minimum of one abatement worker to monitor adjacent spaces of the facility for water leakage outside the containment at all times when removal is in progress.

D. Housekeeping: Essential parts of abatement dust control are housekeeping and clean up procedures. Maintain surfaces of the abatement work area free of accumulations of asbestos or lead debris. Give meticulous attention to restricting the spread of dust and debris. Keep waste from being distributed over the general area. The use of compressed air to move waste material or dust is prohibited. Material generated during gross removal shall be packaged and removed from the containment at the end of each shift and shall not be allowed to accumulate inside the work area. The FAA shall inspect the removal area daily for residual debris.

E. Abatement Superintendent: Designate a qualified employee as abatement superintendent. The superintendent shall meet the requirements of a competent person/supervisor in accordance with OSHA and possesses at least 5 years' asbestos/lead abatement experience. The competent person shall perform the following:

1. Oversee all abatement personnel performing any abatement related work,
2. Oversee construction of all enclosures, including the worker decontamination chamber and the waste load-out chamber.
3. Control entry to and exit from the removal area.
4. Supervise all employee exposure monitoring required by OSHA.
5. Verify the proper use of protective clothing and equipment.
6. Verify that all occupants of the removal area are properly trained and certified.

7. Verify the proper use of hygiene facilities and decontamination procedures.
8. Verify that all engineering controls are functioning per design.

F. The abatement contractor will maintain radio or telephone communication with the on-site Abatement superintendent.

G. Disposal Supervisor: Designate a qualified individual to oversee the following "clean-up", "housekeeping" and disposal tasks in accordance with these Specifications, specifically:

1. Continuous floor and horizontal surface clean up.
2. Continuous clean up of abatement debris.
3. Continuous collection and disposal of water build-up. No puddling or ponding water shall be tolerated. Water or solvent seeping through the concrete floor or down the curtain wall to a lower floor is not permitted. Polyethylene sheeting shall be used to protect equipment in the lower level if leakage is possible.
4. Regular inspection of disposal procedures to verify conformance with this specification as well as all Federal, State and Local Laws.
5. The disposal supervisor shall be responsible for notifying the FAA prior to delivery of any disposal vehicles. The FAA shall conduct an inspection of every vehicle to verify that it is delivered in a clean and empty condition. The rejected disposal vehicle shall be replaced at no additional cost to the FAA.

H. Inspection by the FAA: During abatement work, the work shall be subject to on-site inspection by the FAA, who may be assisted by the monitoring contractor.

I. Work Stoppage: The FAA shall issue a "stop work" order for any of the reasons listed below. No work shall be allowed to resume until the conditions stabilize and upon approval from the FAA. Standby time required to identify and resolve the problem shall be at the expense of the Abatement Contractor and may include the costs incurred by the extended efforts of the FAA's Monitoring Contractor.

1. If asbestos air monitoring results outside the critical barriers indicate the presence of airborne asbestos outside the containment is greater than 0.02 f/cc above baseline.
2. If lead air monitoring results outside the critical barriers indicate the presence of air lead outside the containment to be greater than 30 ug/m^3.
3. If excessive water accumulations appear or if water leakage or gross contamination is detected in areas adjacent to the removal area.
4. If the work is found to violate specified requirements.
5. If conditions arise that may adversely impact or disrupt the flying operations or working conditions at the facility.

3.2 PERSONAL PROTECTIVE EQUIPMENT

A. Personal Protective Equipment (PPE): Besides providing PPE for their worker's, provide disposable coveralls for FAA representatives, monitoring contractor and authorized visitors. Abatement contractor respiratory protection shall comply with 29 CFR 1910.134, 29 CFR 1926.62, and 29 CFR 1926.1101.

3.3 TEMPORARY FACILITIES AND UTILITIES

A. Field Office: The Abatement Contractor shall furnish their temporary office space.

B. Temporary Electric: The Abatement Contractor shall provide and maintain a specified secondary electrical power center for asbestos removal operations throughout the abatement period. Connection locations and lockout/tag out shall be as directed by the FAA and electric power shall be provided at no charge to the Abatement Contractor. Under no circumstances shall FAA existing electrical circuits be used by the Abatement Contractor for any purpose, without prior authorization from the FAA.

1. The Contractor shall provide:

a. Main distribution panel with a capacity of 110-120 volts, single phase and 60 hertz and of sufficient capacity to service the complete project.
b. Circuit protection for each circuit.
c. Ground fault interruption protection for all circuits.
d. Grounded, UL listed extension cords from power centers to the point of operation.

Under no circumstances shall the contractor be allowed to connect into the critical power source.

C. Temporary Lighting: The Abatement Contractor shall provide temporary illumination for construction needs, safe working conditions, public safety and security lighting in compliance with the requirements of 29 CFR 1926.26 and subpart D. Supports and ties shall be constructed of non-conductive materials and exposed two wire conductors shall not be allowed. Lamps shall be covered with safety guards or deeply recessed in reflector and lamps shall not be suspended by their electric cords unless cord and fixture is designed for that purpose.

D. Temporary Water: The Abatement Contractor shall provide and maintain temporary water service connection throughout the abatement period. The temporary water shall be equipped with an approved backflow protection device. The abatement contractor shall install valves at tie-in locations that shall be turned off and locked-out and tagged-out when the contractor is not present on-site.

E. Temporary Sanitary: The Abatement Contractor shall provide and maintain temporary sanitary service connection throughout the abatement period.

F. Existing Systems: The Abatement Contractor may make written arrangements with the FAA to modify, supplement and extend an existing system to meet temporary requirements for the Project, subject to approval by the FAA. If existing systems are modified, supplemented and/or extended, the Abatement Contractor shall not overload the system or interfere with FAA's normal use of the system.

G. Removal of Temporary Systems: The Abatement Contractor shall remove all temporary services and repair all damage caused by the contractor and restore to original conditions.

3.4 ISOLATION OF THE WORK AREA

A. Prepare the work areas in accordance with 29 CFR 1926.62 and 29 CFR 1926.1101, Appendix F, and as detailed in this specification and the AAP for the work areas. All efforts shall be made to verify building ventilation systems supplying air into or returning air out of the regulated area shall be shut down and isolated by lockable switch or other positive means in accordance with 29 CFR 1926.417 and the facility's lockout/tag out program.

1. Establish negative air pressure within enclosures.

B. Pre-Abatement Inspection: Upon completion of the critical barrier erection, the Abatement Contractor shall receive notification from the FAA before removal work is initiated.

C. Work Place Entry and Exit: Enforcement is the responsibility of the Contractor's Abatement Supervisor. Entry shall be controlled to prevent unauthorized, accidental access into the containment area.

D. Maintenance of Enclosure System: The FAA shall be immediately notified of problems that have developed such as a puncture of the glove bags, electrical power loss, GFCI failure, equipment failure, accidental discharge into occupied areas, and breach or partial collapse of the critical barrier (plastic sheet fails to remain in place), etc.

3.5 DECONTAMINATION UNIT

A. Worker Decontamination Unit: Where required, appropriate employee decontamination units will be constructed.

3.6 ABATEMENT PROCEDURES

The sequence of operations to remove asbestos from the Control Wing and Administration Wing is described as guidance in the FAA Asbestos Abatement and LCC Demolition Work Plan. Refer to this document for sequencing and guidance to be performed by the contractor.

3.7 PROCEDURE FOR DISPOSAL

A. Asbestos: Collect asbestos waste, scrap, debris, bags, containers, equipment, and asbestos contaminated clothing, which may produce airborne concentrations of asbestos fibers, and place in sealed impermeable asbestos bags, boxes drums or other approved containers. All wrapped asbestos material shall be contained in a minimum of two layers of 6-mil polyethylene sheeting. All bagged debris shall be double bagged at a minimum. The final bagging shall take place in the decon washroom. Place the generator label between the outer bag and the inner, with the label able to be read through the outer bags. The final asbestos waste bag shall be goose necked. Each bag shall be clear and be pre-printed with an asbestos warning label. Include site-specific labels as required by the local jurisdiction. At a minimum, identify waste bags and containers with waterproof labels as follows:

Federal Aviation Administration
Denver ARTCC
2211 17th Avenue
Longmont, CO 80501

(Name of Abatement Contractor)

1. Dispose of waste asbestos material at an Environmental Protection Agency (EPA) or local-approved landfill off FAA property. For temporary storage, store sealed, impermeable bags in asbestos waste drums or waste storage containers. Storage of waste shall be in an on-site trailer, truck, or dumpster approved for transportation of the ACM waste to the landfill. The contractor shall transport the asbestos waste directly from the FAA facility to the landfill. Procedure for hauling and disposal shall comply with 40 CFR 61 (Subpart B), state, regional, and local standards. Workers unloading the ACM waste shall wear appropriate respirators and personal protective equipment when handling asbestos materials at the disposal site. A fully-sealed and plastic lined dumpster, truck van or trailer shall be used for transportation of all ACM wastes. The Waste Manifests shall be prepared by the contractor and ***s***igned by the Generator (FAA), the Waste Transporter and the Approved Landfill.

2. Minimum requirements for a waste manifest are as follows:

    a. Contain a unique number.
    b. Be signed by generator when shipping.
    c. Be signed by transporter when material is picked-up.
    d. Be signed by disposal facility when received.
    e. Name and address of pick-up site.

f. Estimated quantity of waste.
g. Specific location within the building where waste was generated.
h. Type and number of bags and drums used at each specific location within the building.
i. Name of Transporter.
j. Disposal site name, location and EPA identification number.
k. Copies of the manifest signed by the generator, transporter and disposal site shall be maintained by each entity.

3. The ACM waste shipment shall be transported directly from the job site to the EPA approved landfill. The Contractor shall notify the landfill of the date and time the ACM waste shall arrive at the landfill. The landfill shall have a hole excavated to receive the ACM waste upon arrival. The waste containers shall be hand-placed into the hole, not tossed or thrown, and immediately covered with 6 inches of soil. Provide asbestos waste shipment records to the FAA within three 3 days after delivery of the ACM to the landfill.

B. Lead: Pending TCLP testing (TCLP testing is for painted materials being disposed of in a landfill, otherwise collect metal components and recycle in accordance with local rules and regulations), collect lead waste, scrap, debris, bags, containers, equipment, and lead-contaminated clothing and place in sealed, impermeable containers. Properly label each container including identification of the type of waste (40 CFR 178) and the date the drum was filled. The labeling shall include the following additional information:

Federal Aviation Administration
Denver ARTCC
2211 17th Avenue
Longmont, CO 80501

(Name of Abatement Contractor)

1. Perform TCLP tests (not required for materials being recycled) on the painted material being removed to determine if the material requires disposal as a hazardous waste or can be disposed of as a solid waste. Dispose of hazardous waste lead material at an Environmental Protection Agency (EPA) or local-approved hazardous waste treatment, storage, or disposal facility off FAA property. Comply with land disposal restriction notification requirements as required by 40 CFR 268. An area for interim storage (less than 90 days) of lead waste-containing drums shall be assigned by the FAA. Procedure for hauling and disposal shall comply with 40 CFR 260, 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, and 40 CFR 265, and with state, regional, and local standards. Test results shall be submitted to the FAA prior to transportation off the site.

2. The Generator (FAA), the Waste Transporter (Contractor) and the Approved Landfill (Disposal Facility) shall sign waste Manifests. Minimum requirements for information included on the waste manifest include:

    a. Contain a unique number.
    b. Be signed by generator when shipping.
    c. Be signed by transporter when material is picked-up.
    d. Be signed by disposal facility when received.
    e. Name and address of pick-up site.
    f. Estimated quantity of waste.
    g. Specific location within the building where waste was generated.
    h. Type and number of bags and drums used at each specific location within the building.
    i. Name of Transporter.
    j. Disposal site name, location and EPA identification number.
    k. Copies of the manifest signed by the generator, transporter and disposal site shall be maintained by each entity.

3.8 ABATEMENT AIR MONITORING

A. Personal Monitoring: The Abatement Contractor is responsible for Personal Samples required in accordance with OSHA. An independent American Industrial Hygiene Association accredited laboratory shall be used to analyze air samples in accordance with OSHA. Copies of the results of the air samples shall be furnished within 3 days following the day in which they were collected and shall notify monitored employees.

B. Environmental Monitoring: Environmental monitoring for area airborne asbestos fiber count and area airborne lead concentrations shall be under a separate contract to the FAA as a third party monitoring contractor.

1. Background Monitoring: Background samples shall be collected prior to the isolation of the work area.
2. Abatement Monitoring:
    a. Prior to asbestos abatement, the monitoring contractor shall collect a minimum of two air samples in the Administration Wing work area on the first and basement floors.
    b. Prior to lead coatings abatement, the monitoring contractor shall collect a minimum of two air samples in the Administration Wing work area on the first and basement floors.

3. Clearance Monitoring:
    a. Asbestos: The Contractor shall notify the FAA when the work areas are ready for clearance air monitoring. The FAA shall perform clearance air sampling following either NIOSH 7400 PCM or 40 CFR 763 TEM.

b. Lead: Lead clearance is less than 30ug/m^3 by NIOSH Method 7105, Lead by GFAAS or equivalent or NIOSH 9100, or using ASTM E1792-03(2011), Standard Specification for Wipe Sampling Materials for Lead in Surface Dust, < 100 ug/ft^2 for horizontal surfaces and < 800 ug/ft^2 for rough concrete surfaces.

ATTACHMENT A
CERTIFICATE OF WORKER'S ACKNOWLEDGMENT

PROJECT NAME _____ CONTRACT NO. _____
PROJECT ADDRESS _____
CONTRACTOR'S NAME _____
EMPLOYEE'S NAME _____

WORKING WITH ASBESTOS CAN BE DANGEROUS. INHALING ASBESTOS FIBERS HAVE BEEN LINKED WITH TYPES OF LUNG DISEASE AND CANCER. IF YOU SMOKE AND INHALE ASBESTOS FIBERS, THE CHANCE THAT YOU WILL DEVELOP LUNG CANCER IS GREATER THAN THAT OF THE NONSMOKING PUBLIC.

Your employer's contract for the above project requires that: you be provided with and complete formal and project specific training, you be supplied with proper personal protective equipment including respirators, that you be trained in its use and that you receive a medical examination to evaluate your physical capacity to perform your assigned work tasks, under the environmental conditions expected, while wearing the required personal protective equipment. These things are to be done at no cost to you. By signing this certification, you are acknowledging that your employer has met these obligations to you.
Date Completed _____

FORMAL TRAINING: I have completed a formal training course for: asbestos abatement workers (for workers) (Contractor/Supervisor) that meets EPA's and this state's requirements
Date Completed _____

In addition, I have completed annual refresher as required by EPA and this state's requirements.
Date Completed _____

PROJECT SPECIFIC TRAINING: I have been provided and have completed the Project specific training required by this Contract. My employer’s industrial hygienist and competent person/supervisor conducted the training.
Date Completed _____

RESPIRATORY PROTECTION: I have been trained in accordance with the criteria in the Contractor's Respiratory Protection program. I have been trained in the dangers of handling and breathing asbestos dust and in the proper work procedures and use and limitations of the respirator(s) I will wear. I have been trained in and will abide by the facial hair policy of my employer.
Date Completed _____

RESPIRATOR FIT-TEST TRAINING: I have been trained in the proper selection, fit, use, care, cleaning, and maintenance, and storage of the respirator(s) that I will wear. I have been fit-tested in accordance with the criteria in the Contractor's Respiratory Program and have received a satisfactory fit. I have been assigned my individual respirator. I have been taught how to properly perform positive and negative pressure fit-check upon donning negative pressure respirators each time.
Date Completed _____

CERTIFICATE

MEDICAL EXAMINATION: I have had a medical examination within the last twelve months, which was paid for

by my employer. The examination included: health history, pulmonary function tests, and may have included an evaluation of a chest x-ray. A physician made determination regarding my physical capacity to perform work tasks on the Project while wearing personal protective equipment including a respirator. I was personally provided a copy and informed of the results of that examination. My employer's industrial hygienist evaluated the medical certification provided by the physician and checked the appropriate blank below. The physician determined that here:

_____ were no limitations to performing the required work tasks;

_____ were identified physical limitations to performing the required work tasks.

Employees Signature _____ Date _____

Printed Name _____

Employee Number _____

Contractor's Industrial Hygienist Signature _____
Date _____

Printed Name _____

Employee Number _____

Date medical exam completed _____

END OF SECTION 02 82 00

SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes for the following: footings, pedestals, flume, and slab.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Design Mixtures: For each concrete mixture.

C. Shop Drawings: For steel reinforcement. Placing drawings that detail fabrication, bending, and placement.

D. Material certificates.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94 requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

B. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301, "Specification for Structural Concrete," Sections 1 through 5
2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

C. Preinstallation Conference: Conduct conference at Project site.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

2.2 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.

B. Deformed-Steel Welded Wire Reinforcement: ASTM A 497, flat sheet.

C. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice."

2.3 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C 150, Type II or I/II.

a. Fly Ash: ASTM C 618, Class F.
b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C 33, graded, 3/4-inchnominal maximum coarse-aggregate size.

C. Water: ASTM C 94 and potable.

D. Air-Entraining Admixture: ASTM C 260.

E. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494, Type A.
2. Retarding Admixture: ASTM C 494, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017, Type II.

2.4 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

2.5 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.

2.6 CONCRETE MIXTURES

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

B. Cementitious Materials: Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of Portland cement, which would otherwise be used, by not less than 20 percent.

C. Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: As indicated.
2. Maximum Water-Cementitious Materials Ratio: 0.45.
3. Slump Limit: 5 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
4. Air Content: 5 percent, plus or minus 1.5 percent at point of delivery for 3/4-inch nominal maximum aggregate size.

2.7 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.8 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK

A. Design, erect, shore, brace, and maintain formwork according to ACI 301 to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

3.2 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

3.3 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork and reinforcement is complete and that required inspections have been performed.

B. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.

C. Cold-Weather Placement: Comply with ACI 306.1.

D. Hot-Weather Placement: Comply with ACI 301.

3.4 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces not exposed to public view or below finished grade.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces exposed to public view or above finished grade.

3.5 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days.
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

    a. After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.6 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by COR. Remove and replace concrete that cannot be repaired and patched to COR's approval.

3.7 FIELD QUALITY CONTROL

A. Testing and Inspecting: Contractor shall engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

1. Testing Services: Tests shall be performed according to ACI 301.

END OF SECTION 03 30 00

SECTION 05 12 00 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes structural steel and grout.

1.2 DEFINITIONS

A. Structural Steel: Elements of structural-steel frame, as classified by AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

1.3 PERFORMANCE REQUIREMENTS

A. Connections: Provide details of simple shear connections required by the Contract Documents to be selected or completed by structural-steel fabricator to withstand loads indicated and comply with other information and restrictions indicated.

1. Select and complete connections using schematic details indicated and AISC 360.

B. Moment Connections: Type FR, fully restrained.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show fabrication of structural-steel components.

C. Qualification Data: For qualified Installer and fabricator.

D. Welding certificates.

E. Mill test reports for structural steel, including chemical and physical properties.

F. Source quality-control reports.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.

B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Comply with applicable provisions of the following specifications and documents:

1. AISC 303.
2. AISC 360.
3. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

E. Preinstallation Conference: Conduct conference at Project site.

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A 992.

B. Channels and Angles: ASTM A 36.

C. Plate and Bar: ASTM A 36.

D. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B, structural tubing.

E. Steel Pipe: ASTM A 53, Grade B.

F. Welding Electrodes: Comply with AWS requirements.

2.2 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers; all with plain finish.

B. Zinc-Coated High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers.

1. Finish: Hot-dip or mechanically deposited zinc coating.

2.3 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.

1. Fill vent and drain holes that will be exposed in the finished Work unless they will function as weep holes, by plugging with zinc solder and filing off smooth.

2.4 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.5 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC 360.

B. Galvanize all structural steel members and connections.

2.6 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

2.7 SOURCE QUALITY CONTROL

A. Testing Agency: Engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.

1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

C. Bolted Connections: Shop-bolted connections will be inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

D. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

1. Liquid Penetrant Inspection: ASTM E 165.
2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
3. Ultrasonic Inspection: ASTM E 164.
4. Radiographic Inspection: ASTM E 94.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with steel Erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.

B. Base Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Weld plate washers to top of baseplate.
3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

3.3 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1 for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.

2. Field welding of galvanized parts shall not be permitted without prior authorization from the Contracting Officer and the Structural Engineer.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing and inspecting agency to inspect field welds.

B. Bolted Connections: Bolted connections will be inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

C. Welded Connections: Field welds will be visually inspected according to AWS D1.1/D1.1M.

1. In addition to visual inspection, field welds will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

a. Liquid Penetrant Inspection: ASTM E 165.
b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
c. Ultrasonic Inspection: ASTM E 164.
d. Radiographic Inspection: ASTM E 94.

D. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

END OF SECTION 05 12 00

SECTION 05 50 00 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel framing and supports for mechanical and electrical equipment.
2. Steel framing and supports for applications where framing and supports are not specified in other Sections.
3. Loose bearing and leveling plates for applications where they are not specified in other Sections.
4. Aluminum Prefabricated Stairs, Rails and Landing.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design mechanical and electrical equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: 120 degrees F, ambient; 180 degrees F, material surfaces.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Paint products (galvanizing repair paint).
2. Grout.

B. High Performance Sustainable Building Submittals:

1. Recycled Content: For products having recycled content, documentation indicating percentages by weight of post-consumer and pre-consumer recycled content. Include statement indicating cost for each product having recycled content.
2. VOC Content: For paints and coatings, documentation indicating that products comply with the testing and product requirements of local regulations controlling use of volatile organic compounds (VOC's).

C. Shop Drawings: Show fabrication and installation details for metal fabrications. Shop drawings must be signed and sealed by qualified professional engineer.

1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

D. Delegated Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified professional engineer.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Coordination: Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation. Ensure steel framing locations are coordinated with actual purchased equipment prior to fabrication.

1.6 PROJECT CONDITIONS

A. Field Measurements: Field verification of existing conditions is particularly important to ensure proper fit-up of new framing and equipment. Verify actual locations of piers, steel framing, walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Recycled Content of Steel Products: Post-consumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.

2.2 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Steel Tubing: ASTM A 500, cold-formed steel tubing.

C. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40) unless otherwise indicated.

D. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.

1. Size of Channels: 1-5/8 by 1-5/8 inches or as indicated.
2. Material:

a. Galvanized steel, ASTM A 653/A 653M, structural steel, Grade 33, with G90 coating; 0.108 inch nominal thickness.
b. Cold-rolled steel, ASTM A 1008/A 1008M, commercial steel, Type B; 0.0966 inch minimum thickness; hot-dip galvanized after fabrication.

E. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

2.3 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 325, Type 3; with hex nuts, ASTM A 563, Grade C3; and, where indicated, flat washers.

C. Stainless Steel Bolts and Nuts: Regular hexagon-head annealed stainless steel bolts, ASTM F 593; with hex nuts, ASTM F 594; and, where indicated, flat washers; Alloy Group 1.

D. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.

1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

E. Eyebolts: ASTM A 489.

F. Machine Screws: ASME B18.6.3.

G. Plain Washers: Round, ASME B18.22.1.

H. Lock Washers: Helical, spring type, ASME B18.21.1.

I. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

J. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or

ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.

K. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

L. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 inches by 7/8 inches by length indicated with anchor straps or studs not less than 3 inches long at not more than 8 inches on center. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B 633, Class Fe/Zn 5, as needed for fastening to inserts.

2.4 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of local regulations controlling use of volatile organic compounds (VOC's).

C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it. VOC Content: Products shall comply with VOC limits of Authorities having jurisdiction for paints and coatings applied at the project site, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, subpart D (EPA Method 24).

D. Non-Shrink, Non-Metallic Grout: Factory-packaged, non-staining, non-corrosive, non-gaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.5 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Field-welding within occupied buildings is not permitted. Field connections shall be mechanical type only. Welding in a shop that is on the site but not in the work area is permitted.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form bent metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

E. Form exposed work with accurate angles and surfaces and straight edges.

F. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

H. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

I. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

J. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

K. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 inch by 1-1/2 inches, with a minimum 6 inch embedment and 2 inch hook, not less than 8 inches from ends and corners of units and 24 inches on center, unless otherwise indicated.

2.6 STEEL FRAMING AND SUPPORTS FOR MECHANICAL AND ELECTRICAL EQUIPMENT

A. Provide framing and supports for mechanical and electrical equipment where indicated on Drawings. Provide seismic bracing as required.

B. Units are of varying sizes. In addition, the exact configuration of the support for each unit is expected to be unique because of varying configurations of piping, cabling, and other obstructions underneath the raised access flooring, which cannot be relocated. The overall design of the support structure must permit field modification to accommodate these items.

C. Field welding within occupied buildings is not permitted. Make all field connections with mechanical components.

D. Prior to the installation of any unit, Contractor’s engineer must review the exact configuration, including connections, of the framing and support structure, and must verify that the structure is adequate to support all loads. Engineer must certify in writing that the structure is adequate.

E. Galvanize steel framing and supports for mechanical and electrical equipment.

2.7 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

1. Fabricate units from slotted channel framing where indicated.
2. Furnish inserts for units installed after concrete is placed.

C. Galvanize miscellaneous framing and supports.

2.8 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

B. Galvanize loose bearing and leveling plates.

2.9 FINISHES

A. General:

1. Galvanizing: For those items indicated for galvanizing, apply zinc coating by the hot dipped galvanizing process complying with the requirements below.
2. Comply with NAAMM AMP 500 "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
3. Finish metal fabrications after assembly.
4. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

B. Steel and Iron Finishes:

1. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

a. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

2.10 ALUMINUM PREFABRICATED STAIR, RAILS AND LANDING

A. General:
1. Comply with Osha and ADA Standards.
2. Comply with Authority having Jurisdiction requirements.
3. Heavy Duty Structural Platform.

4. Easy Bolt Together Assembly.
5. Stair Treads to be Bar Grating
6. Stair Landing to be aluminum I Bar Grating.

B. Basis of Design: Basis of Design is FS Industries Engineered Steel Products, PO Box 72659 Providence, RI 02907 Telephone (800) 421-0314. All other manufacturers meeting the requirements of the specifications herein will be considered.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the COR, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

1. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

3.2 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
5. Field welding is not permitted in the work area. On-site welding is only permitted in a remote shop area.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.3 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on shop drawings.

3.4 INSTALLING BEARING AND LEVELING PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.

B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.

1. Use non-shrink, non-metallic grout.
2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.5 ADJUSTING AND CLEANING

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

3.6 PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to the Installer, that shall ensure that the metal fabrications shall be without damage at time of Substantial Completion.

END OF SECTION 05 50 00

SECTION 07 84 13 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Penetrations in fire-resistance-rated walls.
2. Penetrations in horizontal assemblies.
3. Penetrations in smoke barriers.
4. Construction enclosing compartmentalized areas.

1.2 UNIT PRICES

A. Work of this Section is affected by unit prices.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. High Performance Sustainable Building Submittals:

1. VOC Content: For penetration firestopping sealants and sealant primers, documentation indicating that products comply with the testing and product requirements of local regulations controlling use of volatile organic compounds (VOC's).

C. Shop Drawings: Submit shop drawings detailing materials, installation methods, and relationships to adjoining construction for each type of fire resistive joint system, and each kind of construction condition penetrated and kind of penetrating item. Include design designation of qualified inspecting and testing agency evidencing compliance with requirements for each condition indicated.

1. Submit documentation, including, but not limited to, illustrations, from a qualified inspecting and testing agency that is applicable to each type of fire resistive joint system configuration for construction and penetrating items.

2. Submit manufacturer’s engineering judgment identification number and document details when no qualified tested system is available for an application. Engineering judgement must include both project name and contractor’s name who will install firestop system as described in document.

D. Product Schedule: For each penetration firestopping system. Include location and design designation of qualified testing and inspecting agency.

1. Where Project conditions require a firestop application for which no qualified tested system is available through a manufacturer, an engineering judgement derived from

similar qualified tested systems designs or other tests shall be submitted for review and approval prior installation by COR. Submit illustration, with modifications marked, approved by penetration firestopping manufacturer’s fire protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly. Engineering judgement documents shall follow requirements set forth by the international Firestop Council.

2. Coordinate with COR approval of submitted engineering judgement. Judgement is subject to approval by COR.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Installer Certificates: From Installer indicating penetration firestopping has been installed in compliance with requirements and manufacturer's written recommendations.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for penetration firestopping.

D. Submit detail drawings/list, including manufacturer’s descriptive data, typical details conforming to UL Fire Resistance or other details certified by another nationally recognized testing laboratory, installation instructions or UL listing details for firestopping assembly in lieu of fire-test data or report. For those firestop applications for which no UL tested system is available through a manufacturer, a manufacturer’s engineering judgment, derived from similar UL system designs or other tests, shall be submitted for review and approval prior to installation. Submittal shall indicate the firestopping material to be provided for each type of application.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

1. Alternate Installer Qualifications: Certified, licensed, or otherwise qualified by the firestopping manufacturer as having the necessary staff, training, and a minimum of 3 years’ experience in the installation of manufacturer’s products in accordance with specified requirements. A manufacturer's willingness to sell its penetration firestopping products to Contractor or to Installer engaged by Contractor does not in itself confer installer qualification on buyer. The installer shall have been trained by a direct representative of the manufacturer (not distributor or agent) in the proper selection and installation procedures. The installer shall obtain from the manufacturer written certification of training, and retain proof of certification for duration of firestop installation.

B. Fire-Test-Response Characteristics: Penetration firestopping shall comply with the following requirements:

1. Penetration firestopping tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
2. Penetration firestopping is identical to those tested per testing standard referenced in "Penetration Firestopping" Article. Provide rated systems complying with the following requirements:

    a. Penetration firestopping products bear classification marking of qualified testing and inspecting agency.
    b. Classification markings on penetration firestopping correspond to designations listed by the following:

        1) UL in its "Fire Resistance Directory."
        2) Intertek ETL SEMKO in its "Directory of Listed Building Products."
        3) FM Global in its "Building Materials Approval Guide."

C. Pre-Installation Conference: Conduct conference at Project site.

D. Coordination:

1. Coordinate construction of openings and penetrating items to ensure that penetration firestopping is installed according to specified requirements.
2. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping.
3. Notify COR's testing agency at least seven days in advance of penetration firestopping installations; confirm dates and times on day preceding each series of installations.

E. Installation Responsibility: Assign installation of through-penetration firestop systems and fire-resistive joint systems in Project to single sole source firestop specialty contractor.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not install penetration firestopping when ambient or substrate temperatures are outside limits permitted by penetration firestopping manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.

B. Install and cure penetration firestopping per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Hilti, Inc.
2. Nelson Firestop Products.
3. 3M Fire Protection Products.
4. Specified Technologies Inc.

5. Tremco, Inc.; Tremco Fire Protection Systems Group.

B. Basis of Design: Products specified are “EZ Path Series 33” and “EZ Path Series 22” as manufactured by Specified Technologies Inc. Items specified are to establish a standard of quality for design, function, materials, and appearance. Equivalent products by other listed manufacturers are acceptable. The COR will be the sole judge of the basis of what is equivalent.

2.2 PENETRATION FIRESTOPPING

A. Provide penetration firestopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

B. Penetrations in Fire-Resistance-Rated Walls: Provide penetration firestopping and smoke stopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01 inch wg.

1. Fire-resistance-rated walls include fire walls, fire-barrier walls, smoke-barrier walls, and fire partitions.
2. F-Rating: Not less than the fire-resistance rating of constructions penetrated.
3. L-Rating: Not exceeding 5.0 cfm/sq.ft of penetration opening at 0.30 inch wg at both ambient and elevated temperatures.

C. Penetrations in Horizontal Assemblies: Provide penetration firestopping and smoke stopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01 inch wg. Where the smoke and firestopping is in the floor assembly, the assembly shall be capable of supporting the floor’s live and dead loads.

1. Horizontal assemblies include floors, floor/ceiling assemblies, and ceiling membranes of roof/ceiling assemblies.
2. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated.
3. T-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
4. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at 0.30 inch wg at both ambient and elevated temperatures.

D. Penetrations in Smoke Barriers: Provide penetration firestopping with ratings determined per UL 1479.

1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at 0.30 inch wg at both ambient and elevated temperatures.

E. W-Rating: Provide penetration firestopping showing no evidence of water leakage when tested according to UL 1479.

F. Exposed Penetration Firestopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

G. VOC Content: Penetration firestopping sealants and sealant primers shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Sealants: 250 g/L.
2. Sealant Primers for Nonporous Substrates: 250 g/L.
3. Sealant Primers for Porous Substrates: 775 g/L.

H. Low-Emitting Materials: Penetration firestopping sealants and sealant primers shall comply with the testing and product requirements of local regulations controlling use of volatile organic compounds (VOC's).

I. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping manufacturer and approved by qualified testing and inspecting agency for firestopping indicated.

1. Permanent forming/damming/backing materials, including the following:

a. Slag-wool-fiber or rock-wool-fiber insulation.
b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
c. Fire-rated form board.
d. Fillers for sealants.

2. Temporary forming materials.
3. Substrate primers.
4. Collars.
5. Steel sleeves.

J. Mold Resistance: Provide penetration firestopping with mold and mildew resistance rating of 0 as determined by ASTM G21.

2.3 FILL MATERIALS

A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.

C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized-steel sheet.

E. Intumescent Putties: Non-hardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.

F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.

G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a non-shrinking, homogeneous mortar.

H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.

I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.

J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and non-sag formulation for openings in vertical and sloped surfaces, unless indicated firestopping limits use of non-sag grade for both opening conditions.

K. Fire Rated Cable Management Devices:
1. Factory-assemble round metallic sleeve device for use with cable penetrations, containing an integrated smoke seal fabric membrane that can be opened and closed for re-penetration.

L. Drop-In Firestop Devices:
1. Factory-assembled devices for use with combustible or noncombustible penetrants in cored holes within concrete floors. Device shall consist of galvanized steel sleeve lined with an intumescent strip, and extended rectangular flange attached to one end of the sleeve for fastening to concrete floor, and neoprene gasket.

M. Blocks/Plugs:
1. Intumescent flexible block/plug suitable for reuse in re-penetration of openings. Blocks shall allow up to 12” of unreinforced annular space.

2.4 MIXING

A. For those products requiring mixing before application, comply with penetration firestopping manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:
   1. Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the COR, of any conditions detrimental to the proper and timely completion of the work.

B. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

   1. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

3.2 PREPARATION

A. Surface Cleaning: Clean out openings immediately before installing penetration firestopping to comply with manufacturer's written instructions and with the following requirements:

   1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping.
   2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping. Remove loose particles remaining from cleaning operation.
   3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent penetration firestopping from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing firestopping's seal with substrates.

3.3 INSTALLATION

A. General: Install penetration firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestopping.

C. Install fill materials for firestopping by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Identify penetration firestopping with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of firestopping edge so labels will be visible to anyone seeking to remove penetrating items or firestopping. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing and inspecting agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

A. The COR may engage a qualified testing agency to perform tests and inspections.

B. Where deficiencies are found or penetration firestopping is damaged or removed because of testing, repair or replace penetration firestopping to comply with requirements.

C. Proceed with enclosing penetration firestopping with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING

A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping manufacturers and that do not damage materials in which openings occur.

3.7 PROTECTION

A. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping is without damage or deterioration at time of FAA's Contractor Acceptance Inspection. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping and install new materials to produce systems complying with specified requirements.

END OF SECTION 07 84 13

SECTION 07 84 46 - FIRE-RESISTIVE JOINT SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Joints in or between fire-resistance-rated constructions.
2. Joints in smoke barriers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. High Performance Sustainable Building Submittals:

1. VOC Content: For fire-resistive joint system sealants, documentation indicating that products comply with the testing and product requirements of local regulations controlling use of volatile organic compounds (VOC's).

C. Product Schedule: For each fire-resistive joint system. Include location and design designation of qualified testing agency.

1. Where Project conditions require modification to a qualified testing agency's illustration for a particular fire-resistive joint system condition, submit illustration, with modifications marked, approved by fire-resistive joint system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.
2. Coordinate with COR approval of submitted engineering judgement. Judgement is subject to approval by COR.

D. Shop Drawings:

1. Submit shop drawings detailing materials, installation methods, and relationships to adjoining construction for each type of fire-resistive joint system, and each kind of construction condition penetrated and kind of penetrating item. Include design designation of qualified inspecting and testing agency evidencing compliance with requirements for each condition indicated.
2. Submit documentation, including, but not limited to, illustrations, from a qualified inspecting and testing agency that is applicable to each fire-resistive joint system configuration for construction and penetrating items.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Installer Certificates: From Installer indicating fire-resistive joint systems have been installed in compliance with requirements and manufacturer's written recommendations.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for fire-resistive joint systems.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A firm experienced in installing fire-resistive joint systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its fire-resistive joint system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

B. Fire-Test-Response Characteristics: Fire-resistive joint systems shall comply with the following requirements:

1. Fire-resistive joint system tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
2. Fire-resistive joint systems are identical to those tested per testing standard referenced in "Fire-Resistive Joint Systems" Article. Provide rated systems complying with the following requirements:

    a. Fire-resistive joint system products bear classification marking of qualified testing agency.
    b. Fire-resistive joint systems correspond to those indicated by reference to designations listed by the following:

        1) UL in its "Fire Resistance Directory."
        2) Intertek ETL SEMKO in its "Directory of Listed Building Products."

C. Coordination:

1. Coordinate construction of joints to ensure that fire-resistive joint systems are installed according to specified requirements.
2. Coordinate sizing of joints to accommodate fire-resistive joint systems.

1.5 PROJECT CONDITIONS

A. Environmental Limitations: Do not install fire-resistive joint systems when ambient or substrate temperatures are outside limits permitted by fire-resistive joint system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Install and cure fire-resistive joint systems per manufacturer's written instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

PART 2 - PRODUCTS

2.1 FIRE-RESISTIVE JOINT SYSTEMS

A. Where required, provide fire-resistive joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which fire-resistive joint systems are installed. Fire-resistive joint systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.

B. Joints in or between Fire-Resistance-Rated Construction: Provide fire-resistive joint systems with ratings determined per ASTM E 1966 or UL 2079:

1. Joints include those installed in or between fire-resistance-rated walls, floor or floor/ceiling assemblies and roofs or roof/ceiling assemblies.
2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of construction they will join.
3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Grace Construction Products.
b. Hilti, Inc.
c. Johns Manville.
d. Nelson Firestop Products.
e. 3M Fire Protection Products.
f. Tremco, Inc.; Tremco Fire Protection Systems Group.
g. USG Corp.

C. Joints in Smoke Barriers: Provide fire-resistive joint systems with ratings determined per UL 2079.

1. L-Rating: Not exceeding 5.0 cfm/ft. of joint at 0.30 inch wg at both ambient and elevated temperatures.
2. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Grace Construction Products.
b. Hilti, Inc.
c. Johns Manville.
d. Nelson Firestop Products.
e. 3M Fire Protection Products.
f. Tremco, Inc.; Tremco Fire Protection Systems Group.
g. USG Corp.

D. Exposed Fire-Resistive Joint Systems: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

E. VOC Content: Fire-resistive joint system sealants shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Architectural Sealants: 250 g/L.
2. Sealant Primers for Non-Porous Substrates: 250 g/L.
3. Sealant Primers for Porous Substrates: 775 g/L.

F. Accessories: Provide components of fire-resistive joint systems, including primers and forming materials, that are needed to install fill materials and to maintain ratings required. Use only components specified by fire-resistive joint system manufacturer and approved by the qualified testing agency for systems indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:
1. Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the COR, of any conditions detrimental to the proper and timely completion of the work.

B. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

3.2 PREPARATION

A. Surface Cleaning: Clean joints immediately before installing fire-resistive joint systems to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:

1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of fill materials.
2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with fill materials. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by fire-resistive joint system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent fill materials of fire-resistive joint system from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods

used to remove stains. Remove tape as soon as possible without disturbing fire-resistive joint system's seal with substrates.

3.3 INSTALLATION

A. General: Install fire-resistive joint systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.

C. Install fill materials for fire-resistive joint systems by proven techniques to produce the following results:

1. Fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
2. Apply fill materials so they contact and adhere to substrates formed by joints.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Identify fire-resistive joint systems with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of joint edge so labels will be visible to anyone seeking to remove or penetrate joint system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Fire-Resistive Joint System - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

A. Where deficiencies are found or fire-resistive joint systems are damaged or removed due to testing, repair or replace fire-resistive joint systems so they comply with requirements.

B. Proceed with enclosing fire-resistive joint systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTING

A. Clean off excess fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by fire-resistive joint system manufacturers and that do not damage materials in which joints occur.

B. Provide final protection and maintain conditions during and after installation that ensure fire-resistive joint systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire-resistive joint systems immediately and install new materials to produce fire-resistive joint systems complying with specified requirements.

END OF SECTION 07 84 46

SECTION 07 92 00 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes joint sealants for the following applications, including those specified by reference to this Section:

1. Exterior joints in the following vertical surfaces and horizontal non-traffic surfaces:

a. Assembly and joints between framing, windows and louvers.
b. Other joints as indicated.

2. Exterior joints in the following vertical surfaces and horizontal traffic surfaces:
a. Joint between concrete walking surface and concrete curb in Area Way.

3. Interior joints in the following vertical surfaces and horizontal non-traffic surfaces:

a. Perimeter joints of exterior openings where indicated.
b. Perimeter joints between interior wall surfaces and frames of windows.
c. Other joints as indicated.

1.2 PERFORMANCE REQUIREMENTS

A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.

B. Provide joint sealants for interior applications that establish and maintain airtight and water-resistant continuous joint seals without staining or deteriorating joint substrates.

1.3 SUBMITTALS

A. Product Data: For each joint sealant product indicated.

B. High Performance Sustainable Building Submittals:

1. VOC Content: For sealants and sealant primers used, documentation indicating that products comply with the testing and product requirements of local regulations controlling use of volatile organic compounds (VOC's).

C. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

D. Product Certificates: For each type of joint sealant and accessory, signed by product manufacturer.

E. SWRI Validation Certificate: For each elastomeric sealant specified to be validated by SWRI's Sealant Validation Program.

F. Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:

1. Materials forming joint substrates and joint sealant backings have been tested for compatibility and adhesion with joint sealants.
2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

G. Qualification Data: For qualified testing agency.

H. Product Test Reports: Based on comprehensive testing of product formulations performed by a qualified testing agency, indicating that sealants comply with requirements.

I. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized Installer who is approved or licensed for installation of elastomeric sealants required for this Project.

B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

C. Product Testing: Obtain test results for "Product Test Reports" Paragraph in "Submittals" Article from a qualified testing agency based on testing current sealant formulations within a 36-month period preceding the commencement of the Work.

1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated, as documented according to ASTM E 548.
2. Test elastomeric joint sealants for compliance with requirements specified by reference to ASTM C 920, and where applicable, to other standard test methods.
3. Test elastomeric joint sealants according to SWRI's Sealant Validation Program for compliance with requirements specified by reference to ASTM C 920 for adhesion and cohesion under cyclic movement, adhesion-in-peel, and indentation hardness.
4. Test other joint sealants for compliance with requirements indicated by referencing standard specifications and test methods.

D. Pre-Installation Conference: Conduct conference at Project site.

1.5 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 40 degrees F.

2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.
4. Contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.6 WARRANTY

A. Special Installer's Warranty: Installer's standard form in which Installer agrees to repair or replace elastomeric joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer's standard form in which elastomeric sealant manufacturer agrees to furnish elastomeric joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Fifteen years from date of Substantial Completion.

C. Special warranties specified in this Article exclude deterioration or failure of elastomeric joint sealants from the following:

1. Movement of the structure resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression caused by structural settlement or errors attributable to design or construction.
2. Disintegration of joint substrates from natural causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the products listed in other Part 2 articles.

2.2 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.

B. VOC Content of Interior Sealants: Provide interior sealants and sealant primers that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Sealants: 250 g/L.
2. Sealant Primers for Non-Porous Substrates: 250 g/L.
3. Sealant Primers for Porous Substrates: 775 g/L.

C. Colors of Exposed Joint Sealants: As selected by COR from manufacturer's full range.

2.3 ELASTOMERIC JOINT SEALANTS

A. Elastomeric Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

B. Stain Test Response Characteristics: Where elastomeric sealants are specified to be non-staining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

C. Single-Component Neutral-Curing and Basic-Curing Silicone Sealant:

1. Products:

a. Dow Corning Corp.; 791.
b. Dow Corning Corp.; 795
c. GE Silicones; SilPruf NB SCS9000.
d. GE Silicones; UltraPruf II SCS2900.

2. Type and Grade: S (single component) and NS (non-sag).
3. Class: 100/50.
4. Use Related to Exposure: NT (non-traffic).
5. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates indicated, O.

a. Use O Joint Substrates: Coated glass, color anodic aluminum, aluminum coated with a high performance coating, galvanized steel.

6. Stain Test Response Characteristics: Non-staining to porous substrates per ASTM C 1248.

D. Single-Component Neutral-Curing Silicone Sealant

1. Products:

a. Dow Corning Corp.; 799.
b. GE Silicones; UltraGlaze SSG4000.
c. GE Silicones; UltraGlaze SSG4000AC.
d. Polymeric Systems, Inc.; PSI-631.
e. Schnee-Morehead, Inc.; SM5731 Poly-Glaze Plus.

f. Tremco; Proglaze SG.
g. Tremco; Spectrem 2.

2. Type and Grade: S (single component) and NS (non-sag).
3. Class: 25.
4. Uses Related to Exposure: NT (non-traffic).
5. Uses Related to Joint Substrates: G, A, and, as applicable to joint substrates indicated, O.

a. Use O Joint Substrates: Coated glass, color anodic aluminum, aluminum coated with a high performance coating, galvanized steel.

E. Rapid-cure, self-leveling, two-part silicone rubber sealant designed to seal expansion joints
1. Products:
a. Dow Corning Corp 902 RCS Joint Sealant
b. Any equivalent product as determined by the COR.
2. Type and Grade: Two-part silicone rubber sealant
3. Rapid Cure
4. Self-Leveling

2.4 SOLVENT RELEASE JOINT SEALANTS

A. Pigmented Narrow Joint Sealant: Manufacturer's standard, solvent release-curing, pigmented, synthetic rubber sealant complying with AAMA 803.3 and formulated for sealing joints 3/16 inch or smaller in width.

1. Products:

a. Fuller, H.B. Co.; SC-0289.
b. Schnee-Morehead, Inc.; SM 5504 Acryl-R Narrow Joint Sealant.

2.5 PREFORMED JOINT SEALANTS

A. Preformed Silicone Sealant System: Manufacturer's standard system consisting of pre-cured low modulus silicone extrusion, in sizes to fit joint widths indicated, combined with a neutral-curing silicone sealant for bonding extrusions to substrates.

1. Products:

a. Dow Corning Corp.; 123 Silicone Seal.
b. GE Silicones; UltraSpan US1100.
c. Pecora Corp.; Sil-Span.
d. Tremco; Spectrem Ez Seal.

B. Preformed Foam Sealant : Manufacturer's standard preformed, pre-compressed, open cell foam sealant that is manufactured from high density urethane foam impregnated with a non-drying, water repellent agent; is factory produced in precompressed sizes in roll or stick form to fit joint widths indicated; is coated on one side with a pressure-sensitive adhesive and covered with

protective wrapping; develops a watertight and airtight seal when compressed to the degree specified by manufacturer; and complies with the following:

1. Products:

   a. EMSEAL Joint Systems, Ltd.; Emseal 25V.
   b. Sealant Systems, Inc.; Wilseal 600.

2.6 PREFORMED TAPE SEALANTS

A. Back Bedding Mastic Tape Sealant: Preformed, butyl-based elastomeric tape sealant with a solids content of 100 percent; non-staining and non-migrating in contact with non-porous surfaces; with or without spacer rod as recommended in writing by tape manufacturers for application indicated; packaged on rolls with a release paper backing; and complying with ASTM C 1281 and AAMA 800 for products indicated below:

   1. AAMA 804.3 tape, where indicated.
   2. AAMA 806.3 tape, for applications in which tape is subject to continuous pressure.
   3. AAMA 807.3 tape, for applications in which tape is not subject to continuous pressure.

B. Expanded Cellular Tape Sealant: Closed cell, PVC foam tape sealant; factory coated with adhesive on both surfaces; packaged on rolls with release liner protecting adhesive; and complying with AAMA 800 for the following types:

   1. Type 1, for applications in which tape acts as the primary sealant.
   2. Type 2, for applications in which tape is used in combination with a full bead of liquid sealant.

2.7 JOINT SEALANT BACKING

A. General: Provide sealant backings of material and type that are non-staining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C 1330, Type C closed cell material with a surface skin, O (open cell material) B (bicellular material with a surface skin) or any of the preceding types, as approved in writing by joint sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:

C. Elastomeric Tubing Sealant Backings: Neoprene, butyl, EPDM, or silicone tubing complying with ASTM D 1056, non-absorbent to water and gas, and capable of remaining resilient at temperatures down to minus 26 degrees F. Provide products with low compression set and of size and shape to provide a secondary seal, to control sealant depth, and to otherwise contribute to optimum sealant performance.

D. Bond Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint filler materials or

joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.8 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint sealant substrate tests and field tests.

B. Cleaners for Non-Porous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent non-porous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Non-staining, non-absorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions
   1. Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the COR, of any conditions detrimental to the proper and timely completion of the work.

B. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint sealant performance.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

   1. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint sealant manufacturer's written instructions and the following requirements:

   1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

a. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:

1) Concrete.
2) Concrete unit masonry.

b. Clean non-porous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Non-porous joint substrates include the following:

1) Metal.
2) Glass.

B. Joint Priming: Prime joint substrates, where recommended in writing by joint sealant manufacturer, based on preconstruction joint sealant substrate tests or prior experience. Apply primer to comply with joint sealant manufacturer's written instructions. Confine primers to areas of joint sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Acoustical Sealant Application Standard: Comply with recommendations in ASTM C 919 for use of joint sealants in acoustical applications as applicable to materials, applications, and conditions indicated.

D. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.
3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

E. Install bond breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

F. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

G. Tooling of Non-Sag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.
4. Provide flush joint configuration where indicated per Figure 5B in ASTM C 1193.
5. Provide recessed joint configuration of recess depth and at locations indicated per Figure 5C in ASTM C 1193.

    a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

H. Installation of Preformed Tapes: Install according to manufacturer's written instructions.

I. Installation of Preformed Silicone Sealant System: Comply with the following requirements:

1. Apply masking tape to each side of joint, outside of area to be covered by sealant system.
2. Apply silicone sealant to each side of joint to produce a bead of size complying with preformed silicone sealant system manufacturer's written instructions and covering a bonding area of not less than 3/8 inch. Hold edge of sealant bead 1/4 inch inside masking tape.
3. Within 10 minutes of sealant application, press silicone extrusion into sealant to wet extrusion and substrate. Use a roller to apply consistent pressure and ensure uniform contact between sealant and both extrusion and substrate.
4. Complete installation of sealant system in horizontal joints before installing in vertical joints. Lap vertical joints over horizontal joints. At ends of joints, cut silicone extrusion with a razor knife.

J. Installation of Preformed Foam Sealants: Install each length of sealant immediately after removing protective wrapping, taking care not to pull or stretch material, producing seal continuity at ends, turns, and intersections of joints. For applications at low ambient temperatures where expansion of sealant requires acceleration to produce seal, apply heat to sealant in compliance with sealant manufacturer's written instructions.

3.4 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION 07 92 00

SECTION 08 11 13 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes interior and exterior hollow metal doors and frames.

1.2 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM/HMMA 803 or SDI A250.8.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, core descriptions, fire-resistance ratings, temperature-rise ratings, and finishes.

2. VOC Content: For paints and coatings, documentation that products comply with testing and product requirements of local regulations controlling use of volatile organic compounds (VOC's).

B. High Performance Sustainable Building Submittals:
1. Recycled Content: For products having recycled content, documentation indicating percentages by weight of post-consumer and pre-consumer recycled content. Include statement indicating cost for each product having recycled content.

C. Shop Drawings:

1. Elevations of each door type.
2. Details of doors, including vertical-edge and horizontal-edge details and metal thicknesses.
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
4. Locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of anchorages, joints, field splices, and connections.
7. Details of accessories.
8. Details of moldings, removable stops, and glazing.
9. Details of conduit and preparations for power, signal, and control systems.

D. Schedule: Provide a schedule of hollow metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final Door Hardware Schedule.

1.4 INFORMATIONAL SUBMITTALS

A. Product test reports for each type of hollow metal door and frame assembly of tests performed by a qualified testing agency.

1.5 QUALITY ASSURANCE

A. Pre-Installation Conference: Conduct conference at Project site.

B. Coordination: Coordinate anchorage installation for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow metal work palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use non-vented plastic.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow metal work vertically under cover at Project site with head up. Place on minimum 4-inch-high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

1.7 WARRANTY

A. Provide manufacturer's standard warranty for hollow metal doors and frames.

1. Minimum Warranty Period: 2 years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Curries Co.; an Assa Abloy Group company.
2. Republic Doors and Frames.
3. Steelcraft; an Ingersoll-Rand company.

B. Source Limitations: Obtain hollow metal work from single source from single manufacturer.

2.2 REGULATORY REQUIREMENTS

A. Fire-Rated Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings and temperature-rise limits indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.

1. Smoke-Control and Draft-Control Assemblies: Provide an assembly with gaskets listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.

2. Provide Safety Glazing and Labeling.
   a. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.
   b. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

B. Fire-Rated, Borrowed-Light Assemblies: Complying with NFPA 80 and listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9.

C. Temperature Rise Rating: At stairwell enclosures, provide doors which have a temperature rise rating of 450 degrees F maximum in 30 minutes of fire exposure.

D. Recycled content of Steel Products: Post-consumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.

1. Provide documents indicating that products comply with VOC Content in accordance with the testing and product requirements of local regulations controlling use of volatile organic compounds (VOC’s)

E. VOC Content:
1. Products shall comply with VOC limits of authorities having jurisdiction for paints and coatings applied at Project site, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 INTERIOR DOORS AND FRAMES

A. Construct interior doors and frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Heavy Duty Doors and Frames: SDI A250.8, Level 2.

1. Physical Performance: Level B according to SDI A250.4.
2. Doors:

a. Type: As indicated in the Door and Frame Schedule.
b. Thickness: 1-3/4 inches.
c. Face: Uncoated, cold-rolled steel sheet, minimum thickness of 0.042 inch.
d. Edge Construction: Model 2, Seamless.
e. Core: Manufacturer's standard.

3. Frames:

a. Materials: Uncoated, steel sheet, minimum thickness of 0.053 inch.
b. Construction:

1) Full profile welded typically.
2) Knocked down at locations indicated on the Drawings.

4. Exposed Finish: Prime.

2.4 FRAME ANCHORS

A. Jamb Anchors:

1. Stud Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch thick.
2. Post-installed Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.

B. Floor Anchors: Formed from same material as frames, minimum thickness of 0.042 inch, and as follows:

1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.

2.5 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.

D. Frame Anchors: ASTM A 879/A 879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.

E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

F. Grout: ASTM C 476, except with a maximum slump of 4 inches, as measured according to ASTM C 143/C 143M.

G. Mineral Fiber Insulation:
1. ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

H. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

I. Power-Actuated Fasteners in Concrete:
1. From corrosion-resistant materials.
2. Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.

2.6 FABRICATION

A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for metal thickness. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Hollow Metal Doors:

1. Steel-Stiffened Door Cores: Provide minimum thickness 0.026 inch, steel vertical stiffeners of same material as face sheets extending full-door height, with vertical webs spaced not more than 6 inches apart. Spot weld to face sheets no more than 5 inches on center. Fill spaces between stiffeners with glass- or mineral-fiber insulation.
2. Fire Door Cores: As required to provide fire-protection and temperature-rise ratings indicated.
3. Vertical Edges for Single-Acting Doors: Bevel edges 1/8 inch in 2 inches
4. Top Edge Closures: Close top edges of doors with inverted closures, except provide flush closures at exterior doors, of same material as face sheets.
5. Bottom Edge Closures: Close bottom edges of doors with end closures or channels of same material as face sheets.
6. Exterior Doors: Provide weephole openings in bottoms of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
7. Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.

C. Hollow Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

1. Sidelight Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.
2. Exposed Fasteners: Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
3. Floor Anchors: Weld anchors to bottoms of jambs with at least four spot welds per anchor; however, for slip-on drywall frames, provide anchor clips or countersunk holes at bottoms of jambs.
4. Jamb Anchors: Provide number and spacing of anchors as follows:

    a. Masonry Type: Locate anchors not more than 16 inches from top and bottom of frame. Space anchors not more than 32 inches on center, to match coursing, and as follows:

        1) Two anchors per jamb up to 60 inches high.
        2) Three anchors per jamb from 60 to 90 inches high.
        3) Four anchors per jamb from 90 to 120 inches high.
        4) Four anchors per jamb plus one additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high.

    b. Stud Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches on center. and as follows:

        1) Three anchors per jamb up to 60 inches high.
        2) Four anchors per jamb from 60 to 90 inches high.
        3) Five anchors per jamb from 90 to 96 inches high.
        4) Five anchors per jamb plus one additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high.

    c. Post-Installed Expansion Type: Locate anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches on center.

5. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers.

    a. Single Door Frames: Drill stop in strike jamb to receive three door silencers.
    b. Double Door Frames: Drill stop in head jamb to receive two door silencers.

D. Stiffeners and Edge Channels: Fabricate concealed stiffeners and edge channels from either cold-rolled or hot-rolled steel sheet.

E. Hardware Preparation: Factory prepare hollow metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.

1. Reinforce doors and frames to receive non-templated, mortised, and surface-mounted door hardware.
2. Comply with applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow metal work for hardware.

F. Provisions for Glazing: Doors and frames with openings to be glazed shall be prepared to receive the glass. Glazing stops and molding on the outside of exterior openings and on outside

of interior openings shall be non-removable. Glazing beads on the inside of openings shall be removable screw-on or snap-on type. Provide fire-rated glass for fire rated doors and clear tempered glass for non-rated doors.

2.7 GLAZING

A. Fire-Protection-Rated Glazing: Listed and labeled by a testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated based on testing according to NFPA 252 for door assemblies.

1. Monolithic Ceramic Glazing: Clear, ceramic flat glass; 3/16 inch nominal thickness; polished on both sides. Impact Safety Rating: CPSC 16 CFR 1201 Category I and II.
2. Basis-of-Design: Subject to compliance with requirements, provide glazing by Safti First, Schott North America, Inc.; SuperLite Pyran Platinum-F or by one of the following manufacturers:

    a. Nippon Glass Company (distributed by Technical Glass Products).
    b. Vetrotech Saint-Gobain; SGG Keralite FR-R.

B. Non-Fire-Protection Rated Glazing:
1. Fully Tempered Float Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear), Quality-Q3.

2.8 FINISHES

A. General: Comply with NAAMMM's AMP 500, Metal Finishes Manual for Architectural and Metal Products for recommendations relative to applying and designating finishes. Protect mechanical finishes on exposed surfaces from damage by applying a strippable temporary protective covering prior to shipment.

B. Steel Sheet Finishes: Comply with SSPC PA-1, Shop, field and Maintenance Painting of Steel. Apply primers and organic finishes after fabrication.
1. Surface Preparation: Solvent clean surfaces to comply with SSPC SP-1, Solvent Cleaning to remove dirt, oil, grease, and other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel to comply with SSPC SP-5/NACE No. 1, White Metal Blast Cleaning or SSPC SP-8, Pickling.

2. Pretreatment: Immediately after surface preparation, apply a conversion coating of type suited to organic coating applied over it.

3. Factory priming for Field-Paint Finish: Apply shop primer that complies with ANSI/SDI A250.10 acceptance criteria, is compatible with finish paint systems indicated, and has capability to provide a sound foundation for field applied topcoats. Apply primer immediately after surface preparation and pretreatment. Field-applied paint finish is specified in Section 09 91 23 Interior Painting.

    a. Shop Primer: SDI A250.10.

2.9 ACCESSORIES

A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.

B. Grout Guards: Formed from same material as frames, not less than 0.016 inch thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:
1. Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the COR, of any conditions detrimental to the proper and timely completion of the work.

B. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.
2. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

3.2 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

B. Drill and tap doors and frames to receive non-templated, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place. Comply with Drawings and manufacturer's written instructions.

B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with SDI A250.11 or NAAMM/HMMA 840 as required by standards specified.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.

a. At fire-rated openings, install frames according to NFPA 80.
b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
c. Install frames with removable stops located on secure side of opening.
d. Install door silencers in frames before grouting.
e. Remove temporary braces necessary for installation only after frames have been properly set and secured.
f. Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with post-installed expansion anchors.

a. Floor anchors may be set with power-actuated fasteners instead of post-installed expansion anchors if so indicated and approved on Shop Drawings.

3. Metal Stud Partitions: Solidly pack mineral-fiber insulation inside frames.
4. In-Place Concrete or Masonry Construction: Secure frames in place with post-installed expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
5. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:

a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.

1. Non-Fire-Rated Steel Doors:

a. Between Door and Frame Jambs and Head: 1/8 inch plus or minus 1/32 inch.
b. Between Edges of Pairs of Doors: 1/8 inch to 1/4 inch plus or minus 1/32 inch.
c. At Bottom of Door: 3/4 inch plus or minus 1/32 inch.
d. Between Door Face and Stop: 1/16 inch to 1/8 inch plus or minus 1/32 inch.

2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.

D. Glazing: Comply with installation requirements of the hollow metal manufacturer's written instructions.

1. Secure Stops with counter sunk flat or oval head machine screws spaced uniformly not more than 9 inches O.C. and not more than 2 inches O.C. from each corner.

3.4 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.

B. Remove grout and other bonding material from hollow metal work immediately after installation.

C. Prime Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

3.5 PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to the Installer, that shall ensure that the hollow metal doors and frames shall be without damage at time of Substantial Completion.

END OF SECTION 08 11 13

SECTION 08 71 00 - DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Mechanical door hardware for the following:

a. Swinging Doors.

b. Swing Gate

2. Cylinders for door hardware.
3. Electrified door hardware.

B. Products furnished, but not installed under this Section include:

1. Cylinders for locks on doors.
2. Final replacement cores and keys to be installed by FAA.

C. Retain as part of this contract the FAA's Security Systems Design and Integration (SSDI) contractor for installation for some of electrical door hardware.

1.2 REFERENCES

A. NFPA 80-1999 "Standard for Fire Doors and Fire Windows".

B. NFPA 252-1995 "Standard Methods of Fire Test of Door Assemblies"

C. Underwriters Laboratories Standard for Safety UL 10B "Fire Test of Door Assemblies"

D. Underwriters Laboratories Standard for Safety UL 10C "Positive Pressure Fire Test of Door Assemblies"

E. Uniform Building Code Standard 7-2 "Fire Test of Door Assemblies"

F. International Building Code (IBC) 2015

G. Underwriters Laboratories "Building Materials Directory"

H. INTERTEK Testing Services "Directory of Listed Products"

I. Door and Hardware Institute "Hardware for Labeled Fire Doors"

J. Building Hardware Manufacturers Association (BHMA)

K. FAA Facilities Security Management Program FAA Order 1600.69C

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: Details of electrified door hardware, indicating the following:

1. Wiring Diagrams: For power, signal, and control wiring and including the following:

a. Details of interface of electrified door hardware and building safety and security systems.
b. Schematic diagram of systems that interface with electrified door hardware.
c. Elevations doors controlled by electrified door hardware.

2. Operation Narrative: Describe the operation of doors controlled by electrified door hardware.

C. Samples for Verification: For exposed door hardware of each type required, in each finish specified, prepared on Samples of size indicated below. Tag Samples with full description for coordination with the door hardware schedule. Submit Samples before, or concurrent with, submission of door hardware schedule.

1. Sample Size: Full-size units or minimum 2 inch by 4 inch samples for sheet and 4 inch long samples for other products.

a. Full-size samples will be returned to Contractor. Units that are acceptable and remain undamaged through submittal, review, and field comparison process may, after final check of operation, be incorporated into the Work, within limitations of keying requirements.

D. Other Action Submittals:

1. Door Hardware Schedule: Prepared by or under the supervision of Installer, detailing fabrication and assembly of door hardware, as well as installation procedures and diagrams. Coordinate final door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

a. Submittal Sequence: Submit door hardware schedule concurrent with submissions of product data, samples, and shop drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate the fabrication of other work that is critical in Project construction schedule.
b. Format: Use same scheduling sequence and format and use same door numbers as in the Contract Documents.
c. Content: Include the following information:

1) Identification number, location, hand, fire rating, size, and material of each door and frame.

2) Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
3) Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.
4) Description of electrified door hardware sequences of operation and interfaces with other building control systems.
5) Fastenings and other pertinent information.
6) Explanation of abbreviations, symbols, and codes contained in schedule.
7) Mounting locations for door hardware.
8) List of related door devices specified in other Sections for each door and frame.

2. Keying Schedule: Prepared by or under the supervision of Installer, detailing FAA's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations that are coordinated with the Contract Documents.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and Architectural Hardware Consultant.

B. Product Certificates: For electrified door hardware, from the manufacturer.

1. Certify that door hardware approved for use on types and sizes of labeled fire-rated doors complies with listed fire-rated door assemblies.

C. Product Test Reports: For compliance with accessibility requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for door hardware on doors located in accessible routes.

D. Warranty: Special warranty specified in this Section.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of door hardware to include in maintenance manuals. Include final hardware schedule.

1.6 QUALITY ASSURANCE

A. Building Hardware Manufacturer’s Association (BHMA) Grade 1 hardware throughout.

B. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and an Architectural Hardware Consultant who is available during the course of the Work to consult with Contractor, and COR about door hardware and keying.

1. Warehousing Facilities: In Project's vicinity.
2. Scheduling Responsibility: Preparation of door hardware and keying schedules.

3. Engineering Responsibility: Preparation of data for electrified door hardware, including shop drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

C. Architectural Hardware Consultant Qualifications: A person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and who is currently certified by DHI as follows:

1. For door hardware, an Architectural Hardware Consultant (AHC) who is also an Electrified Hardware Consultant (EHC).
2. Require supplier to meet with COR to finalize keying requirements and to obtain final instructions in writing.

D. Source Limitations: Obtain each type of door hardware from a single manufacturer.

1. Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated. Manufacturers that perform electrical modifications and that are listed by a testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.

E. Fire-Rated Door Assemblies: Where fire-rated door assemblies are indicated, provide door hardware rated for use in assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C, unless otherwise indicated.

F. Smoke-Control and Draft-Control Door Assemblies: Where smoke-control and draft-control door assemblies are required, provide door hardware that meet requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.

1. Air Leakage Rate: Maximum air leakage of 0.3 cfm/sq. ft. at the tested pressure differential of 0.3 inch wg of water.

G. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

H. Means of Egress Doors: Latches do not require more than 15 lbf to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.

I. Accessibility Requirements: For door hardware on doors in an accessible route, comply with the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines.

1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf.
2. Comply with the following maximum opening-force requirements:

a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf applied perpendicular to door.
b. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.

3. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch high.

4. Adjust door closer sweep periods so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches from the latch, measured to the leading edge of the door.

J. Pre-Installation Conference: Conduct conference at Project site.

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Inspect and discuss preparatory work performed by other trades.
3. Inspect and discuss electrical roughing-in for electrified door hardware.
4. Review sequence of operation for each type of electrified door hardware.
5. Review required testing, inspecting, and certifying procedures.

K. Coordination:

1. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check shop drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
2. Security: Coordinate installation of door hardware, keying, and access control with FAA’s SSDI Contractor, retained as part of this project.
3. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.
4. Existing Openings: Where hardware components are scheduled for application to existing construction or where modifications to existing door hardware are required, field verify existing conditions and coordinate installation of door hardware to suit opening conditions and to provide proper door operation.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.

B. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.

C. Deliver keys and permanent cores to COR by registered mail or overnight package service.

D. Provide secure lock-up for door hardware delivered to the Project, but not yet installed. Control handling and installation of hardware items that are not immediately replaceable so that completion of the Work will not be delayed by hardware losses both before and after installation.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

    a. Structural failures including excessive deflection, cracking, or breakage.
    b. Faulty operation of doors and door hardware.
    c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period: Three years from date of Substantial Completion, unless otherwise indicated.

    a. Exit Devices: Two years from date of Substantial Completion.
    b. Manual Closers: 10 years from date of Substantial Completion.

1.9 MAINTENANCE SERVICE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions for FAA's continued adjustment, maintenance, and removal and replacement of door hardware.

B. Maintenance Service: Beginning at Substantial Completion, provide six months' full maintenance by skilled employees of door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door and door hardware operation. Provide parts and supplies that are the same as those used in the manufacture and installation of original products.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work are listed in other Part 2 articles.

2.2 SCHEDULED DOOR HARDWARE

A. Provide door hardware for each door as scheduled in Part 3 "Door Hardware Schedule" Article to comply with requirements in this Section.

1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and products equivalent in function and comparable in quality to named products.
2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.

B. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in Part 3 "Door Hardware Schedule" Article. Products are identified by using door hardware designations, as follows:

1. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names are abbreviated in Part 3 "Door Hardware Schedule" Article.

2.3 HINGES

A. Hinges: BHMA A156.1. Provide template-produced hinges for hinges installed on hollow-metal doors and hollow-metal frames. Hinges to be non-removable pin hinges.

1. Manufacturers:

a. Hager Companies.
b. IVES Hardware; an Ingersoll-Rand company.
c. McKinney Products Co.; an ASSA ABLOY Group company.
d. Stanley Commercial Hardware; div. of The Stanley Works.

2.4 SELF-CLOSING HINGES AND PIVOTS

A. Self-Closing Hinges and Pivots: BHMA A156.17
1. Manufacturers:
a. Hager Companies.
b. McKinney Products Company; am ASSA ABLOY Group Company.
c. Stanley Commercial Hardware; Div. of The Stanly Works.

2.5 CONTINUOUS HINGES

A. Continuous Hinges: BHMA A156.26; minimum 0.120-inch-thick, hinge leaves with minimum overall width of 4 inches; fabricated to full height of door and frame and to template screw locations; with components finished after milling and drilling are complete.

B. Continuous, Gear-Type Hinges: Extruded-aluminum, pinless, geared hinge leaves joined by a continuous extruded-aluminum channel cap; with concealed, self-lubricating thrust bearings.

1. Manufacturers:

a. Hager Companies.
b. IVES Hardware; an Ingersoll-Rand company.
c. McKinney Products Co.; an ASSA ABLOY Group company.
d. Stanley Commercial Hardware; div. of The Stanley Works.

2.6 MECHANICAL LOCKS AND LATCHES

A. Lock Functions: As indicated in door hardware schedule.

B. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:

1. Bored Locks: Minimum 1/2-inch latch bolt throw.

2. Mortise Locks: Minimum 3/4-inch latch bolt throw.
3. Deadbolts: Minimum 1 inch bolt throw.

C. Lock Backset: 2-3/4 inches, unless otherwise indicated.

D. Lock Trim:

1. Description: As indicated on Drawings.
2. Levers: Cast.
3. Escutcheons (Roses): Wrought.
4. Operating Device: Lever with escutcheons (roses).

E. Strikes: Provide manufacturer's standard strike for each lock bolt or latch bolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.

1. Flat-Lip Strikes: For locks with three-piece antifriction latch bolts, as recommended by manufacturer.

F. Bored Locks: BHMA A156.2; Grade 1; Series 4000.

1. Manufacturers:

a. Best Access Systems; div. of Stanley Security Solutions, Inc.
b. SARGENT Manufacturing Co.; an ASSA ABLOY Group company.
c. Schlage Commercial Lock Div.; an Ingersoll-Rand company.
d. Yale Security, Inc.; an ASSA ABLOY Group company.

G. Mortise Locks: BHMA A156.13; Operational Grade 1; stamped steel case with steel or brass parts; Series 1000.

1. Manufacturers:

a. Best Access Systems; div. of Stanley Security Solutions, Inc.
b. Corbin Russwin Architectural Hardware; an ASSA ABLOY Group company.
c. Falcon Lock; an Ingersoll-Rand company.
d. SARGENT Manufacturing Co.; an ASSA ABLOY Group company.
e. Schlage Commercial Lock Div.; an Ingersoll-Rand company.
f. Yale Security, Inc.; an ASSA ABLOY Group company.

2.7 ELECTRIC STRIKES

A. Electric Strikes: BHMA A156.31; Grade 1; with faceplate to suit lock and frame.

1. Manufacturers:

a. Adams Rite Manufacturing Co.; an ASSA ABLOY Group company.
b. Dortronics Systems, Inc.
c. DynaLock Corp.
d. Rutherford Controls Int'l. Corp.

e. Security Door Controls.
f. Trine Access Technology.
g. Von Duprin; an Ingersoll-Rand company.

2.8 ELECTROMECHANICAL LOCKS

A. Electromechanical Locks: BHMA A156.25; Grade 1; motor or solenoid driven; mortise latch bolt; with strike that suits frame.

1. Manufacturers:

a. Best Access Systems; div. of Stanley Security Solutions, Inc.
b. SARGENT Manufacturing Co.; an ASSA ABLOY Group company.
c. Schlage Commercial Lock Div.; an Ingersoll-Rand company.
d. Yale Security, Inc.; an ASSA ABLOY Group company.

2.9 FLUSH BOLTS

A. Manual Flush Bolts: BHMA A156.16; minimum 3/4 inch throw; designed for mortising into door edge.

1. Manufacturers:

a. Adams Rite Manufacturing Co.; an ASSA ABLOY Group company.
b. Burns Manufacturing, Inc.
c. Don-Jo Mfg., Inc.
d. Door Controls International, Inc.
e. Hager Companies.
f. IVES Hardware; an Ingersoll-Rand company.
g. Trimco.

B. Automatic and Self-Latching Flush Bolts: BHMA A156.16; minimum 3/4 inch throw; designed for mortising into door edge.

1. Manufacturers:

a. Cal-Royal Products, Inc.
b. Hager Companies.
c. IVES Hardware; an Ingersoll-Rand company.
d. Trimco.

2.10 EXIT DEVICES AND AUXILIARY ITEMS

A. Exit Devices and Auxiliary Items: BHMA A156.3.

1. Manufacturers:

a. Adams Rite Manufacturing Co.; an ASSA ABLOY Group company.

b. Corbin Russwin Architectural Hardware; an ASSA ABLOY Group company.
c. Door Controls International, Inc.
d. DORMA Architectural Hardware; member of The DORMA Group North America.
e. SARGENT Manufacturing Co.; an ASSA ABLOY Group company.
f. Von Duprin; an Ingersoll-Rand company.

2.11 LOCK CYLINDERS

A. Provide construction cores and keys during the construction period. Construction, control and operating key and cores shall not be part of the FAA's permanent keying system. Furnish permanent cores and keys to the FAA.

B. Cylinders shall be: Best CoreMax Core to receive type X key: 1CX7XC11626.

C. Coordinate with COR installation of interchangeable cores by Contractor in locksets. At completion of installation deliver keysets back to FAA. FAA will test locksets and keying to ensure proper installation. Contractor shall perform necessary corrections as directed by COR.

D. Metals: Construct lock cylinder parts from brass or bronze, stainless steel, or nickel silver.

2.12 KEYING

A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, Appendix A. Incorporate decisions made in keying conference.

1. Coordinate with COR keying requirements. Locks to receive Best's CoreMax Type X keys.
2. Existing System:

    a. Master key or grand master key locks to FAA's existing system.

3. Keyed Alike: Key all cylinders to same change key.

B. Keys: Nickel silver.

1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:

    a. Notation: Information to be furnished by COR.

2. Quantity: In addition to one extra key blank for each lock, provide the following:

    a. Cylinder Change Keys: Three.
    b. Master Keys: Five (confirm with COR).
    c. Grand Master Keys: Five (confirm with COR).
    d. Great-Grand Master Keys: Five (confirm with COR).

2.13 KEY CONTROL SYSTEM

A. Key Control Cabinet: BHMA A156.5; metal cabinet with baked-enamel finish; containing key-holding hooks, labels, two sets of key tags with self-locking key holders, key-gathering envelopes, and temporary and permanent markers; with key capacity of 150 percent of the number of locks.

1. Manufacturers:

a. American Key Boxes and Cabinets.
b. GE Security, Inc.
c. HPC, Inc.
d. Lund Equipment Co., Inc.
e. MMF Industries.
f. Tri Palm International.

2. Wall-Mounted Cabinet: Cabinet with hinged-panel door equipped with key-holding panels and pin-tumbler cylinder door lock.

a. Coordinate location of cabinet with COR.

2.14 OPERATING TRIM

A. Operating Trim: BHMA A156.6; stainless steel, unless otherwise indicated.

1. Manufacturers:

a. Burns Manufacturing, Inc.
b. Don-Jo Mfg., Inc.
c. Forms + Surfaces.
d. Hager Companies.
e. Hiawatha, Inc.
f. IVES Hardware; an Ingersoll-Rand company.
g. Rockwood Manufacturing Co.
h. Trimco.

2.15 ACCESSORIES FOR PAIRS OF DOORS

A. Coordinators: BHMA A156.3; consisting of active-leaf, hold-open lever and inactive-leaf release trigger; fabricated from steel with nylon-coated strike plates; with built-in, adjustable safety release.

B. Carry-Open Bars: BHMA A156.3; prevent the inactive leaf from opening before the active leaf; provide polished brass or bronze carry-open bars with strike plate for inactive leaves of pairs of doors unless automatic or self-latching bolts are used.

C. Astragals: BHMA A156.22.

2.16 SURFACE CLOSERS

A. Surface Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.

1. Manufacturers:

a. Arrow USA; an ASSA ABLOY Group company.
b. Corbin Russwin Architectural Hardware; an ASSA ABLOY Group company.
c. DORMA Architectural Hardware; member of The DORMA Group North America.
d. Dor-O-Matic; an Ingersoll-Rand company.
e. LCN Closers; an Ingersoll-Rand company.
f. SARGENT Manufacturing Co.; an ASSA ABLOY Group company.
g. Yale Security, Inc.; an ASSA ABLOY Group company.

2.17 STOPS AND HOLDERS

A. Mechanical Wall- and Floor-Mounted Stops: BHMA A156.16; polished cast brass, bronze, or aluminum base metal.

1. Manufacturers:

a. Architectural Builders Hardware Mfg., Inc.
b. Baldwin Hardware Corp.
c. Burns Manufacturing, Inc.
d. Cal-Royal Products, Inc.
e. Don-Jo Mfg., Inc.
f. Door Controls International, Inc.
g. Hager Companies.
h. Hiawatha, Inc.
i. IVES Hardware; an Ingersoll-Rand company.
j. Rockwood Manufacturing Co.
k. Stanley Commercial Hardware; div. of The Stanley Works.
l. Trimco.

B. Electromagnetic Door Holders: BHMA A156.15, Grade 1; wall-mounted electromagnetic single unit with strike plate attached to swinging door; coordinated with fire detectors and interface with fire alarm system for labeled fire-rated door assemblies.

1. Manufacturers:

a. Architectural Builders Hardware Mfg., Inc.
b. DORMA Architectural Hardware; member of The DORMA Group North America.
c. SARGENT Manufacturing Co.; an ASSA ABLOY Group company.

C. Overhead Stops and Holders: BHMA A156.8.

1. Manufacturers:

a. Architectural Builders Hardware Mfg., Inc.
b. Glynn-Johnson; an Ingersoll-Rand company.
c. Rockwood Manufacturing Co.
d. SARGENT Manufacturing Co.; an ASSA ABLOY Group company.

2.18 DOOR GASKETING

A. Door Gasketing: BHMA A156.22; air leakage not to exceed 0.50 cfm per foot of crack length for gasketing other than for smoke control, as tested according to ASTM E 283; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.

1. Manufacturers:

a. Hager Companies.
b. National Guard Products.
c. Pemko Manufacturing Co.; an ASSA ABLOY Group company.

2.19 THRESHOLDS

A. Thresholds: BHMA A156.21; fabricated to full width of opening indicated.

1. Manufacturers:

a. Hager Companies.
b. National Guard Products.
c. Pemko Manufacturing Co.; an ASSA ABLOY Group company.
d. Rixson Specialty Door Controls; an ASSA ABLOY Group company.

2.20 METAL PROTECTIVE TRIM UNITS

A. Metal Protective Trim Units: BHMA A156.6; fabricated from 0.050-inch-thick brass or bronze unless otherwise noted; with manufacturer's standard machine or self-tapping screw fasteners.

1. Manufacturers:

a. Baldwin Hardware Corp.
b. Hager Companies.
c. Hiawatha, Inc.
d. IVES Hardware; an Ingersoll-Rand company.
e. Trimco.

2.21 AUXILIARY DOOR HARDWARE

A. Auxiliary Hardware: BHMA A156.16.

1. Manufacturers:

a. Baldwin Hardware Corp.
b. Hager Companies.
c. Stanley Commercial Hardware; div. of The Stanley Works.
d. Trimco.

2.22 AUXILIARY ELECTRIFIED DOOR HARDWARE

A. Auxiliary Electrified Door Hardware:

1. Manufacturers:

a. DynaLock Corp.
b. GE Security, Inc.
c. SARGENT Manufacturing Co.; an ASSA ABLOY Group company.
d. Schlage Commercial Lock Div.; an Ingersoll-Rand company.
e. Securitron Magnalock Corp.; an ASSA ABLOY Group company.
f. Security Door Controls.
g. Von Duprin; an Ingersoll-Rand company.

2.23 FABRICATION

A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rated labels and as otherwise approved by the COR.

1. Manufacturer's identification is permitted on rim of lock cylinders only.

B. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18.

C. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.

1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.

2. Fire-Rated Applications:

a. Machine Screws: For the following:

1) Hinges mortised to doors or frames.
2) Strike plates to frames.
3) Closers to doors and frames.

b. Steel Through Bolts: For the following unless door blocking is provided:

1) Surface hinges to doors.
2) Closers to doors and frames.
3) Surface-mounted exit devices.

3. Spacers or Sex Bolts: For through bolting of hollow-metal doors.
4. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.24 FINISHES

A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance.

1. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

3.2 PREPARATION

A. Steel Doors and Frames: For surface applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.

3.3 INSTALLATION

A. Mounting Heights: Mount door hardware units at heights to comply with the following unless otherwise indicated or required to comply with governing regulations.

1. Standard Steel Doors and Frames: ANSI/SDI A250.8.

B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing. Do not install surface-mounted items until finishes have been completed on substrates involved.

1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

C. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches of door height, whichever is more stringent.

D. Lock Cylinders: Install construction cores to secure building and areas during construction period.

1. Furnish permanent cores to the COR for installation. The COR will install cores and return construction cores to contractor.

E. Key Control System: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.

F. Boxed Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings. Verify location with COR.

1. Coordinate with FAA’s SSDI Contractor.

G. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Section 07 92 00 "Joint Sealants."

H. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they will impede traffic.

I. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.

J. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.

K. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

3.4 FIELD QUALITY CONTROL

A. Independent Architectural Hardware Consultant: The COR will engage a qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.

1. Independent Architectural Hardware Consultant will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted.

3.5 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

1. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
2. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.

B. Occupancy Adjustment: Approximately six months after date of Substantial Completion, Installer's Architectural Hardware Consultant shall examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors, door hardware, and electrified door hardware.

3.6 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items as necessary to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train FAA's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes. Refer to Section 01 79 00 "Demonstration and Training."

3.8 DOOR HARDWARE SCHEDULE

A. Coordinate door hardware, especially door hinges, with existing door frames.

HDW-1 DoorM-14

3	Piano Hinges	Hager
1	Lockset	Best, keyed both sides
1	Latch Protection Plate	Hager 40D, US32D
1	Hinge Side Closers, C00191	LCN 4040SE, Alum
2	Armor Plate, J101	Hager, 194SxB4E, 36” h x 34” w, 26D UL Stamped
1	Weather Stripping	Pemko
1	Card Reader	

HDW-2 Door 30

6	Hinges	Hager 26D
1 pair	Automatic Flush Bolts,	Hager, 292D, 26D
1	Dustproof Strike	Hager 280X, 26D
1	Latchset, F01	Best, 45H0N16J626
1	Latch Protection Plate	Hager 40D, US32D
2	Parallel Closers, C02021	LCN 4111 DA, Alum
2	Magnetic Hold Opener	LCN
2	Door Stops, L02101	Hager, 232W 26D
1	Smoke Gasketing	Hager, 721S
2	Astragal	Hager, 872S X
1	Coordinator	Ives, COR Series
1	Card Reader	

Sequence of Operation

Active door is in the normally open position, while inactive door is in the normally closed position.

If fire alarm is activated, or smoke detectors adjacent to door is activated, magnetic hold open device releases active door and door closes.

HDW-3 Door 51

2	Pivot Hinges,	Hager,
1 pair	Automatic Flush Bolts,	Hager, 292D, 26D
1	Dustproof Strike	Hager 280X, 26D
1	Lockset, F01	Best, 45H0N16J626
2	Parallel Closers, C02021	LCN 4111-3077SCxDA, Alum
2	Kick Plates, J102	Hager, 194SxB4E, 8x35, 26D
1	Smoke Gasketing	Hager, 721S
2	Astragal	Hager, 872S X
1	Coordinator	Ives, COR Series
1	Astragal	Hager, 872SX
1	Card Readers	Reuse existing or SSDI to provide replacement
1	Door Power Loop	Reuse existing or SSDI to provide replacement
1	Electric Strike	Reuse existing or SSDI to provide replacement

HDW-4 Doors 25 and 52

4	Hinges, A8111	Hager, BB1168, 4 1/2x4 1/2, 26D NRP
1	Lockset, F07	Best, 45H7D16J626
2	Parallel Closer, C02021	LCN 4111 DA, Alum
1	Exit Device	
2	Astragal	Hager, 756S A
2	Kick Plate, J101	Hager, 194SxB4E, 36” h x 34”w, 26D UL Stamped
2	Door Stops, L02101	Hager, 232W 26D
1	Smoke Gasketing	Hager, 721S
1	Door Position Switches	Reuse existing or SSDI to provide replacement
1	PIR	Reuse existing or SSDI to provide replacement
1	Power Supply	Reuse existing or SSDI to provide replacement
1	Card Reader	Reuse existing or SSDI to provide replacement

Notes:

1. Coordinate work with electrical.
2. Retain FAA’s SSDI contractor for work not directly attached to door.
3. Coordinate with SSDI and COR Sequence of Operation.
4. Coordinate with SSDI contractor on equipment, junction-box and conduit requirements.

Proposed Sequence of Operation

Door is normally closed and secured.

Person approaching door, shall initiate card reader to release door strike and notify system that door is opening. Coordinate with COR duration time that door can remain in open position before door position switch alarms security system that door is in open position.

Person exiting through door activates PIR notifying system that door is to be open. Coordinate with COR duration time that door can remain in open position before door position switch alarms security system that door is in open position.

If power fails, door remains in fail secure mode. Door still retains free egress.

Door can be opened from non-secure side by key, this does not shunt door position alarm system.

HDW-5 Door M-15

2	Full Mortise Hinges	Hager,
1	Lockset	Best, Mortise 45H Series 1000 Series Grade 1 oper16J626
1	Latch Protection Plate	Hager 40D, US32D
2	Hinge Side Closers, C00191	LCN 4040SE, Alum
2	Kick Plates, J102	Hager, 194SxB4E, 8x34, 26D
2	Floor Door Stops, L02161	Hager, 243F 26D
1	Door Position Switch	Schlage 7766 Mag Door Switch

Note:

1. Coordinate with COR if floor stops are acceptable, as the FAA may consider them trip hazards.
2. Connect door closer to existing refrigerant leak detection system. Coordinate voltage with existing system and COR.

HDW-6 Doors 20 and 50

1	Lockset	Best, Mortise 45H Series 1000 Series Grade 1 oper16J626
6	Full Mortise Hinges	Hager, BB1199 5 x 5 32D
2	Parallel Closer, C02021	LCN 4111-DA, Alum
1	PIR	
1	Freon Gasketing	Pemko
2	Closers, C02021	LCN 4111 DA, Alum
1	Freon Leak Detection	

Note:

1. Coordinate door stop with existing conditions. Door is raised on concrete curb, and floor stop will not work.
2. Provide sequence of operations.

For Door No. 50 as follows:

1	Card Readers	Reuse existing or SSDI to provide replacement
1	Door Power Loop	Reuse existing or SSDI to provide replacement
1	Electric Strike	Reuse existing or SSDI to provide replacement
1	PIR	Reuse existing or SSDI to provide replacement
1	Door Position Switch	Reuse existing or SSDI to provide replacement
1	Power Supply	Reuse existing or SSDI to provide replacement

Notes:

1. Coordinate work with electrical.
2. Retain FAA's SSDI contractor for work not directly attached to door.
3. Coordinate with SSDI and COR Sequence of Operation.
4. Coordinate with SSDI contractor on equipment, junction-box and conduit requirements.

Proposed Sequence of Operation

Door is normally closed and secured.

Person approaching door, shall initiate card reader to release door strike and notify system that door is opening. Coordinate with COR duration time that door can remain in open position before door position switch alarms security system that door is in open position.

Person exiting through door activates PIR notifying system that door is to be open. Coordinate with COR duration time that door can remain in open position before door position switch alarms security system that door is in open position.

If power fails, door remains in fail secure mode. Door still retains free egress.

Door can be opened from non-secure side by key, this does not shunt door position alarm system

HDW-7 Doors 22, 27 and 46

Hinges, A8111		Hager, BB1168, 4 1/2x4 1/2, 26D NRP
1	Lockset, F07	Best, 45H7D16J626
1	Closer, C02021	LCN 4111 DA, Alum
2	Kick Plate, J101	Hager, 194SxB4E, 36" h x 34" w, 26D UL Stamped
1	Freon Gasketing	Hager, 721S
1	Freon Leak Detection	

HDW-8 Door 23, 36, 37, 43, and 49

3	Full Mortise Hinges, A8111	Hager,
1	Dustproof Strike	Hager 280X, 26D
1	Lockset, F01	Best, 45H0N16J626
1	Latch Protection Plate	Hager 40D, US32D
1	Closers, C02021	LCN 4111-3077SCxDA, Alum
2	Magnetic Hold Opener	LCN

For Door No's. 23, 43 and 49 as follows:

1	Card Readers	Reuse existing or SSDI to provide replacement
1	Door Power Loop	Reuse existing or SSDI to provide replacement
1	Electric Strike	Reuse existing or SSDI to provide replacement
1	PIR	Reuse existing or SSDI to provide replacement
1	Door Position Switch	Reuse existing or SSDI to provide replacement
1	Power Supply	Reuse existing or SSDI to provide replacement

Notes:

Coordinate work with electrical.
Retain FAA's SSDI contractor for work not directly attached to door.
Coordinate with SSDI and COR Sequence of Operation.
Coordinate with SSDI contractor on equipment, junction-box and conduit requirements.

Proposed Sequence of Operation

Door is normally closed and secured.
Person approaching door, shall initiate card reader to release door strike and notify system that door is opening. Coordinate with COR duration time that door can remain in open position before door position switch alarms security system that door is in open position.
Person exiting through door activates PIR notifying system that door is to be open. Coordinate with COR duration time that door can remain in open position before door position switch alarms security system that door is in open position.
If power fails, door remains in fail secure mode. Door still retains free egress.

Door can be opened from non-secure side by key, this does not shunt door position alarm system

HDW-9 Door 17, 18, 44, 45, 56, and 57

6	Hinges, A8111	Hager, BB1168, 4 1/2x4 1/2, 26D, half mortise Hinges
1 pair	Automatic Flush Bolts,	Hager, 292D, 26D
1	Dustproof Strike	Hager 280X, 26D
1	Lockset, F01	Best, 45H0N16J626
2	Parallel Closers, C02021	LCN 4111-3077SCxDA, Alum
2	Kick Plates, J102	Hager, 194SxB4E, 8x35, 26D
1	Smoke Gasketing	Hager, 721S
2	Astragal	Hager, 872S X
2	Magnetic Hold Opener	LCN

HDW-10 Door 11

6	Hinges, A8111	Hager, BB1168, 4 1/2x4 1/2, 26D, half mortise Hinges
1 pair	Automatic Flush Bolts,	Hager, 292D, 26D
1	Dustproof Strike	Hager 280X, 26D
1	Lockset, F01	Best, 45H0N16J626
2	Parallel Closers, C02021	LCN 4111-3077SCxDA, Alum With Hold open devices
1	Smoke Gasketing	Hager, 721S
2	Astragal	Hager, 872S X
1	Coordinator	Ives, COR Series
1	Astragal	Hager, 872SX
1	Card Readers	Reuse existing or SSDI to provide replacement
1	Door Power Loop	Reuse existing or SSDI to provide replacement
1	Electric Strike	Reuse existing or SSDI to provide replacement
1	PIR	Reuse existing or SSDI to provide replacement
1	Door Position Switch	Reuse existing or SSDI to provide replacement
1	Power Supply	Reuse existing or SSDI to provide replacement

Notes:
Coordinate work with electrical.
Retain FAA's SSDI contractor for work not directly attached to door.
Coordinate with SSDI and COR Sequence of Operation.
Coordinate with SSDI contractor on equipment, junction-box and conduit requirements.

Proposed Sequence of Operation

Door is normally closed and secured.

Person approaching door, shall initiate card reader to release door strike and notify system that door is opening. Coordinate with COR duration time that door can remain in open position before door position switch alarms security system that door is in open position.

Person exiting through door activates PIR notifying system that door is to be open. Coordinate with COR duration time that door can remain in open position before door position switch alarms security system that door is in open position.

If power fails, door remains in fail secure mode. Door still retains free egress.

Door can be opened from non-secure side by key, this does not shunt door position alarm system

HDW-11 Doors 40 and 53

6	Hinges, A8111	Hager, BB1168, 4 1/2x4 1/2, 26D, half mortise Hinges
2 pair	Automatic Flush Bolts,	Hager, 292D, 26D
1	Dustproof Strike	Hager 280X, 26D
1	Lockset, F01	Best, 45H0N16J626
2	Exit Devices	
2	Parallel Closers, C02021	LCN 4111-3077SCxDA, Alum
1	Smoke Gasketing	Hager, 721S
1	Astragal	Hager, 872S X
2	Door Bottom Sweep	Hager, 754S X
1	Coordinator	Ives, COR Series
1	Astragal	Hager, 872SX
1	Door Power Loop	Reuse existing or SSDI to provide replacement
1	Electric Strike	Reuse existing or SSDI to provide replacement
1	PIR	Reuse existing or SSDI to provide replacement
1	Door Position Switch	Reuse existing or SSDI to provide replacement
1	Power Supply	Reuse existing or SSDI to provide replacement

Notes:
Coordinate work with electrical.
Retain FAA's SSDI contractor for work not directly attached to door.
Coordinate with SSDI and COR Sequence of Operation.
Coordinate with SSDI contractor on equipment, junction-box and conduit requirements.

HDW-12 Doors 1ER, 2ER and 1PH

6	Hinges, A8111	Hager, BB1168, 4 1/2x4 1/2, 26D, half mortise Hinges
1	Dustproof Strike	Hager 280X, 26D
1	Lockset, F01	Best, 45H0N16J626
2	Door Bottom Sweep	Hager, 754S X
1	Latch Protection Plate	Hager 40D, US32D

END OF SECTION 08 71 00

SECTION 08 80 00 - GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:

1. Glass for interior windows and interior doors.
2. Glazing sealants and accessories.

1.3 DEFINITIONS

A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.

C. IBC: International Building Code.

1.4 COORDINATION

A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.5 ACTION SUBMITTALS

A. High Performance Sustainable Building Submittals:
1. VOC Content:
a. For adhesives, documentation indicating that products comply with the testing and product requirements of local regulations controlling use of volatile organic compounds (VOC's).

B. Product Data: For each type of product.

C. Glazing Accessory Samples: For sealants, in 12-inch lengths

D. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer

B. Product Certificates: For glass.

C. Product Test Reports: For glazing sealants, for tests performed by a qualified testing agency.

1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer shall be a firm engaged in the manufacture of glazing of types and size required and whose product s have been in satisfactory use in similar service for a minimum of five years

B. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

C. Pre-Installation Conference: Conduct conference at Project Site
1. Review and finalize construction schedule and verify availability of materials, Installer’s personnel, equipment and facilities need to make progress and avoid delays.
2. Review temporary production requirements for glazing during and after installation.
3. Coordination: Coordinate existing glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thickness, with reasonable tolerances.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

B. Comply with insulating-glass manufacturer's written instructions for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below 40 deg F.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. AGC Flat Glass North America.
   2. Cardinal FG.
   3. Guardian Industries Corp.
   4. Pilkington Glass Ltd.
   5. PPG Industries, Inc.

B. Source Limitations for Glass: Obtain from single source from single manufacturer for each glass type.

C. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

2.2 PERFORMANCE REQUIREMENTS

A. General: Installed glazing systems shall withstand normal movement and impact loads without failure, including loss or glass breakage attributable to the following:
   1. Defective manufacture, fabrication, or installation;
   2. Failure of sealants or gaskets to remain watertight and airtight;
   3. Deterioration of glazing materials;
   4. Other defects in construction.

B. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the IBC and ASTM E 1300.
   1. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch, whichever is less.

C. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.

D. Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:

   1. For monolithic-glass lites, properties are based on units with lites 6 mm thick.

2.3 GLASS PRODUCTS, GENERAL

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.

   1. GANA Publications: "Glazing Manual."

B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

C. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated.

D. Strength: Where fully tempered float glass is indicated, provide fully tempered float glass

2.4 GLASS PRODUCTS

A. Clear Annealed Float Glass: ASTM C 1036, Type I, Class 1 (clear), Quality-Q3.

B. Fully Tempered Float Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear), Quality-Q3.

1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

2.5 GLAZING SEALANTS

A. General:

1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
3. Colors of Exposed Glazing Sealants: Black.
4. VOC Content: Field applied sealant shall have a VOC content of not more than 250 g/L.

B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.

1. Manufacturers: Subject to compliance with requirements available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Dow Corning Corp.
   b. GE Advanced Materials-Silicones
   c. May National Associates, Inc
   d. Pecora Corp.
   e. Polymeric Systems, Inc.
   f. Sika Corp. U.S.
   g. Tremco, Inc
2. Applications: As indicated on the Drawings.

2.6 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; non-staining and non-migrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:

1. AAMA 804.3 tape, where indicated.
2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

2.7 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, with requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

D. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

2.8 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:

1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
2. Minimum required face and edge clearances.
3. Effective sealing between joints of glass-framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.
1. Beginning the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

3.3 GLAZING

A. GENERAL
1. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
2. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.
3. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
4. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
5. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
6. Provide spacers for glass lites where length plus width is larger than 50 inches.
   a. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
   b. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
7. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
8. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
9. Set glass lites with proper orientation so that coatings face exterior or interior as specified.

10. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement. Square cut wedge-shape gaskets at corners and install gaskets in a manner recommended by gasket manufacture to prevent corners from pulling away, seal corner joints and butt joints with sealant recommended by gasket manufacturer.

B. Glazing: Provide either of the following at the Contractor's option:
   1. Tape Glazing:
      a. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
      b. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
      c. Cover vertical framing joints by applying tapes to heads and sills first, then to jambs. Cover horizontal framing joints by applying tapes to jambs, then to heads and sills.
      d. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
      e. Do not remove release paper from tape until right before each glazing unit is installed.
      f. Apply heel bead of elastomeric sealant.
      g. Center glass lites in openings on setting blocks, and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
   2. Sealant Glazing (Wet):
      a. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
      b. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
      c. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.4 MONOLITHIC GLASS SCHEDULE

A. Glass Type: Clear fully tempered float glass.
   1. Minimum Thickness: 6mm
   2. Safety glazing required

3.5 ADJUSTING AND CLEANING

A. Immediately after installation remove non-permanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.

1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.

C. Remove and replace glass that is damaged during construction period.

D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

3.6 PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to the installer that shall ensure that the glazing shall be without damage at time of Substantial Completion.

END OF SECTION 088000

SECTION 09 22 16 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Non-load-bearing steel framing systems for interior gypsum board assemblies.

2. Suspension Systems

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. High Performance Sustainable Building Submittals:
1. Recycled Content: For products having recycled content, documentation indicating percentages by weight of post-consumer and pre-consumer recycled content. Include statement indicating cost for each product having recycled content.

C. Fastener Calculations:
1. Concrete Substrates:
   a. Confirm anchors identified on Partition Schedule are of adequate type, material, size, holding power, and spacing required to fasten steel members. Anchorage identified on Partition Schedule indicates a minimum for anchor size, embedment, holding power, and spacing.
2. Slotted Channel Framing Substrates:
   a. Provide calculations proving fasteners provided to attach head track to slotted channel framing are of type, material, size, holding power, spacing, and other properties required to fasten steel members.
3. Structural Steel Framing Substrates:
   a. Provide calculations proving fasteners provided to attach head track to structural steel framing are of type, material, size, holding power, spacing, and other properties required to fasten steel members.

1.3 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For dimpled steel studs and runners, from ICC-ES.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide framing of size and spacing indicated on the Drawings. Manufacturer's designated professional engineer shall design members and spacings not specifically indicated on the Drawings for the loading criteria indicated on Drawings.

B. Fire Test Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 119 by an independent testing agency.

C. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

D. Recycled Content of Steel Products: Post-consumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.

2.2 FRAMING SYSTEMS

A. Provide structural grade framing members (studs and tracks) with 0.0329-inch minimum thickness but not less than indicated on Drawings.

B. Framing Members, General: Comply with ASTM C 754 for conditions indicated.

1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
2. Protective Coating: ASTM A 653/A 653M, G40, hot-dip galvanized unless otherwise indicated.

C. Studs and Runners: ASTM C 645. Use either steel studs and runners or dimpled steel studs and runners.

1. Steel Studs and Runners:

   a. Minimum Base Metal Thickness: 0.0329 inch unless otherwise indicated.
   b. Depth: As indicated on the Drawings.

2. Dimpled Steel Studs and Runners:

   a. Minimum Base Metal Thickness: 0.0329 inch unless otherwise indicated.
   b. Depth: As indicated on the Drawings.

D. Slip Type Head Joints: Where indicated, provide the following:

1. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) Dietrich Metal Framing; SLP-TRK Slotted Deflection Track.
2) MBA Building Supplies; Slotted Deflecto Track.
3) Superior Metal Trim; Superior Flex Track System (SFT).

b. Provide tracks capable of accommodating 1 inch of vertical deflection.

E. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Fire Trak Corp.; Fire Trak System.
b. Grace Construction Products; FlameSafe FlowTrak System.
c. Metal-Lite, Inc.; The System.

F. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.

1. Minimum Base Metal Thickness: 0.033 inch.

G. Cold-Rolled Channel Bridging: Steel, 0.053-inch minimum base metal thickness, with minimum 1/2-inch-wide flanges.

1. Depth: 1-1/2 inches
2. Clip Angle: Not less than 1-1/2 inches by 1-1/2 inches, 0.068-inch-thick, galvanized steel.

H. Hat-Shaped, Rigid Furring Channels: ASTM C 645.

1. Minimum Base Metal Thickness: 0.018 inch.
2. Depth: As indicated on the Drawings.

I. Resilient Furring Channels: 1/2-inch-deep, steel sheet members designed to reduce sound transmission.

1. Configuration: Asymmetrical.

2.3 SUSPENSION SYSTEMS

A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch diameter wire, or double strand of 0.048-inch diameter wire.

B. Hanger Attachments to Concrete:

1. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E 1190 by an independent testing agency.

C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.

D. Carrying Channels: Cold-rolled, commercial steel sheet with a base metal thickness of 0.053 inch and minimum 1/2-inch-wide flanges.

1. Depth: 2-1/2 inches.

E. Furring Channels (Furring Members):

1. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch deep.

a. Minimum Base Metal Thickness: 0.018 inch.

2.4 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.

1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

B. Isolation Strip at Exterior Walls: Provide one of the following:

1. Asphalt-Saturated Organic Felt: ASTM D 226, Type I (No. 15 asphalt felt), non-perforated.
2. Foam Gasket: Adhesive-backed, closed cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8-inch-thick, in width to suit steel stud size.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:
1. Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the COR, of any conditions detrimental to the proper and timely completion of the work.

B. Examine areas and substrates, with Installer present, and including welded hollow metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

3.2 PREPARATION

A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.

3.3 INSTALLATION, GENERAL

A. Installation Standard: ASTM C 754.

1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

C. Install bracing at terminations in assemblies.

D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLING FRAMED ASSEMBLIES

A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.

D. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.

1. Slip Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.

2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.

    a. Install two studs at each jamb unless otherwise indicated.
    b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
    c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.

3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.

    a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.

5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.

E. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.5 INSTALLING SUSPENSION SYSTEMS

A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

1. Hangers: 48 inches on center.
2. Carrying Channels (Main Runners): 48 inches on center.
3. Furring Channels (Furring Members): 16 inches on center.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

C. Suspend hangers from building structure as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.

    a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.

a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.

3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
4. Do not attach hangers to steel roof deck.
5. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
6. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
7. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. Seismic Bracing: Sway-brace suspension systems with hangers used for support.

E. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

3.6 PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to the Installer, that shall ensure that the non-structural metal framing shall be without damage at time of Substantial Completion.

END OF SECTION 09 22 16

SECTION 09 29 00 - GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior gypsum board.

B. Do not provide or install gypsum board manufactured in China.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include place of manufacture.

B. High Performance Sustainable Building Submittals:

1. Recycled Content: For products having recycled content, documentation indicating percentages by weight of post-consumer and pre-consumer recycled content. Include statement indicating cost for each product having recycled content.
2. VOC Content: For adhesives and joint sealants, documentation indicating that products comply with the testing and product requirements of local regulations controlling use of volatile organic compounds (VOC's).

C. Environmental Data: Submit environmental data in accordance with Table 1 of ASTM E 2129 for products provided under work of this Section.

1.3 DELIVERY, STORAGE AND HANDLING

A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.4 FIELD CONDITIONS

A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.

2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 INTERIOR GYPSUM BOARD

A. Recycled Content: Minimum 10 percent post-consumer recycled content, or minimum 20 percent pre-consumer recycled content at contractor’s option.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following except that Chinese products are not acceptable:

1. CertainTeed Corp.
2. Georgia-Pacific Gypsum LLC.
3. National Gypsum Co.
4. USG Corp.

C. Gypsum Wallboard: ASTM C 1396/C1936M.

1. Thickness: 5/8 inch.
2. Long Edges: Tapered.

D. Gypsum Board, Type X: ASTM C 1396/C 1396M.

1. Thickness: 5/8 inch.
2. Long Edges: Tapered and featured (rounded or beveled) for prefilling.

E. Gypsum Ceiling Board: ASTM C 1396/C 1396M.

1. Thickness: 1/2 inch.
2. Long Edges: Tapered.

F. Moisture-Resistant and Mold-Resistant Gypsum Board: ASTM C 1396/C 1396M. With moisture-resistant and mold-resistant core and paper surfaces.

1. Core: 5/8 inch, Type X.
2. Long Edges: Tapered.

3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

2.3 SPECIALTY GYPSUM BOARD

A. Gypsum Board, Type C: ASTM C 1396/C 1396M. Manufactured to have increased fire-resistive capability.

1. Thickness: As required by fire-resistance-rated assembly indicated on Drawings.
2. Long Edges: Tapered.

2.4 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.

1. Material: Galvanized or aluminum-coated steel sheet.

B. Aluminum Trim: ASTM B 221, Alloy 6063-T5.

2.5 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:

1. Interior Gypsum Board: Paper; fiberglass joint tape not permitted.

C. Joint Compound for Interior Gypsum Board: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Lime Compound: All-purpose joint and texturing compound containing inert fillers and natural binders. Pre-mixed compounds shall be free of antifreeze, vinyl adhesives, preservatives, biocides and other slow releasing compounds

2.6 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.

B. Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.

1. Adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.

D. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing).

1. Recycled Content of Blankets: Post-consumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.
2. Fire Resistant Rated Assemblies: Comply with mineral fiber requirements of assembly.

E. Acoustical Joint Sealant: ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings as demonstrated by testing according to ASTM E 90.

1. Acoustical joint sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the COR, of any conditions detrimental to the proper and timely completion of the work.

B. Examine areas and substrates including welded hollow metal frames and framing, with Installer present, for compliance with requirements and other conditions affecting performance.

1. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

3.2 APPLYING AND FINISHING PANELS

A. Comply with ASTM C 840.

B. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4 inch to 1/2-inch-wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.

D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

E. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

F. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

G. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.

H. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

I. Single-Layer Application:

1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
2. On partitions/walls, apply gypsum panels vertically (parallel to framing), unless otherwise indicated, and provide panel lengths that shall minimize end joints. At stairwells and other high walls, install panels horizontally.

    a. Stagger abutting end joints not less than one framing member in alternate courses of panels.

3. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

J. Multilayer Application:

1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face layer joints one framing member, 16 inches minimum, from parallel base layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face layer joints offset at least one stud or furring member with base layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
3. Fastening Methods: Fasten base layers and face layers separately to supports with screws.

    a. Only at locations indicated, fasten face layer with adhesive. Comply with gypsum board manufacturer's written recommendations and temporarily brace or fasten gypsum panels until fastening adhesive has set.

3.3 INSTALLING TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

3.4 FINISHING GYPSUM BOARD

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints, rounded or beveled edges, and damaged surface areas.

C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:

1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
2. Level 4: For all gypsum wall and ceiling panels not otherwise indicated as Level 1, 2, or 3 on the Drawings.

    a. Primer and its application to surfaces are specified in Section 09 91 23 "Interior Painting."

3.5 PROTECTION

A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

C. Remove and replace panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

3.6 SITE ENVIRONMENTAL PROCEDURES

A. Indoor Air Quality:

1. Temporary ventilation: Provide temporary ventilation for work of this Section.

B. Waste Management: As specified in Section 01 74 19 “Construction Waste Management” and as follows:

Select panel sizes and layout panels to minimize waste; reuse cutoffs to the greatest extent possible.

END OF SECTION 09 29 00

SECTION 095113 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes acoustical panels and exposed suspension systems for interior ceilings.

B. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices.

1.3 PRE-INSTALLATION MEETINGS

A. Conduct a Pre-Installation Conference at the project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified.

C. Samples for Initial Selection: For components with factory-applied finishes.

D. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of sizes indicated below:

1. Acoustical Panels: Set of 6” samples of each type, color, pattern, and texture.
2. Exposed Suspension System: All support members, Moldings, and Trim: Set of samples of each type, finish, and color.
3. Clips: Full-size for each type proposed for use.

E. Delegated-Design Submittal: For seismic restraints for ceiling systems.

1. Include design calculations for seismic restraints including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
2. Include design drawings for seismic restraint members and layout, signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension-system members.
2. Structural members and structural components to which suspension systems will be attached.
3. Method of attaching hangers to building structure.

    a. Furnish layouts for cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.

4. Carrying channels or other supplemental support for hanger-wire attachment where conditions do not permit installation of hanger wires at required spacing.
5. Size and location of initial access modules for acoustical panels.
6. Items penetrating finished ceiling and ceiling-mounted items including the following:

    a. Lighting fixtures
    b. Diffusers Grilles and Registers
    c. Speakers
    d. Sprinklers and probes
    e. Access panels
    f. Perimeter moldings
    g. Wireless network components
    h. Fire alarm/detection components.

7. Show operation of hinged and sliding components covered by or adjacent to acoustical panels.
8. Minimum Drawing Scale: 1/4 inch = 1 foot
9. Coordinate "Qualification Data" Paragraph below with qualification requirements in Section 014000 "Quality Requirements" and as may be supplemented in "Quality Assurance" Article.

B. Product Test Reports: For each acoustical panel ceiling, for tests performed by manufacturer and witnessed by a qualified testing agency.

C. Evaluation Reports: For each acoustical panel ceiling suspension system including anchors and fastener types, from ICC-ES.

D. Field quality-control reports.

E. Environmental Data:
1. Submit environmental data in accordance with Table 1 of ASTM E 2129 for products provided under work of this Section.

F. High Performance Sustainable Building Submittals:
1. Recycled Content: For products having recycled content, documentation indicating percentages by weight of post-consumer and pre-consumer recycled content. Include statement indicating cost for each product having recycled content.

G. VOC Content:
   1. For acoustical panel ceilings and sealants, documentation indicating that products comply with the testing and product requirements of local regulations controlling use of volatile organic compounds (VOC's).

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: Include Care and Use Instructions and ceiling system product data (system components) in Operations and Maintenance Manuals.

1.7 MAINTENANCE MATERIAL (EXTRA STOCK)

A. Furnish extra materials from the same product run that match products installed. Extra materials/extra stock shall be packaged with protective covering for storage and identified with labels describing contents.

   1. Acoustical Ceiling Units: Full-size panels equal to five (5) percent of quantity installed.
   2. Suspension-System Components: Quantity of each exposed component equal to two (2) percent of quantity installed.
   3. Hold-Down Clips: Equal to five (5) percent of quantity installed.
   4. Impact Clips: Equal to two (2) percent of quantity installed.

1.8 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

   1. Build mockup of typical ceiling area as shown on Drawings.
   2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical panels, suspension-system components, and accessories to Project site and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weather tight, wet-work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic restraints for ceiling systems.

B. Seismic Performance: Suspended ceilings shall withstand the effects of earthquake motions determined according to ASCE/SEI 7

C. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: Class A according to ASTM E 1264.
2. Smoke-Developed Index: 25 or less.

D. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL or from the listings of another qualified testing agency.

E. ACOUSTICAL PANELS:
1. Acoustical Panel Standard: Provide manufacturer's standard panels according to ASTM E 1264 and designated by type, form, pattern, acoustical rating, and light reflectance unless otherwise indicated.
2. Classification: Provide Class ‘A’ fire rated panels as follows:
   a. Pattern: E (lightly textured)
   b. Color: White. Light Reflectance (LR): Not less than 0.85.
   c. Ceiling Attenuation Class (CAC): Not less than 35.
   d. Noise Reduction Coefficient (NRC): Not less than 0.75
   e. Articulation Class (AC): Not less than 180.
   f. Edge/Joint Detail: Beveled tegular and rabbeted long edges and square, butt-on short edges.
   g. Thickness: 3/4 inch. Modular Size: 24 by 48 inches.
3.

4. Antimicrobial Treatment: Manufacturer's standard broad spectrum, antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273, ASTM D 3274, or ASTM G 21 and evaluated according to ASTM D 3274 or ASTM G 21.
5. Recycled Content:
    a. Minimum 10 percent post-consumer recycled content, or minimum 40 percent pre-consumer recycled content.
6. Low-Emitting Materials:
    a. Acoustical panel ceilings shall comply with the testing and product requirements of local regulations controlling use of volatile organic compounds (VOC's).
7. Source Limitations:
    a. Obtain each type of acoustical ceiling panel and supporting suspension system from single source from single manufacturer.

2.2 METAL SUSPENSION SYSTEM

A. Metal Suspension-System Standard: Provide manufacturer's standard, direct-hung, metal suspension system and accessories according to ASTM C 635/C 635M and designated by type, structural classification, and finish indicated.

B. Wide-Face, Capped, Double-Web, Fire-Rated, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; pre-painted, electrolytically zinc coated, or hot-dip galvanized, G30 coating designation; with prefinished 15/16-inch-wide metal caps on flanges.

1. Structural Classification: Heavy-duty system.
2. End Condition of Cross Runners: Override type.
3. Face Design: Flat, flush.
4. Cap Material: Cold-rolled steel].
5. Cap Finish: Painted white.

2.3 ACCESSORIES

A. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing according to ASTM E 488/E 488M or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.

    a. Type: Post-installed expansion or post-installed bonded anchors.
    b. Corrosion Protection: Carbon-steel components zinc plated according to ASTM B 633, Class SC 1 (mild) service condition.
    c. Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Group 1 Alloy 304 or 316.

d. Corrosion Protection: Components fabricated from nickel-copper-alloy rods complying with ASTM B 164 for UNS No. No. 4400 alloy.

2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing according to ASTM E 1190, conducted by a qualified testing and inspecting agency.

B. Wire Hangers, Braces, and Ties: Provide wires as follows:

1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
2. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304, nonmagnetic.
3. Nickel-Copper-Alloy Wire: ASTM B 164, nickel-copper-alloy UNS No. N04400.
4. Size: Wire diameter sufficient for its stress at three times hanger design load (ASTM C 635/C 635M, Table 1, "Direct Hung") will be less than yield stress of wire, but not less than 0.106 inch (12 gauge) diameter wire.

C. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.

D. Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.

E. Angle Hangers: Angles with legs not less than 7/8-inch-wide; formed with 0.04-inch (20 gauge) thick, galvanized-steel sheet complying with ASTM A 653/A 653M, G90 coating designation; with bolted connections and 5/16-inchdiameter bolts.

F. Hold-Down Clips: Manufacturer's standard hold-down.

G. Impact Clips: Manufacturer's standard impact-clip system designed to absorb impact forces against acoustical panels.

H. Seismic Clips: Manufacturer's standard seismic clips designed to secure acoustical panels in place during a seismic event.

I. Seismic Stabilizer Bars: Manufacturer's standard perimeter stabilizers designed to accommodate seismic forces.

J. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.

K. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.

1. Edge moldings shall fit acoustical panel edge details and suspension systems indicated and match width and configuration of exposed runners unless otherwise indicated.

2. For lay-in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member
3. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.

B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders unless otherwise indicated, and comply with layout shown on reflected ceiling plans.

B. Layout openings for penetrations centered on the penetrating items.

3.3 INSTALLATION

A. Install acoustical panel ceilings according to ASTM C 636/C 636M, seismic design requirements, and manufacturer's written instructions.

1. Fire-Rated Assembly: Install fire-rated ceiling systems according to tested fire-rated design.

B. Suspend ceiling hangers from building's structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
2. Splay hangers only where required and, if permitted with fire-resistance-rated ceilings, to miss obstructions; offset resulting horizontal forces by bracing, counter splaying, or other equally effective means.
3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.

4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly to structure or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, post-installed mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
8. Do not attach hangers to steel deck tabs.
9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
10. Space hangers not more than 48 inches on center along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.

C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or post-installed anchors.

D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.

1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
2. Screw attach moldings to substrate at intervals not more than 16 inches on center and not more than 3 inches from ends. Miter corners accurately and connect securely.
3. Do not use exposed fasteners, including pop rivets, on moldings and trim.

E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

F. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide precise fit.

1. Arrange directionally patterned acoustical panels as follows:

    a. As indicated on reflected ceiling plans.

2. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.

3. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
4. Install hold-down, impact and seismic clips in areas indicated; space according to panel manufacturer's written instructions unless otherwise indicated.

    a. Hold-Down Clips: Space 24 inches on center on all cross runners.

5. Protect lighting fixtures and air ducts according to requirements indicated for fire-resistance-rated assembly.

3.4 ERECTION TOLERANCES

A. Suspended Ceilings: Install main and cross runners level to a tolerance of 1/4 inch in 10', non-cumulative.

B. Moldings and Trim: Install moldings and trim to substrate and level with ceiling suspension system to a tolerance of 1/4 inch in 10' non-cumulative.

3.5 FIELD QUALITY CONTROL

A. Special Inspections: Contractor shall engage a qualified special inspector to perform the following special inspections:

1. Periodic inspection during the installation of suspended ceiling grids according to ASCE/SEI 7.

B. Testing Agency: Contractor shall engage a qualified testing agency to perform tests and inspections.

C. Perform the following tests and inspections of completed installations of acoustical panel ceiling hangers and anchors and fasteners in successive stages and when installation of ceiling suspension systems in a contiguous area has reached 20 percent completion, but no panels have been installed. Do not proceed with installations of acoustical panel ceiling hangers for the next area until test results for previously completed installations of acoustical panel ceiling hangers show compliance with requirements.

1. Within each test area, testing agency will select one of every 10 power-actuated fasteners and post-installed anchors used to attach hangers to concrete and will test them for 330 lbf of tension; it will also select one of every two post-installed anchors used to attach bracing wires to concrete and will test them for 330 lbf of tension.
2. When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.

D. Acoustical panel ceiling hangers, anchors, and fasteners will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 CLEANING

A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.

B. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095113

SECTION 09 65 13 - RUBBER BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rubber base.
2. Rubber stair accessories.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. High Performance Sustainable Building Submittals:

1. VOC Content: For adhesives, documentation indicating that products comply with the testing and product requirements of local regulations controlling use of volatile organic compounds (VOC's).

C. Samples for Verification: For each type of product indicated and for each color, texture, and pattern required in manufacturer's standard-size samples, but not less than 12 inches long.

1.3 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Furnish not less than 10 linear feet for every 500 linear feet or fraction thereof, of each type, color, pattern, and size of rubber product installed.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store rubber products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 degrees F or more than 90 degrees F.

1.5 FIELD CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 degrees F or more than 95 degrees F, in spaces to receive rubber products during the following time periods:

1. 48 hours before installation.

2. During installation.
3. 48 hours after installation.

B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 degrees F or more than 95 degrees F.

C. Install rubber products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Low-Emitting Materials: Base system shall comply with the testing and product requirements of local regulations controlling use of volatile organic compounds (VOC's).

2.2 RUBBER BASE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Armstrong World Industries, Inc.
2. Johnsonite; a Tarkett company.
3. Roppe Corp., USA.

B. Product Standard: ASTM F 1861, Type TP (thermoplastic rubber).

1. Group: 2 (layered).
2. Style and Location:

a. Style: Style B, Cove (with top-set toe).

C. Minimum Thickness: 1/8 inch.

D. Height: 4 inches.

E. Lengths: Coils in manufacturer's standard length.

F. Outside Corners: Preformed.

G. Inside Corners: Preformed.

H. Colors and Patterns: P193 Black-Brown by Roppe or matching color by other approved equal manufacturer.

2.3 RUBBER STAIR ACCESSORIES

A. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.

1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Armstrong World Industries, Inc.
2. Johnsonite; a Tarkett company.
3. Roppe Corp., USA.

C. Stair Treads: ASTM F 2169.

1. Type: TS rubber.
2. Class: 2 pattern; embossed.
3. Group: 1 embedded abrasive strips.
4. Nosing Style: Round.
5. Nosing Height: 1-1/2 inches.
6. Thickness: 1/4 inch and tapered to back edge.
7. Size: Lengths and depths to fit each stair tread in one piece.
8. Integral Risers: Smooth, flat; in height that fully covers substrate.

D. Landing Tile: Matching treads; produced by same manufacturer as treads and recommended by manufacturer for installation with treads.

E. Locations: Provide rubber stair accessories in areas indicated on Room Finish Schedule and plan located in the Drawings.

F. Colors and Patterns: As indicated on Material Finish Schedule located in the Drawings.

2.4 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by rubber product manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by rubber product manufacturer for rubber products and substrate conditions indicated.

1. Adhesives shall have a VOC content of 50 g/L or less.

C. Stair Tread Nose Filler: Two-part epoxy compound recommended by rubber stair tread manufacturer to fill nosing substrates that do not conform to tread contours.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the COR, of any conditions detrimental to the proper and timely completion of the work.

B. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of rubber products.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

3.2 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of rubber products.

B. Concrete Substrates for Rubber Stair Accessories: Prepare horizontal surfaces according to ASTM F 710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
4. Moisture Testing: Proceed with installation only after substrates pass testing according to manufacturer's written recommendations, but not less stringent than the following:

a. Perform anhydrous calcium chloride test according to ASTM F 1869. Proceed with installation only after substrates have maximum moisture vapor emission rate of 3 lb of water/1000 sq. ft**.** in 24 hours.
b. Perform relative humidity test using in situ probes according to ASTM F 2170. Proceed with installation only after substrates have maximum 75 percent relative humidity level.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

D. Do not install rubber products until they are the same temperature as the space where they are to be installed.

1. At least 48 hours in advance of installation, move rubber products and installation materials into spaces where they will be installed.

E. Immediately before installation, sweep and vacuum clean substrates to be covered by rubber products.

3.3 RUBBER BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing rubber base.

B. Apply rubber base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install rubber base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere rubber base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch rubber base during installation.

F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of rubber base with manufacturer's recommended adhesive filler material.

G. Preformed Corners: Install preformed corners before installing straight pieces.

3.4 RUBBER ACCESSORY INSTALLATION

A. Comply with manufacturer's written instructions for installing rubber accessories.

B. Rubber Stair Accessories:

1. Use stair tread nose filler to fill nosing substrates that do not conform to tread contours.
2. Tightly adhere to substrates throughout length of each piece.

3.5 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protecting rubber products.

B. Perform the following operations immediately after completing rubber product installation:

1. Remove adhesive and other blemishes from exposed surfaces.
2. Sweep and vacuum horizontal surfaces thoroughly.
3. Damp-mop horizontal surfaces to remove marks and soil.

C. Protect rubber products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

D. Cover rubber products subject to wear and foot traffic until Substantial Completion.

END OF SECTION 09 65 13

SECTION 09 65 19 - RESILIENT TILE FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Heavy duty resilient tile flooring
   2. Interlocking floor tile

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. High Performance Sustainable Building Submittals:

   1. VOC Content: Flooring systems and adhesives, documentation indicating that products comply with the testing and product requirements of local regulations controlling use of volatile organic compounds (VOC's).
   2. Recycled Content: For products having recycled content, documentation indicating percentages by weight of post-consumer and pre-consumer recycled content. Include statement indicating cost for each product having recycled content.

C. Shop Drawings: For each type of floor tile. Include floor tile layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.

   1. Show details of special patterns.

D. Samples:

   1. Samples for Initial Selection: For each type of floor tile indicated if manufacturer is other than the basis of design manufacturer for color selections as indicated on the Drawings.
   2. Samples for Verification: Full-size units of each color and pattern of floor tile required.

E. Product Schedule: For floor tile.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of floor tile to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Floor Tile: Furnish one box for every 50 boxes or fraction thereof, of each type, color, and pattern of floor tile installed.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs workers for this Project who are competent in techniques required by manufacturer for floor tile installation and seaming method indicated.

1. Engage an installer who employs workers for this Project who are trained or certified by floor tile manufacturer for installation techniques required.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store floor tile and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 degrees F or more than 90 degrees F. Store floor tiles on flat surfaces.

1.8 FIELD CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 degrees F or more than 95 degrees F, in spaces to receive floor tile during the following time periods:

1. 48 hours before installation.
2. During installation.
3. 48 hours after installation.

B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 degrees F or more than 95 degrees F.

C. Close spaces to traffic during floor tile installation.

D. Close spaces to traffic for 48 hours after floor tile installation.

E. Install floor tile after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For resilient tile flooring, as determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.

1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

B. Low-Emitting Materials: Flooring system shall comply with the testing and product requirements of local regulations controlling use of volatile organic compounds (VOC's).

2.2 HEAVY DUTY RESILIENT TILE FLOORING

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following

1. Altro Quartz Tile or approved equal
2. Provide “no-wax required” product.

B. Basis of Design: Product specified is “Altro Quartz Tile, Homogeneous Quartz Floor Tile, as manufactured by ALTRO, USA. Items specified are to establish a standard of quality for design, function, materials, and appearance. Equivalent products are acceptable. The COR will be the sole judge of the basis of what is equivalent:

C. Tile Standard: ASTM F 1066, Class I, solid color tile.

D. Wearing Surface: Smooth.

E. Thickness: 0.125 inch.

F. Size: 24 inches by 24 inches.

G. Colors and Patterns: AQT9322 “Sand CD” as indicated on the Drawings.

2.3 INTERLOCKING PVC FLOOR TILE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following

1. Armorpoxy or approved equal

B. Basis of Design: Product specified is “Armorpoxy Interlocking Floor Tile, 805 Lehigh Avenue, Union New Jersey, USA 07083, 888-755-7361, info@armorpoxy.com. Items specified are to establish a standard of quality for design, function, materials, and appearance. The COR will be the sole judge of the basis of what is equivalent:

C. Tile Standard: ASTM F 1700, Class III, solid color tile.

D. Wearing Surfaces: Coin and Textured.

E. Thickness: 6.5 MM.

F. Material: 100% PVC polymer Compound.

G. Connecting Edge: T-Joint

H. Size: 20.5 inches by 20.5 inches.

I. Colors and Patterns: As indicated on the Drawings.

2.4 INSTALLATION MATERIALS

A. All products shall comply with the following:
   1. VOC is limited to 50 g/L.
   2. The testing and product requirements of local regulations controlling use of volatile organic compounds (VOC's).

B. Moisture Mitigation System:
   1. Provide rapid drying ready-mixed acrylic type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.
   2. Provide Schonox SDG or approved equal.

C. Substrate Primer:
   1. Provide product recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.
   2. Provide Schonox SHP or approved equal.

D. Trowelable Leveling and Patching Compounds:
   1. Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by floor tile manufacturer for applications indicated.
   2. Provide Schonox ZM or Schonox US cement based self-leveling compound or approved equal.

E. Floor Tile Adhesives (for quartz floor tile only):
   1. Water-resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.
   2. Provide Altro EcoFix #25 or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the COR, of any conditions detrimental to the proper and timely completion of the work.

B. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor tile.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

3.2 PREPARATION

A. Prepare substrates according to floor tile manufacturer's written instructions to ensure adhesion of resilient products.

B. Concrete Substrates: Prepare according to ASTM F 710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by floor tile manufacturer. Do not use solvents.
3. Alkalinity and Adhesion Testing: Perform tests recommended by floor tile manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
4. Moisture Testing: Proceed with installation only after substrates pass testing according to floor tile manufacturer's written recommendations, but not less stringent than the following:

    a. Perform anhydrous calcium chloride test according to ASTM F 1869. Proceed with installation only after substrates have maximum moisture vapor emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
    b. Perform relative humidity test using in situ probes according to ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

D. Do not install floor tiles until they are the same temperature as the space where they are to be installed.

1. At least 48 hours in advance of installation, move resilient floor tile and installation materials into spaces where they will be installed.

E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient floor tile and interlocking floor tile

3.3 FLOOR TILE INSTALLATION

A. Comply with manufacturer's written instructions for installing floor tile.

B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.

1. Lay tiles square with room axis.

C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.

1. Lay tiles with grain running in one direction.

D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.

E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.

F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent marking device.

G. Install floor tiles on covers for telephone and electrical ducts, building expansion joint covers, and similar items in finished floor areas. Maintain overall continuity of color and pattern between pieces of tile installed on covers and adjoining tiles. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.

H. Adhere quartz floor tiles to flooring substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

3.4 CLEANING

A. Comply with manufacturer's written instructions for cleaning and protecting floor tile.

B. Perform the following operations immediately after completing floor tile installation:

1. Remove adhesive and other blemishes from exposed surfaces.
2. Sweep and vacuum surfaces thoroughly.
3. Damp-mop surfaces to remove marks and soil.

C. Protect floor tile from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

D. Remove soil, adhesive, and blemishes from floor tile surfaces.

E. Cover floor tile until Substantial Completion.

3.5 PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to the Installer that shall ensure that the resilient tile flooring shall be without damage at time of Substantial Completion.

END OF SECTION 09 65 19

SECTION 09 84 33 - SOUND-ABSORBING WALL UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes shop-fabricated, fabric-wrapped panel units tested for acoustical performance, including:

1. Fabric-covered sound-absorbing wall panels.

1.2 DEFINITIONS

A. NRC: Noise Reduction Coefficient.

B. SAA: Sound Absorption Average.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of fabric facing**,** panel edge, core material, and mounting indicated.

B. "High Performance Sustainable Building Submittals":

1. VOC Content: For sound-absorbing wall units, documentation indicating that products comply with the testing and product requirements of local regulations controlling use of volatile organic compounds (VOC's).

C. Shop Drawings: For sound-absorbing wall units. Include mounting devices and details; details at panel head, base, joints, and corners; and details at ceiling, floor base, and wall intersections. Indicate panel edge and core materials.

1. Include elevations showing panel sizes and direction of fabric weave and pattern matching.

D. Samples:

1. Samples for Initial Selection: For each type of fabric facing from sound-absorbing wall unit manufacturer's full range to match finishes, patterns and colors indicated on the Drawings.
2. Samples for Verification: For the following products, prepared on Samples of size indicated below:

a. Fabric: Full-width by approximately 24 inch long sample, but not smaller than required to show complete pattern repeat, from dye lot to be used for the Work, and with specified treatments applied. Mark top and face of fabric.
b. Panel Edge: 12 inch long sample(s) showing each edge profile, corner, and finish.
c. Core Material: 12 inch square sample at corner.

d. Mounting Devices: Full-size samples.
e. Assembled Panels: Approximately 36 inches by 36 inches, including joints and mounting methods.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Elevations and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Electrical outlets, switches, and thermostats.
2. Items penetrating or covered by sound-absorbing wall units including, but not limited to, the following:

a. Lighting fixtures.
b. Air outlets and inlets.
c. Speakers.
d. Alarms.
e. Access panels.
f. Electrical Panels

3. Show operation of hinged and sliding components covered by or adjacent to sound-absorbing wall units.

B. Product Certificates: For each type of sound-absorbing wall unit, from manufacturer.

C. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For sound-absorbing wall units to include in maintenance manuals. Include fabric manufacturers' written cleaning and stain removal recommendations.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials from same production run that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fabric: For each fabric, color and pattern installed, provide length equal to 10 percent of amount installed, but no fewer than 10 yards.
2. Mounting Devices: Full-size units equal to 5 percent of amount installed, but no fewer than 10 devices, including unopened adhesives.

1.7 QUALITY ASSURANCE

A. Source Limitations: Obtain sound-absorbing wall units from single source from single manufacturer.

B. Fire-Test-Response Characteristics: Provide sound-absorbing wall units meeting the following as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

1. Surface-Burning Characteristics: As determined by testing per ASTM E 84.

a. Flame-Spread Index: 25 or less.
b. Smoke-Developed Index: 450 or less.

2. Fire Growth Contribution: Meeting acceptance criteria of local code and authorities having jurisdiction when tested according to NFPA 265 or NFPA 286.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with fabric and sound-absorbing wall unit manufacturers' written instructions for minimum and maximum temperature and humidity requirements for shipment, storage, and handling.

B. Deliver materials and units in unopened bundles and store in a temperature-controlled dry place with adequate air circulation.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not install sound-absorbing wall units until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work at and above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Air Quality Limitations: Protect sound-absorbing wall units from exposure to airborne odors, such as tobacco smoke, and install units under conditions free from odor contamination of ambient air.

C. Field Measurements: Verify locations of sound-absorbing wall units and actual dimensions of openings and penetrations by field measurements before fabrication.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of sound-absorbing wall units that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to the following:

a. Acoustical performance.
b. Fabric sagging, distorting, or releasing from panel edge.
c. Warping of core.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 FABRIC-COVERED SOUND-ABSORBING WALL UNITS

A. Manufacturers: Basis of Design is Decoustics Acoustical Panel. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Acoustical Solutions, Inc.
2. Armstrong World Industries.
3. Decoustics Limited; a CertainTeed Ceilings company.
4. Kinetics Noise Control, Inc.
5. Tectum, Inc.

B. General Requirements for removable Sound-Absorbing Wall Units: Units shall comply with the testing and product requirements of local regulations controlling use of volatile organic compounds (VOC's).

C. Sound-Absorbing Removable Wall Panel:

1. General: Manufacturer's standard panel construction consisting of facing material stretched over front face of edge-framed core and bonded or attached to edges and back of frame.

a. Mounting:

1) Mounting: Edge mounted with splines secured to substrate.

a) Finish Color at Exposed Edges: Wrap facing material.

2) Back mounted with manufacturer's standard metal clips or bar hangers, secured to substrate.

a) Finish Color at Exposed Edges: Wrap facing material.

b. Core: Manufacturer’s standard core material for a 1 inch deep unit to comply with 0.85 NRC per ASTM C423.

1) Core Face Layer: Manufacturer's standard tackable, impact-resistant, high density board.

c. Edge Construction: Manufacturer's standard chemically hardened core with no frame.
d. Edge Profile: Square.
e. Corner Detail in Elevation: Square with continuous edge profile indicated.
f. Reveals between Panels: Flush.
g. Facing Material: Refer to Interior Material Finish Schedule.
h. Acoustical Performance: Sound absorption NRC 0.85 according to ASTM C 423 for Type F5 mounting according to ASTM E 795.
i. Nominal Overall Panel Thickness: 1 inch.

j. Panel Width: As indicated on Drawings.
k. Panel Height: As indicated on Drawings.

2. Basis of Design Product: Decoustics Acoustical Panel.
   a. Items specified are to establish a standard of quality for design, function, materials, and appearance. Equivalent products by listed manufacturers are acceptable. The COR will be the sole judge of the basis of what is equivalent.

2.2 MATERIALS

A. Core Materials: Manufacturer's standard or as follows:

1. Glass Fiber Board: ASTM C 612, Type standard with manufacturer; nominal density of 6 to 7 lb/cu. ft., unfaced, and dimensionally stable, molded rigid board; and with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.
2. Mineral Fiber Board: Maximum flame-spread and smoke-developed indexes of 25 and 10, respectively; minimum density of 13 lb/cu. ft., and with perforated surface.
3. Cementitious Fiber Board: Density of not less than 20 lb/cu. ft.
4. Tackable, Impact-Resistant, High Density Board for Face Layer: 1/8 inch thick layer of compressed molded glass fiber board with a nominal density of 16 to 18 lb/cu. ft. laminated to face of core.
5. Impact-Resistant, Acoustically Transparent, Copolymer Sheet for Face Layer: 1/16 inch to 1/8 inch thick layer of perforated, noncombustible, copolymer sheet laminated to face of core.

B. Facing Material:
1. Fabric Manufacturer: Basis of Design is Guilford of Maine. Subject to the requirements of these specification other acceptable manufacturers include, but are not limited to:
   a. Knoll
   b. Texture Solutions
   c. Refer to Interior Material Finish Schedule.
2. The fabric shall be furnished and installed by the panel manufacture and coordinated so that the entire assembly meets specifications for sound reduction and other specified requirements.
3. The fabric shall meet requirements of ASTM E84 Class A for surface burning requirements.
4. The Fabric shall be available in at least 100 different standard color patterns for the FAA to choose from a standard color during the submittal process.
5. Refer to the Interior Color Scheme Schedule in the drawings for the Basis of Design Style and Color.

C. Mounting Devices: Concealed on back of unit, recommended by manufacturer to support weight of unit, and as follows:

1. Splines: Manufacturer's standard concealed metal or plastic splines that engage the kerfed edges of the unit, with other moldings and trim for interior corners, exterior corners, and exposed edges, with factory-applied finish on exposed items.
2. Metal Clips or Bar Hangers: Manufacturer's standard two-part metal Z-clips, with one part of each clip mechanically attached to back of unit and the other part to substrate, designed to permit unit removal.

D. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction for sound-absorbing wall units installed at Project site, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 FABRICATION

A. General: Use manufacturer's standard construction except as otherwise indicated; with facing material applied to face, edges, and back border of dimensionally stable core; and with rigid edges to reinforce panel perimeter against warpage and damage.

1. Glass Fiber Board and Mineral Fiber Board Cores: Chemically harden core edges and areas of core where mounting devices are attached.

B. Core Face Layer: Evenly stretched over core face and edges and securely attached to core; free from puckers, ripples, wrinkles, or sags.

C. Facing Material: Apply fabric facing fully covering visible surfaces of unit; with material stretched straight, on the grain, tight, square, and free from puckers, ripples, wrinkles, sags, blisters, seams, adhesive, or other visible distortions or foreign matter.

1. Square Corners: Tailor corners.
2. Radius and Other Non-Square Corners: Attach facing material so there are no seams or gathering of material.
3. Fabrics with Directional or Repeating Patterns or Directional Weave: Mark fabric top and attach fabric in same direction so pattern or weave matches in adjacent units.

D. Dimensional Tolerances of Finished Units: Plus or minus 1/16 inch for the following:

1. Thickness.
2. Edge straightness.
3. Overall length and width.
4. Squareness from corner to corner.
5. Chords, radii, and diameters.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:
1. Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the COR, of any conditions detrimental to the proper and timely completion of the work.

B. Examine fabric, fabricated units, substrates, areas, and conditions, for compliance with requirements, installation tolerances, and other conditions affecting performance of sound-absorbing wall units.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

3.2 INSTALLATION

A. Install sound-absorbing wall units in locations indicated with vertical surfaces and edges plumb, top edges level and in alignment with other units, faces flush, and scribed to fit adjoining work accurately at borders and at penetrations.

B. Comply with sound-absorbing wall unit manufacturer's written instructions for installation of units using type of mounting devices indicated. Mount units securely to supporting substrate.

C. Align and level fabric pattern and grain among adjacent units.

3.3 INSTALLATION TOLERANCES

A. Variation from Plumb and Level: Plus or minus 1/16 inch.

B. Variation of Panel Joints from Hairline: Not more than 1/16 inch wide.

3.4 CLEANING

A. Clip loose threads; remove pills and extraneous materials.

B. Clean panels on completion of installation to remove dust and other foreign materials according to manufacturer's written instructions.

3.5 PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to the Installer, that shall ensure that the sound-absorbing wall units shall be without damage at time of Substantial Completion.

END OF SECTION 09 84 33

SECTION 09 91 23 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes surface preparation and the application of paint systems on the following interior substrates:
   1. Gypsum board.
   2. Concrete
   3. Metal

1.2 DEFINITIONS

A. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523 (a traditional matte finish).

B. Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523 (a high side sheen flat, a velvet-like finish).

C. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523 (a traditional eggshell-like finish).

D. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523 (a satin-like finish).

E. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523 (a traditional semi-gloss finish).

F. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523 (a traditional gloss finish).

G. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523 (a high gloss finish).

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:

B. High Performance Sustainable Building Submittals: For solvent borne and waterborne paints and related coatings documentation indicating that products comply with the testing and product requirements of local regulations controlling use of volatile organic compounds (VOC’s).

   a. Submit Green Seal Certification to GS-11 and description of the basis for certification.

C. Environmental Data: Submit environmental data in accordance with Table 1 of ASTM E 2129 for products provided under work of this Section.

D. Samples: For each type of paint system and in each color and gloss of topcoat.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint: 5 percent, but not less than 1 gallon of each material and color applied.

1.5 QUALITY ASSURANCE

A. VOC Content: Determine VOC (Volatile Organic Compound) content of solvent borne and waterborne paints and related coatings in accordance with EPA Method 24 or ASTM D 3960. Provide low VOC products. Comply with:

1. Interior Architectural Paints: Comply with Green Seal GS-11

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 degrees F.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.7 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 degrees F.

B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 degrees F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Benjamin Moore & Co.
2. M.A.B. Paints.
3. PPG Architectural Finishes, Inc.

4. Pratt & Lambert.
5. Sherwin-Williams Co.

B. Basis of Design: Items specified are to establish a standard of quality for design, function, materials, and appearance. Equivalent products by listed manufacturers are acceptable. The COR will be the sole judge of the basis of what is equivalent.

2.2 PAINT, GENERAL

A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."

B. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

C. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction and, for interior paints and coatings applied at Project site, the following VOC limits, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1. Flat Paints and Coatings: 50 g/L.
2. Non-Flat Paints and Coatings: 100 g/L.
3. Primers, Sealers, and Undercoaters: 100 g/L.
4. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
5. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
6. Pretreatment Wash Primers: 420 g/L.
7. Floor Coatings: 100 g/L.

D. Colors: As indicated on Drawings Room Finish Schedule.

2.3 PRIMERS/SEALERS

A. Block Filler, Latex, Interior/Exterior: MPI #4.

2.4 PRIMERS/SEALERS

A. Interior Latex Primer/Sealer: MPI #149.

2.5 FLOOR COATINGS

A. Sealer, Water Based, for Concrete Floors: MPI #99.

B. Sealer, Solvent Based, for Concrete Floors: MPI #104.

2.6 LATEX PAINTS

A. Latex, Interior, Institutional Low Odor/VOC, Flat (Gloss Level 1): MPI #143.

B. Institutional Low-Odor/VOC Latex (Eggshell): MPI #145 (Gloss Level 3).

C. Institutional Low-Odor/VOC Latex (Semi-Gloss): MPI #147 (Gloss Level 5).

2.7 SOURCE QUALITY CONTROL

A. Testing of Paint Materials: COR reserves the right to invoke the following procedure:

1. COR may engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency will perform tests for compliance with product requirements.
3. COR may direct Contractor to stop applying coatings if test results show materials being used do not comply with product requirements. Contractor shall remove non-complying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:
1. Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the COR, of any conditions detrimental to the proper and timely completion of the work.

B. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

1. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

a. Concrete: 12 percent.
b. Masonry (CMU): 12 percent.
c. Gypsum Board: 12 percent.
d. Plaster: 12 percent.

2. Plaster Substrates: Verify that plaster is fully cured.
3. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
4. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

C. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Applicator.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceed that permitted in manufacturer's written instructions.

F. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer.

G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 Shop, Field, and Maintenance Painting of Steel for touching up shop-primed surfaces.

H. Galvanized Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."

1. Use applicators and techniques suited for paint and substrate indicated. Coordinate with COR for restricted paint methods allowed at facility.

2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

B. Tint undercoats same color as topcoat, but tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Coordinate with requirements identified in specifications and on drawings for painting of: Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work.
1. Paint the following work where exposed in equipment rooms:
    a. Uninsulated metal piping.
    b. Metal conduit within 6” of a ceiling or wall
    c. Pipe hangers and supports (unless hot-dip galvanized or cadmium plated).
    d. Duct, equipment, and pipe insulation having paintable jacket material.
        1) Do not paint aluminum or stainless steel piping or jackets.
        2) Do not paint PVC jacket piping, refer to mechanical for color PVC jackets.
    e. Other items as directed by the Architect.
    f. Fire alarm conduits shall be painted per specification 28 31 00.
    g. Fire suppression piping shall be painted per specification 21 13 13
2. Paint the following where exposed in occupied spaces:
    a. Uninsulated metal piping.
    b. Pipe hangers and supports (unless hot-dip galvanized or cadmium plated).
    c. Duct, equipment, and pipe insulation having paintable jacket material.
        1) Do not paint aluminum or stainless steel piping or jackets.
        2) Do not paint PVC jacket piping, refer to mechanical for color PVC jackets.
    d. Other items as directed by the Architect.
    e. Fire alarm conduits shall be painted per specification 28 31 00.
    f. Fire suppression piping shall be painted per specification 21 13 13
3. Refer to drawings and other disciplines for additional information.
4. Coordinate with COR color scheme used by facility for utilities.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: COR may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.

1. Contractor shall touch up and restore painted surfaces damaged by testing.
2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by COR, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

E. Provide final protection and maintain conditions in a manner acceptable to the Applicator, that shall ensure that the interior painting shall be without damage at time of Substantial Completion.

3.6 INTERIOR PAINTING SCHEDULE

A. Gypsum Board and Plaster Substrates:

1. Institutional Low-Odor/VOC Latex System:

a. Prime Coat: Primer sealer, interior, institutional low odor/VOC, MPI #149.
b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
c. Topcoat:

1) Latex, interior, institutional low odor/VOC, flat (Gloss Level 1), MPI #143.
2) Latex, interior, institutional low odor/VOC, (Gloss Level 3), MPI #145.
3) Latex, interior, institutional low odor/VOC, satin/semi-gloss (Gloss Level 4), MPI #146.

d. Basis of Design: Refer to Interior Materials Finish Schedule on Drawings.

B. Concrete Substrates, Non-traffic Surfaces:
1. Latex System,: Institutional Low-Odor/VOC
a. Prime Coat: Primer, alkali resistant, water based MPI#3

1) Sherwin-Williams: Loxon Concrete & Masonry Primer a24W8300
b. Intermediate Coat: Latex, Interior, matching topcoat
c. Topcoat: Latex, interior, flat (MPI Gloss Level 1), MPI #53
1) Sherwin-Williams: Pro Mar 200 Zero Voc B30W12651
d. Topcoat: Latex, interior, semi-gloss (MPI Gloss Level 5) MPI #54
1) Sherwin-Williams: ProMar 200 Zero VOC B21W12651

C. Concrete Substrates, Traffic Surfaces:
1. Solvent-Based Clear Sealer System:
a. First Coat: Sealer, solvent based, for concrete floors, MPI #104.
b. Topcoat: Sealer, solvent based, for concrete floors, MPI #104.
c. Basis of Design: Refer to Material Finish Schedule on Drawings.

D. Steel Substrates, Institutional Low-Odor/VOC:
1. Latex System, Alkyd Primer
a. Prime Coat: Primer, alkyd, quick dry, for metal, MPI #76
1) Sherwin-Williams: Protective & Marine, Steel Spec Universial Metal Primer B50WV8430
b. Prime Coat: Shop primer specified in Section where substrate is specified.
c. Intermediate Coat: Latex, interior, matching topcoat.
d. Topcoat: Latex, interior (MPI Gloss Level 4) MPI #43
1) Sherwin-Williams: ProMar 400 Zero VOC, ProMar 400 Zero VOC Semi-Gloss B31W04651

END OF SECTION 09 91 23

SECTION 10 14 23 - PANEL SIGNAGE

1.1 SUMMARY

A. Section Includes:

1. Field-applied, vinyl signs.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. High Performance Sustainable Building Submittals:

1. VOC Content: For adhesives, documentation indicating that products comply with the testing and product requirements of local regulations controlling use of volatile organic compounds (VOC's).

C. Shop Drawings: Show message list, typestyles, graphic elements and layout for each sign.

D. Samples:

1. Samples for Initial Selection: For each type of sign and exposed finish.

a. Include representative samples of available typestyles and graphic symbols.

2. Samples for Verification: For each type of sign with the required finish, in manufacturer's standard size unless otherwise indicated and as follows:

a. Field-Applied, Vinyl Signs: Full-size sample.

E. Sign Schedule: Use same designations specified or indicated on the Drawings or in a sign schedule.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For signs to include in maintenance manuals.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Deterioration of finishes beyond normal weathering.
b. Separation or delamination of sheet materials and components.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 FIELD-APPLIED, VINYL SIGNS

A. Field-Applied, Vinyl Sign: 3 mil to 3.5 mil thick, weather-resistant vinyl film with release liner on the back and carrier film on the front for on-site alignment and application, with message as directed by the COR.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Allen Markings International.
b. APCO Graphics, Inc.
c. ASI Sign Systems, Inc.
d. Best Sign Systems Inc.
e. Mohawk Sign Systems.
f. Nelson-Harkins Industries.
g. Seton Identification Products.

2. Size: As indicated.
3. Substrate: As indicated.
4. Text and Font: As indicated.
5. Adhesives: As recommended by sign manufacturer and with a VOC content of 70 g/L or less for adhesives when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.2 FABRICATION

A. General: Provide manufacturer's standard according to requirements indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of signage work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

3.2 INSTALLATION

A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.

1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
2. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.

B. Field-Applied, Vinyl Signs: Clean and dry substrate. Align sign in final position before removing release liner. Remove release liner in stages, and apply and firmly press into final position. Press from the middle outward to obtain good bond without blisters or fishmouths.

3.3 ADJUSTING AND CLEANING

A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.

B. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by the COR.

3.4 PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to the Installer, that shall ensure that the panel signage shall be without damage at time of Substantial Completion.

END OF SECTION 10 14 23

SECTION 10 26 00 - WALL AND DOOR PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Corner guards.

1.2 ACTION SUBMITTALS

A. Product Data: Include physical characteristics for each wall protection system component indicated.

B. Shop Drawings: Show locations, extent, and installation details of each wall protection system component. Show methods of attachment to adjoining construction.

C. Samples for Initial Selection: Manufacturer's color charts consisting of sections of material showing the full range of textures available for each wall protection system component indicated.

D. High performance Sustainable Building Submittals:
1. Recycled Content: For products having recycled content, documentation indicating percentages by weight of post-consumer recycled content. Include statement indicating cost for each product having recycled content.

1.3 INFORMATIONAL SUBMITTALS

A. Material Test Reports: From a qualified testing agency indicating compliance of each wall protection system component with requirements indicated, based on tests performed by testing agency within the past five years.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wall protection system component from a single source with resources to provide components of consistent quality in appearance and physical properties.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store wall protection units in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install wall protection units until building is enclosed and weatherproof, wet work is complete and dry, and HVAC system is operating and maintaining temperature at 70 degrees F for not less than 72 hours before beginning installation and for the remainder of the construction period.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Aluminum Extrusions: Alloy and temper recommended by manufacturer for type of use and finish indicated, but with not less than strength and durability properties specified in ASTM B 221 for Alloy 6063-T5.

B. Fasteners: Provide aluminum, non-magnetic stainless steel, or other non-corrosive metal screws, bolts, and other fasteners compatible with aluminum components, hardware, anchors, and other items being fastened. Use theft-proof fasteners where exposed to view.

C. Recycled Content of Aluminum Products: Post-consumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.

2.2 CORNER GUARDS

A. Surface-Mounted, Metal Corner Guards: Fabricated from one-piece 4-foot-high formed of extruded metal with formed edges; with 90 degree turn to match wall condition.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Arden Architectural Specialties, Inc.
b. Balco, Inc.
c. Construction Specialties, Inc.
d. IPC Door and Wall Protection Systems; div. of InPro Corp.
e. Korogard Wall Protection Systems; div. of RJF International Corp.
f. Pawling Corp.
g. Tepromark International, Inc.

2. Material: Extruded aluminum, minimum 0.0625 inch thick, with clear anodized finish.
3. Wing Size: Nominal 2-1/2 inches by 2-1/2 inches.
4. Corner Radius: 1/8 inch.
5. Mounting: Flat-head, countersunk screws through factory-drilled mounting holes or oval head, countersunk screws through factory-drilled mounting holes.

2.3 FABRICATION

A. Fabricate wall and door protection systems to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including thicknesses of components.

B. Provide surfaces free of chips, dents, and other imperfections.

C. Provide anchors for interconnecting members to other construction.

2.4 FINISHES

A. Metal Finishes:

1. Comply with NAAMM AMP 500 "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

a. Remove tool and die marks and stretch lines, or blend into finish.
b. Grind and polish surfaces to produce uniform finish, free of cross scratches.
c. Run grain of directional finishes with long dimension of each piece.
d. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

2. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

3. Finish designations prefixed by "AA" conform to the system established by the Aluminum Association for designating finishes.

B. Aluminum Finishes: Remove die markings, scratches, abrasions, dents, and other blemishes before applying finish.
1. Class 1 Clear Anodized Finish: AA-M12-C22-A41 (Mechanical Finish: non-specular as fabricated; Chemical Finish: etched, medium matte, Anodic Coating: Architectural Class 1, clear coating 0.7 mil and greater film thickness) complying with AAMA 611.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions
1. Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the COR, of any conditions detrimental to the proper and timely completion of the work.

B. Examine areas and conditions in which wall protection system components will be installed.

1. Complete finishing operations, including painting, before installing wall protection system components.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

3.2 INSTALLATION

A. General: Install wall protection units level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.

1. Install corner guard units in locations indicated on Drawings and bottom of corner guard mounted at 5 inches above the finish floor.

3.3 CLEANING

A. General: Immediately on completion of installation, clean metal components according to the manufacturer's written instructions.

B. Remove surplus materials, rubbish, and debris, resulting from installation, on completion of work and leave installation areas in neat, clean condition.

3.4 PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to the Installer, that shall ensure that the wall and door protection shall be without damage at time of Substantial Completion.

END OF SECTION 10 26 00

SECTION 133419 - METAL BUILDING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Structural-steel framing.
2. Metal roof panels.
3. Metal wall panels.
4. Personnel doors and frames.
5. Accessories

B. Related Requirements:

1. Section 08 88 88 "Hollow Metal Doors and Frames" for doors and frames.
2. Section 08 33 23 "Door Hardware" for door hardware
3 Section 03 30 00 "Cast-in Place Concrete" for foundation, floor slab and reinforcing bars.

1.3 DEFINITIONS

A. Terminology Standard: See MBMA's "Metal Building Systems Manual" for definitions of terms for metal building system construction not otherwise defined in this Section or in standards referenced by this Section.

1.4 COORDINATION

A. Coordinate sizes and locations of concrete foundations and casting of anchor-rod inserts into foundation walls and footings. Anchor rod installation, concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-in-Place Concrete."

B. Coordinate metal panel assemblies with rain drainage work, flashing, trim, and construction of supports and other adjoining work to provide a leak-proof, secure, and noncorrosive installation.

1.5 PREINSTALLATION MEETINGS

A. Pre-installation Conference: Conduct conference at Project site.

1. Review methods and procedures related to metal building systems including, but not limited to, the following:

    a. Condition of foundations and other preparatory work performed by other trades.
    b. Structural load limitations.
    c. Construction schedule. Verify availability of materials and erector's personnel, equipment, and facilities needed to make progress and avoid delays.
    d. Required tests, inspections, and certifications.
    e. Unfavorable weather and forecasted weather conditions and impact on construction schedule.

2. Review methods and procedures related to metal roof panel assemblies including, but not limited to, the following:

    a. Compliance with requirements for purlin and rafter conditions, including flatness and attachment to structural members.
    b. Structural limitations of purlins and rafters during and after roofing.
    c. Flashings, special roof details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect metal roof panels.
    d. Temporary protection requirements for metal roof panel assembly during and after installation.
    e. Roof observation and repair after metal roof panel installation.

3. Review methods and procedures related to metal wall panel assemblies including, but not limited to, the following:

    a. Compliance with requirements for support conditions, including alignment between and attachment to structural members.
    b. Structural limitations of girts and columns during and after wall panel installation.
    c. Flashings, special siding details, wall penetrations, openings, and condition of other construction that will affect metal wall panels.
    d. Temporary protection requirements for metal wall panel assembly during and after installation.
    e. Wall observation and repair after metal wall panel installation.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of metal building system component.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

    a. Metal roof panels.
    b. Metal wall panels.
    c. Louvers

B. Shop Drawings: Indicate components by others. Include full building plan, elevations, sections, details and the following:

1. Anchor-Rod Plans: Submit anchor-rod plans and templates before foundation work begins. Include location, diameter, and minimum required projection of anchor rods required to attach metal building to foundation. Indicate column reactions at each location.
2. Structural-Framing Drawings: Show complete fabrication of primary and secondary framing; include provisions for openings. Indicate welds and bolted connections, distinguishing between shop and field applications. Include transverse cross-sections.

    a. Show provisions for attaching existing structure and service walkways.

3. Metal Roof and Wall Panel Layout Drawings: Show layouts of panels including methods of support. Include details of edge conditions, joints, panel profiles, corners, anchorages, clip spacing, trim, flashings, closures, and special details. Distinguish between factory- and field-assembled work; show locations of exposed fasteners.

    a. Show roof-mounted items including lighting fixtures, and items mounted on roof curbs.
    b. Show wall-mounted items including personnel doors, louvers, and lighting fixtures.
    c. Show mounted items including wall mounted ventilation exhaust fan.

4. Accessory Drawings: Include details of the following items, at a scale of not less than 1 ½ inches per 12 inches:

    a. Flashing and trim.
    b. Gutters.
    c. Downspouts.
    d. Service walkways.

C. Samples for Initial Selection: For units with factory-applied finishes.

D. Samples for Verification: For the following products:

1. Panels: Nominal 12 inches long by actual panel width. Include fasteners, closures, and other exposed panel accessories.
2. Flashing and Trim: Nominal 12 inches long. Include fasteners and other exposed accessories.
3. Accessories: Nominal 12-inchlong Samples for each type of accessory.

E. Door Schedule: For doors and frames. Use same designations indicated on Drawings. Include details of reinforcement.

1. Door Hardware Schedule: Include details of fabrication and assembly of door hardware. Organize schedule into door hardware sets indicating complete designations of every item required for each door or opening.
2. Keying Schedule: Detail Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations.

F. Delegated-Design Submittal: For metal building systems.

1. Include analysis data indicating compliance with performance requirements and design data signed and sealed by the qualified professional engineer responsible for their preparation.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For erector and manufacturer.

B. Welding certificates.

C. Letter of Design Certification: Signed and sealed by a qualified professional engineer. Include the following:

1. Name and location of Project.
2. Order number.
3. Name of manufacturer.
4. Name of Contractor.
5. Building dimensions including width, length, height, and roof slope.
6. Indicate compliance with AISC standards for hot-rolled steel and AISI standards for cold-rolled steel, including edition dates of each standard.
7. Governing building code and year of edition.
8. Design Loads: Include dead load, roof live load, collateral loads, roof snow load, deflection, wind loads/speeds and exposure, seismic design category or effective peak velocity-related acceleration/peak acceleration, and auxiliary loads (cranes).
9. Load Combinations: Indicate that loads were applied acting simultaneously with concentrated loads, according to governing building code.
10. Building-Use Category: Indicate category of building use and its effect on load importance factors.

D. Erector Certificates: For qualified erector, from manufacturer.

E. Material Test Reports: For each of the following products:

1. Structural steel including chemical and physical properties.
2. Bolts, nuts, and washers including mechanical properties and chemical analysis.
3. Tension-control, high-strength, bolt-nut-washer assemblies.
4. Shop primers.
5. Non shrink grout.

F. Source quality-control reports.

G. Field quality-control reports.

H. Surveys: Show final elevations and locations of major members. Indicate discrepancies between actual installation and the Contract Documents. Have surveyor who performed surveys certify their accuracy.

I. Sample Warranties: For special warranties.

1.8 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panel finishes and door hardware to include in maintenance manuals.

1.9 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer.

1. Accreditation: Manufacturer's facility accredited according to the International Accreditation Service's AC472, "Accreditation Criteria for Inspection Programs for Manufacturers of Metal Building Systems."
2. Engineering Responsibility: Preparation of comprehensive engineering analysis and Shop Drawings by a professional engineer who is legally qualified to practice in jurisdiction where Project is located.

B. Erector Qualifications: An experienced erector who specializes in erecting and installing work similar in material, design, and extent to that indicated for this Project and who is acceptable to manufacturer.

C. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3, "Structural Welding Code - Sheet Steel."

D. Land Surveyor Qualifications: A professional land surveyor who practices in jurisdiction where Project is located and who is experienced in providing surveying services of the kind indicated.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, sheets, panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels horizontally on platforms or pallets, covered with suitable weather tight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

1.11 FIELD CONDITIONS

A. Weather Limitations: Proceed with panel installation only when weather conditions permit metal panels to be installed according to manufacturers' written instructions and warranty requirements.

1.12 WARRANTY

A. Special Warranty on Metal Panel Finishes: Manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

B. Special Weather Tightness Warranty for Standing-Seam Metal Roof Panels: Manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that leak or otherwise fail to remain weather tight within specified warranty period.

1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to the conditions of the specifications acceptable manufacturers are but not limited to the following. All other manufacturers meeting the requirements of the specifications will be considered.
1. Butler Manufacturing
2. Vulcan Steel Structures
3. Pinnacle Structures, Inc
4. Trident Building Systems

B. Source Limitations: Obtain metal building system components, including primary and secondary framing and metal panel assemblies, from single source from single manufacturer.

2.2 SYSTEM DESCRIPTION

A. Provide a complete, integrated set of mutually dependent components and assemblies that form a metal building system capable of withstanding structural and other loads, thermally induced movement, and exposure to weather without failure or infiltration of water into building interior.

B. Primary-Frame Type:

1. Rigid Clear Span: Solid-member, structural-framing system without interior columns.

C. Secondary-Frame Type: Manufacturer's standard purlins and joists and exterior framed bypass girts.

D. Eave Height: as indicated by nominal height on Drawings.

E. Bay Spacing: As indicated on Drawings.

F. Roof Slope: 1 inch per 12 inches.

G. Roof System: Manufacturer's standard standing-seam, trapezoidal rib, metal roof panels.

1. Liner Panels: Tapered rib.

H. Exterior Wall System: Manufacturer's standard concealed-fastener, foamed-insulation-core metal wall panels.

1. Liner Panels: Tapered rib.

2.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design metal building system.

B. Structural Performance: Metal building systems shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to procedures in MBMA's "Metal Building Systems Manual."

1. Design Loads: As indicated on Drawings and as per IBC 2015 and ASCE 7-10.
2. Deflection and Drift Limits: Design metal building system assemblies to withstand serviceability design loads without exceeding deflections and drift limits recommended in AISC Steel Design Guide No. 3 "Serviceability Design Considerations for Steel Buildings."
3. Deflection and Drift Limits: No greater than the following:

    a. Purlins and Rafters: Vertical deflection of 1/240 of the span.
    b. Girts: Horizontal deflection of 1/240 of the span.
    c. Metal Roof Panels: Vertical deflection of 1/240 of the span.
    d. Metal Wall Panels: Horizontal deflection of 1/240 of the span.
    e. Design secondary-framing system to accommodate deflection of primary framing and construction tolerances, and to maintain clearances at openings.
    f. Lateral Drift: Maximum of 1/60 of the building height. Clear space between the existing and the new addition shall exceed the factored drift.

C. Seismic Performance: Metal building system shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: 120 deg Ambient; 180 deg F, material surfaces.

E. Fire-Resistance Ratings: Where assemblies are indicated to have a fire-resistance rating, provide metal panel assemblies identical to those of assemblies tested for fire resistance per ASTM E 119 or ASTM E 108 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory," FM Global's "Approval Guide," or from the listings of another qualified testing agency.

F. Fire Propagation Characteristics: Exterior wall assemblies containing foam plastics pass NFPA 285 fire test.

G. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.

1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.

H. Structural Performance for Metal Roof and Wall Panels: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 1592:

1. Wind Loads: As indicated on Drawings.

I. Air Infiltration for Metal Roof Panels: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E 1680 at the following test-pressure difference:

1. Test-Pressure Difference: 1.57 lbf/sq. ft.

J. Air Infiltration for Metal Wall Panels: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E 283 at the following test-pressure difference:

1. Test-Pressure Difference: 1.57 lbf/sq. ft.

K. Water Penetration for Metal Roof Panels: No water penetration when tested according to ASTM E 1646 at the following test-pressure difference:

1. Test-Pressure Difference: 2.86 lbf/sq. ft.

L. Water Penetration for Metal Wall Panels: No water penetration when tested according to ASTM E 331 at the following test-pressure difference:

1. Test-Pressure Difference: 2.86 lbf/sq. ft.

M. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.

1. Uplift Rating: UL 90.

N. FM Global Listing: Provide metal roof panels and component materials that comply with requirements in FM Global 4471 as part of a panel roofing system and that are listed in FM

Global’ s "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.

1. Fire/Windstorm Classification: Class 1A90
2. Hail Resistance: SH

O. Energy Performance: Provide roof panels according to one of the following when tested according to CRRC-1:

1. Three-year, aged, solar reflectance of not less than 0.55 and emissivity of not less than 0.75.
2. Three-year, aged, Solar Reflectance Index of not less than 64 value when calculated according to ASTM E 1980.

P. Thermal Performance for Opaque Elements: Provide the following maximum U-factors and minimum R-values per ASHRAE 90.1, Table 5.5-5, minimum R-Values according to ASTM C 1363 or ASTM C 518:

1. Roof:
   a. R-Value: 18.2

2. Walls:
   a. R-Value: 14.5
3. Insulation at Slab for 24inches:
   a. R-Value: 15

2.4 STRUCTURAL-STEEL FRAMING

A. Structural Steel: Comply with AISC 360, "Specification for Structural Steel Buildings."

B. Bolted Connections: Comply with RCSC's "Specification for Structural Joints Using High-Strength Bolts."

C. Primary Framing: Manufacturer's standard primary-framing system, designed to withstand required loads and specified requirements. Primary framing includes transverse and lean-to frames; rafters, rake, and canopy beams; sidewall, intermediate, end-wall, and corner columns; and wind bracing.

1. General: Provide frames with attachment plates, bearing plates, and splice members. Factory drill for field-bolted assembly. Provide frame span and spacing indicated.

   a. Slight variations in span and spacing may be acceptable if necessary to comply with manufacturer's standard, as approved by Architect.

2. Rigid Clear-Span Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Interior columns are not permitted.

D. Secondary Framing: Manufacturer's standard secondary framing, including purlins, girts, eave struts, flange bracing, base members, gable angles, clips, headers, jambs, and other miscellaneous structural members. Unless otherwise indicated, fabricate framing from either

cold-formed, structural-steel sheet or roll-formed, metallic-coated steel sheet, pre-painted with coil coating, to comply with the following:

1. Purlins: C- or Z-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes; minimum 2-1/2-inch wide flanges.

    a. Depth: As needed to comply with system performance requirements.

2. Purlins: Steel joists of depths indicated on Drawings.
3. Girts: C- or Z-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes. Form ends of Z-sections with stiffening lips angled 40 to 50 degrees from flange, with minimum 2-1/2-inch wide flanges.

    a. Depth: As required to comply with system performance requirements.

4. Eave Struts: Unequal-flange, C-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes; to provide adequate backup for metal panels.
5. Flange Bracing: Minimum 2-by-2-by-1/8-inchstructural-steel angles or 1-inch diameter, cold-formed structural tubing to stiffen primary-frame flanges.
6. Sag Bracing: Minimum 1-by-1-by-1/8-inchstructural-steel angles.
7. Base or Sill Angles: Manufacturer's standard base angle, minimum 3-by-2-inch, fabricated from zinc-coated (galvanized) steel sheet.
8. Purlin and Girt Clips: Manufacturer's standard clips fabricated from steel sheet. Provide galvanized clips where clips are connected to galvanized framing members.
9. Framing for Openings: Channel shapes; fabricated from cold-formed, structural-steel sheet or structural-steel shapes. Frame head and jamb of door openings and head, jamb, and sill of other openings.
10. Miscellaneous Structural Members: Manufacturer's standard sections fabricated from cold-formed, structural-steel sheet; built-up steel plates; or zinc-coated (galvanized) steel sheet; designed to withstand required loads.

E. Bracing: Provide adjustable wind bracing using any method as follows:

1. Rods: ASTM A 36/A 36M; ASTM A 572/A 572M, Grade 50; or ASTM A 529/A 529M, Grade 50; ASTM A615 Grade 75; minimum 1/2-inch-diameter steel; threaded full length or threaded a minimum of 6 inches at each end.
2. Rigid Portal Frames: Fabricated from shop-welded, built-up steel plates or structural-steel shapes to match primary framing; of size required to withstand design loads.

F. Anchor Rods: Headed anchor rods as indicated in Anchor Rod Plan for attachment of metal building to foundation.

G. Materials:

1. W-Shapes: ASTM A 992/A 992M; ASTM A 572/A 572M, Grade 50 or 55; or ASTM A 529/A 529M, Grade 50 or 55.
2. Channels, Angles, M-Shapes, and S-Shapes: ASTM A 36/A 36M; ASTM A 572/A 572M, Grade 50 or 55; or ASTM A 529/A 529M, Grade 50 or 55.
3. Plate and Bar: ASTM A 36/A 36M; ASTM A 572/A 572M, Grade 50 or 55; or ASTM A 529/A 529M, Grade 50 or 55.
4. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.

5. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B or C, structural tubing.
6. Structural-Steel Sheet: Hot-rolled, ASTM A 1011/A 1011M, Structural Steel (SS), Grades 30 through 55, or High-Strength Low-Alloy Steel (HSLAS) or High-Strength Low-Alloy Steel with Improved Formability (HSLAS-F), Grades 45 through 70; or cold-rolled, ASTM A 1008/A 1008M, Structural Steel (SS), Grades 25 through 80, or HSLAS, Grades 45 through 70.
7. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, SS, Grades 33 through 80, or HSLAS or HSLAS-F, Grades 50 through 80; with G60coating designation; mill phosphatized.
8. Metallic-Coated Steel Sheet Preprinted with Coil Coating: Steel sheet, metallic coated by the hot-dip process and preprinted by the coil-coating process to comply with ASTM A 755/A 755M.

    a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, SS, Grades 33 through 80, or HSLAS or HSLAS-F, Grades 50 through 80; with G90coating designation.
    b. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, SS, Grade 50 or 80; with Class AZ50coating.
9. Non-High-Strength Bolts, Nuts, and Washers: ASTM A 307, Grade A, carbon-steel, hex-head bolts; ASTM A 563 carbon-steel hex nuts; and ASTM F 844 plain (flat) steel washers.

    a. Finish: Hot-dip zinc coating, ASTM F 2329, Class C or Mechanically deposited zinc coating, ASTM B 695, Class 50.

10. Structural Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563 heavy-hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.

    a. Finish: Hot-dip zinc coating, ASTM F 2329, Class C or Mechanically deposited zinc coating, ASTM B 695, Class 50.

11. High-Strength Bolts, Nuts, and Washers: ASTM A 490, Type 1, heavy-hex steel structural bolts; ASTM A 563heavy-hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers, plain.
12. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy-hex-head steel structural bolts with spline ends.

    a. Finish: Mechanically deposited zinc coating, ASTM B 695, Class 50.

13. Un-headed Anchor Rods: ASTM F 1554, Grade 36.

    a. Configuration: Straight.
    b. Nuts: ASTM A 563hex carbon steel.
    c. Plate Washers: ASTM A 36/A 36M carbon steel.
    d. Washers: ASTM F 436hardened carbon steel.
    e. Finish: Hot-dip zinc coating, ASTM F 2329, Class C or Mechanically deposited zinc coating, ASTM B 695, Class 50.

14. Headed Anchor Rods: ASTM F 1554, Grade 36.

a. Configuration: Straight.
b. Nuts: ASTM A 563hex carbon steel.
c. Plate Washers: ASTM A 36/A 36M carbon steel.
d. Washers: ASTM F 436hardened carbon steel.
e. Finish: Hot-dip zinc coating, ASTM F 2329, Class C or Mechanically deposited zinc coating, ASTM B 695, Class 50.

15. Threaded Rods: ASTM A 572/A 572M, Grade 50.

a. Nuts: ASTM A 563hex carbon steel.
b. Washers: ASTM F 436hardened ASTM A 36/A 36M carbon steel.
c. Finish: Hot-dip zinc coating, ASTM F 2329, Class C or Mechanically deposited zinc coating, ASTM B 695, Class 50.

H. Finish: Factory primed. Apply specified primer immediately after cleaning and pretreating.

1. Clean and prepare in accordance with SSPC-SP2.
2. Coat with manufacturer's standard primer. Apply primer to primary and secondary framing to a minimum dry film thickness of 1 mil.

a. Prime secondary framing formed from uncoated steel sheet to a minimum dry film thickness of 0.5 mil each side.

2.5 METAL ROOF PANELS

A. Standing-Seam, Trapezoidal Rib, Metal Roof Panels: Formed with raised trapezoidal ribs at panel edges and intermediate stiffening ribs symmetrically spaced, flat pan between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.024-inch nominal uncoated steel thickness. Pre-painted by the coil-coating process to comply with ASTM A 755/A 755M.

a. Exterior Finish: Two-coat fluoropolymer
b. Color: Match existing building.

2. Clips: Two-piece floating to accommodate thermal movement.
3. Joint Type: Mechanically seamed.
4. Panel Coverage: 16 inches.
5. Panel Height: Match existing building.
6. Uplift Rating: UL 90

B. Finishes:

1. Exposed Coil-Coated Finish:

a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply

coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

2.6 METAL WALL PANELS

A. Concealed-Fastener, Flush-Profile, Metal Wall Panels: Formed with vertical panel edges and a single wide recess, centered between panel edges; with flush joint between panels; with 1-inch-wide flange for attaching interior finish; designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners in side laps.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.024-inch nominal uncoated steel thickness. Preprinted by the coil-coating process to comply with ASTM A 755/A 755M.

a. Exterior Finish: Fluoropolymer.
b. Color: Match existing building.

2. Panel Coverage: Match existing building.
3. Panel Height: Match existing building.

B. Finishes:

1. Exposed Coil-Coated Finish:

a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

2.7 THERMAL INSULATION

A. Faced Metal Building Insulation: ASTM C 991, Type II, glass-fiber-blanket insulation; 0.5-lb/cu. ft. density; 2-inch wide, continuous, vapor-tight edge tabs; with a flame-spread index of 25 or less.

B. Faced, Polyisocyanurate Board Insulation: ASTM C 1289, Type I (foil facing), Class 2, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, based on tests performed on un-faced core. Provide units tested for interior exposure without an approved thermal barrier.

C. Retainer Strips: For securing insulation between supports, 0.025-inch nominal-thickness, formed, metallic-coated steel or PVC retainer clips colored to match insulation facing.

D. Vapor-Retarder Facing: ASTM C 1136, with permeance not greater than 0.02 perm when tested according to ASTM E 96/E 96M, Desiccant Method.

1. Composition: White metallized-polypropylene film facing, fiberglass scrim reinforcement, and kraft-paper backing.
2. Composition: Aluminum foil facing, elastomeric barrier coating, fiberglass scrim reinforcement, and kraft-paper backing.
3. Composition: White polypropylene film facing, fiberglass scrim reinforcement, and metallized-polyester film backing.
4. Composition: White polypropylene film facing and fiberglass-polyester-blend fabric backing.

E. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

2.8 PERSONNEL DOORS AND FRAMES

A. Swinging Personnel Doors and Frames: As specified in Section 081113 "Hollow Metal Doors and Frames" is for purpose of these specifications the minimum standard.

B. Swinging Personnel Doors and Frames: Metal building system manufacturer's standard doors and frames; prepared and reinforced at strike and at hinges to receive factory- and field-applied hardware according to BHMA A156 Series unless otherwise provided by Section 081113 "Hollow Metal Doors and Frames".

C. Swing Personnel Doors Hardware: As specified in Section 087100 "Door Hardware" is for purpose of these specifications the minimum requirement.

D. Finishes for Personnel Doors and Frames:

1. Prime Finish: Factory-apply manufacturer's standard primer immediately after cleaning and pretreating.

a. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

2. Factory-Applied Paint Finish: Manufacturer's standard, complying with SDI A250.3 for performance and acceptance criteria.

a. Color and Gloss: As indicated on drawings.

2.9 ACCESSORIES

A. General: Provide accessories as standard with metal building system manufacturer and as specified. Fabricate and finish accessories at the factory to greatest extent possible, by

manufacturer's standard procedures and processes. Comply with indicated profiles and with dimensional and structural requirements.

1. Form exposed sheet metal accessories that are without excessive oil-canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.

B. Roof Panel Accessories: Provide components required for a complete metal roof panel assembly including copings, fasciae, corner units, ridge closures, clips, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal roof panels unless otherwise indicated.

1. Closures: Provide closures at eaves and ridges, fabricated of same material as metal roof panels.
2. Clips: Manufacturer's standard, formed from steel sheet, designed to withstand negative-load requirements.
3. Cleats: Manufacturer's standard, mechanically seamed cleats formed from steel sheet.
4. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
5. Closure Strips: Closed-cell, expanded, cellular, rubber or cross linked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch-thick, flexible closure strips; cut or pre-molded to match metal roof panel profile. Provide closure strips where indicated or necessary to ensure weather tight construction.
6. Thermal Spacer Blocks: Where metal panels attach directly to purlins, provide thermal spacer blocks of thickness required to provide 1-inch standoff; fabricated from extruded polystyrene.

C. Wall Panel Accessories: Provide components required for a complete metal wall panel assembly including copings, fasciae, mullions, sills, corner units, clips, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal wall panels unless otherwise indicated.

1. Closures: Provide closures at eaves and rakes, fabricated of same material as metal wall panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
3. Closure Strips: Closed-cell, expanded, cellular, rubber or cross linked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch-thick, flexible closure strips; cut or pre-molded to match metal wall panel profile. Provide closure strips where indicated or necessary to ensure weather tight construction.

D. Flashing and Trim: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inchnominal uncoated steel thickness, pre painted with coil coating; finished to match adjacent metal panels.

1. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers.
2. Opening Trim: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch nominal uncoated steel thickness, prepainted with coil coating. Trim head and jamb of door openings, and head, jamb, and sill of other openings.

E. Gutters: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch nominal uncoated steel thickness, pre painted with coil coating; finished to match roof fascia and rake trim. Match profile of gable trim, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch long sections, sized according to SMACNA's "Architectural Sheet Metal Manual."

1. Gutter Supports: Fabricated from same material and finish as gutters.
2. Strainers: Bronze, copper, or aluminum wire ball type at outlets.

F. Downspouts: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch nominal uncoated steel thickness, pre painted with coil coating; finished to match metal wall panels. Fabricate in minimum 10-foot long sections, complete with formed elbows and offsets.

1. Mounting Straps: Fabricated from same material and finish as gutters.

G. Louvers: Size and design indicated; self-framing and self-flashing. Fabricate welded frames from zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.048-inch nominal uncoated steel thickness; finished to match metal wall panels. Form blades from zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.036-inch nominal uncoated steel thickness; folded or beaded at edges, set at an angle that excludes driving rains, and secured to frames by riveting or welding. Fabricate louvers with equal blade spacing to produce uniform appearance.

1. Blades: Fixed.
2. Blades: Adjustable type, with weather-stripped edges, and manually operated by hand crank or pull chain.
3. Free Area: Not less than 7.0 sq. ft.
4. Bird Screening: Galvanized steel, 1/2-inch-square mesh, wire; with rewirable frames, removable and secured with clips; fabricated of same kind and form of metal and with same finish as louvers.

    a. Mounting: Interior face of louvers.

H. Pipe Flashing: Pre-molded, EPDM pipe collar with flexible aluminum ring bonded to base.

I. Materials:

1. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide fasteners with heads matching color of materials being fastened by means of plastic caps or factory-applied coating.
    a. Fasteners for Metal Roof Panels: Self-drilling, Type 410 stainless steel or self-tapping, Type 304 stainless-steel or zinc-alloy-steel hex washer head, with EPDM washer under heads of fasteners bearing on weather side of metal panels.
    b. Fasteners for Metal Wall Panels: Self-drilling, Type 410 stainless steel or self-tapping, Type 304 stainless-steel or zinc-alloy-steel hex washer head, with EPDM sealing washers bearing on weather side of metal panels.
    c. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws with hex washer head.
    d. Blind Fasteners: High-strength aluminum or stainless-steel rivets.

2. Corrosion-Resistant Coating: Cold-applied asphalt mastic, compounded for 15-mildry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.
3. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107/C 1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time.
4. Metal Panel Sealants:

    a. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene-compound sealant tape with release-paper backing. Provide permanently elastic, non-sag, nontoxic, non-staining tape of manufacturer's standard size.
    b. Joint Sealant: ASTM C 920; one-part elastomeric polyurethane or polysulfide; of type, grade, class, and use classifications required to seal joints in metal panels and remain weather tight; and as recommended by metal building system manufacturer.

2.10 FABRICATION

A. General: Design components and field connections required for erection to permit easy assembly.

1. Mark each piece and part of the assembly to correspond with previously prepared erection drawings, diagrams, and instruction manuals.
2. Fabricate structural framing to produce clean, smooth cuts and bends. Punch holes of proper size, shape, and location. Members shall be free of cracks, tears, and ruptures.

B. Tolerances: Comply with MBMA's "Metal Building Systems Manual" for fabrication and erection tolerances.

C. Primary Framing: Shop fabricate framing components to indicated size and section, with baseplates, bearing plates, stiffeners, and other items required for erection welded into place. Cut, form, punch, drill, and weld framing for bolted field assembly.

1. Make shop connections by welding or by using high-strength bolts.
2. Join flanges to webs of built-up members by a continuous, submerged arc-welding process.
3. Brace compression flange of primary framing with steel angles or cold-formed structural tubing between frame web and purlin web or girt web, so flange compressive strength is within allowable limits for any combination of loadings.
4. Weld clips to frames for attaching secondary framing if applicable, or punch for bolts.
5. Shop Priming: Prepare surfaces for shop priming according to SSPC-SP 2. Shop prime primary framing with specified primer after fabrication.

D. Secondary Framing: Shop fabricate framing components to indicated size and section by roll forming or break forming, with baseplates, bearing plates, stiffeners, and other plates required for erection welded into place. Cut, form, punch, drill, and weld secondary framing for bolted field connections to primary framing.

1. Make shop connections by welding or by using non-high-strength bolts.

2. Shop Priming: Prepare uncoated surfaces for shop priming according to SSPC-SP 2. Shop prime uncoated secondary framing with specified primer after fabrication.

E. Metal Panels: Fabricate and finish metal panels at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements. Comply with indicated profiles and with dimensional and structural requirements.

1. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of metal panel.

2.11 SOURCE QUALITY CONTROL

A. Special Inspection: Owner will engage a qualified special inspector to perform source quality control inspections and to submit reports.

1. Accredited Manufacturers: Special inspections will not be required if fabrication is performed by an IAS AC472-accredited manufacturer approved by authorities having jurisdiction to perform such Work without special inspection.

a. After fabrication, submit copy of certificate of compliance to authorities having jurisdiction, certifying that Work was performed according to Contract requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with erector present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Before erection proceeds, survey elevations and locations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments to receive structural framing, with erector present, for compliance with requirements and metal building system manufacturer's tolerances.

1. Engage land surveyor to perform surveying.

C. Proceed with erection only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition.

B. Provide temporary shores, guys, braces, and other supports during erection to keep structural framing secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural framing, connections, and bracing are in place unless otherwise indicated.

3.3 ERECTION OF STRUCTURAL FRAMING

A. Erect metal building system according to manufacturer's written instructions and drawings.

B. Do not field cut, drill, or alter structural members without written approval from metal building system manufacturer's professional engineer.

C. Set structural framing accurately in locations and to elevations indicated, according to AISC specifications referenced in this Section. Maintain structural stability of frame during erection.

D. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
3. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

E. Align and adjust structural framing before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with framing. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.
2. Make allowances for difference between temperature at time of erection and mean temperature when structure will be completed and in service.

F. Primary Framing and End Walls: Erect framing level, plumb, rigid, secure, and true to line. Level baseplates to a true even plane with full bearing to supporting structures, set with double-nutted anchor bolts. Use grout to obtain uniform bearing and to maintain a level base-line elevation. Moist-cure grout for not less than seven days after placement.

1. Make field connections using high-strength bolts installed according to RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt type and joint type specified.

a. Joint Type: Snug tightened or pre-tensioned as required by manufacturer.

G. Secondary Framing: Erect framing level, plumb, rigid, secure, and true to line. Field bolt secondary framing to clips attached to primary framing.

1. Provide rake or gable purlins with tight-fitting closure channels and fasciae.
2. Locate and space wall girts to suit openings such as doors and windows.
3. Provide supplemental framing at entire perimeter of openings, including doors, windows, louvers, ventilators, and other penetrations of roof and walls.

H. Steel Joists: Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Standard Specifications and Load Tables for Steel

Joists and Joist Girders," joist manufacturer's written instructions, and requirements in this Section.

1. Before installation, splice joists delivered to Project site in more than one piece.
2. Space, adjust, and align joists accurately in location before permanently fastening.
3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
4. Joist Installation: Bolt joists to supporting steel framework using carbon-steel bolts unless otherwise indicated.
5. Joist Installation: Bolt joists to supporting steel framework using high-strength structural bolts unless otherwise indicated. Comply with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for high-strength structural bolt installation and tightening requirements.
6. Joist Installation: Weld joist seats to supporting steel framework.
7. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

I. Bracing: Install bracing in roof and sidewalls where indicated on erection drawings.

1. Tighten rod and cable bracing to avoid sag.
2. Locate interior end-bay bracing only where indicated.

J. Framing for Openings: Provide shapes of proper design and size to reinforce openings and to carry loads and vibrations imposed, including equipment furnished under mechanical and electrical work. Securely attach to structural framing.

K. Erection Tolerances: Maintain erection tolerances of structural framing within AISC 303.

3.4 METAL PANEL INSTALLATION, GENERAL

A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.

C. Examination: Examine primary and secondary framing to verify that structural-panel support members and anchorages have been installed within alignment tolerances required by manufacturer.

1. Examine roughing-in for components and systems penetrating metal panels, to verify actual locations of penetrations relative to seams before metal panel installation.

D. General: Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Field cut metal panels as required for doors, windows, and other openings. Cut openings as small as possible, neatly to size required, and without damage to adjacent metal panel finishes.

    a. Field cutting of metal panels by torch is not permitted unless approved in writing by manufacturer.

2. Install metal panels perpendicular to structural supports unless otherwise indicated.
3. Flash and seal metal panels with weather closures at perimeter of openings and similar elements. Fasten with self-tapping screws.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Locate metal panel splices over structural supports with end laps in alignment.
6. Lap metal flashing over metal panels to allow moisture to run over and off the material.

E. Lap-Seam Metal Panels: Install screw fasteners using power tools with controlled torque adjusted to compress EPDM washers tightly without damage to washers, screw threads, or metal panels. Install screws in predrilled holes.

1. Arrange and nest side-lap joints so prevailing winds blow over, not into, lapped joints. Lap ribbed or fluted sheets one full rib corrugation. Apply metal panels and associated items for neat and weather tight enclosure. Avoid "panel creep" or application not true to line.

F. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with corrosion-resistant coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal roof panel manufacturer.

G. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal panel assemblies. Provide types of gaskets, fillers, and sealants indicated; or, if not indicated, provide types recommended by metal panel manufacturer.

1. Seal metal panel end laps with double beads of tape or sealant the full width of panel. Seal side joints where recommended by metal panel manufacturer.
2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

3.5 METAL ROOF PANEL INSTALLATION

A. General: Provide metal roof panels of full length from eave to ridge unless otherwise indicated or restricted by shipping limitations.
1. Flash and seal metal roof panels with weather closures at eaves and rakes. Fasten with self-tapping screws.

B. Standing-Seam Metal Roof Panels: Fasten metal roof panels to supports with concealed clips at each standing-seam joint, at location and spacing and with fasteners recommended by manufacturer.

1. Install clips to supports with self-drilling or self-tapping fasteners.

2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.
4. Seamed Joint: Crimp standing seams with manufacturer-approved motorized seamer tool so that clip, metal roof panel, and factory-applied sealant are completely engaged.
5. Rigidly fasten eave end of metal roof panels and allow ridge end free movement for thermal expansion and contraction. Predrill panels for fasteners.
6. Provide metal closures at peaks rake walls and each side of ridge and hip caps.

C. Lap-Seam Metal Roof Panels: Fasten metal roof panels to supports with exposed fasteners at each lapped joint, at location and spacing recommended by manufacturer.

1. Provide metal-backed sealing washers under heads of exposed fasteners bearing on weather side of metal roof panels.
2. Provide sealant tape at lapped joints of metal roof panels and between panels and protruding equipment, vents, and accessories.
3. Apply a continuous ribbon of sealant tape to weather-side surface of fastenings on end laps and on side laps of nesting-type metal panels, on side laps of ribbed or fluted metal panels, and elsewhere as needed to make metal panels weatherproof to driving rains.
4. At metal panel splices, nest panels with minimum 6-inchend lap, sealed with butyl-rubber sealant and fastened together by interlocking clamping plates.

D. Metal Roof Panel Installation Tolerances: Shim and align metal roof panels within installed tolerance of 1/4 inch in 20 feet on slope and location lines and within 1/8-inchoffset of adjoining faces and of alignment of matching profiles.

3.6 METAL WALL PANEL INSTALLATION

A. General: Install metal wall panels in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to girts, extending full height of building, unless otherwise indicated. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Unless otherwise indicated, begin metal panel installation at corners with center of rib lined up with line of framing.
2. Shim or otherwise plumb substrates receiving metal wall panels.
3. When two rows of metal panels are required, lap panels 4 inches minimum.
4. When building height requires two rows of metal panels at gable ends, align lap of gable panels over metal wall panels at eave height.
5. Rigidly fasten base end of metal wall panels and allow eave end free movement for thermal expansion and contraction. Predrill panels.
6. Flash and seal metal wall panels with weather closures at eaves and rakes, and at perimeter of all openings. Fasten with self-tapping screws.
7. Install screw fasteners in predrilled holes.
8. Install flashing and trim as metal wall panel work proceeds.
9. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete, and elsewhere as indicated on Drawings; if not indicated, as necessary for waterproofing.

10. Align bottom of metal wall panels and fasten with blind rivets, bolts, or self-drilling or self-tapping screws.
11. Provide weatherproof escutcheons for pipe and conduit penetrating exterior walls.

B. Metal Wall Panels: Install metal wall panels on exterior side of girts. Attach metal wall panels to supports with fasteners as recommended by manufacturer.

C. Insulated Metal Wall Panels: Install insulated metal wall panels on exterior side of girts. Attach panels to supports at each panel joint using concealed clip and fasteners at maximum 42 inches o.c., spaced not more than manufacturer's recommendation. Fully engage tongue and groove of adjacent insulated metal wall panels.

1. Install clips to supports with self-tapping fasteners.
2. Apply continuous ribbon of sealant to panel joint on concealed side of insulated metal wall panels as vapor seal; apply sealant to panel joint on exposed side of panels as weather seal.

D. Installation Tolerances: Shim and align metal wall panels within installed tolerance of 1/4 inch in 20 feet, noncumulative; level, plumb, and on location lines; and within 1/8-inchoffset of adjoining faces and of alignment of matching profiles.

3.7 THERMAL INSULATION INSTALLATION

A. General: Install insulation concurrently with metal panel installation, in thickness indicated to cover entire surface, according to manufacturer's written instructions.

1. Set vapor-retarder-faced units with vapor retarder toward warm side of construction unless otherwise indicated. Do not obstruct ventilation spaces except for firestopping.
2. Tape joints and ruptures in vapor retarder, and seal each continuous area of insulation to the surrounding construction to ensure airtight installation.
3. Install factory-laminated, vapor-retarder-faced blankets straight and true in one-piece lengths, with both sets of facing tabs sealed, to provide a complete vapor retarder.
4. Install blankets straight and true in one-piece lengths. Install vapor retarder over insulation, with both sets of facing tabs sealed, to provide a complete vapor retarder.

B. Blanket Roof Insulation: Comply with the following installation method:

1. Over-Framing Installation: Extend insulation and vapor retarder over and perpendicular to top flange of secondary framing. Hold in place by metal roof panels fastened to secondary framing.
2. Between-Purlin Installation: Extend insulation and vapor retarder between purlins. Carry vapor-retarder-facing tabs up and over purlin, overlapping adjoining facing of next insulation course and maintaining continuity of retarder. Hold in place with bands and cross bands below insulation.
3. Over-Purlin-with-Spacer-Block Installation: Extend insulation and vapor retarder over and perpendicular to top flange of secondary framing. Install layer of filler insulation over first layer to fill space formed by metal roof panel standoffs. Hold in place by panels fastened to standoffs.

a. Thermal Spacer Blocks: Where metal roof panels attach directly to purlins, install thermal spacer blocks.

4. Two-Layers-between-Purlin-with-Spacer-Block Installation: Extend insulation and vapor retarder between purlins. Carry vapor-retarder-facing tabs up and over purlin, overlapping adjoining facing of next insulation course and maintaining continuity of retarder. Install layer of filler insulation over first layer to fill space between purlins formed by thermal spacer blocks. Hold in place with bands and crossbands below insulation.

a. Thermal Spacer Blocks: Where metal roof panels attach directly to purlins, install thermal spacer blocks.

5. Retainer Strips: Install retainer strips at each longitudinal insulation joint, straight and taut, nesting with secondary framing to hold insulation in place.

C. Blanket Wall Insulation: Extend insulation and vapor retarder over and perpendicular to top flange of secondary framing. Hold in place by metal wall panels fastened to secondary framing.

1. Retainer Strips: Install retainer strips at each longitudinal insulation joint, straight and taut, nesting with secondary framing to hold insulation in place.
2. Sound-Absorption Insulation: Where sound-absorption requirement is indicated for metal liner panels, cover insulation with polyethylene film and provide inserts of wire mesh to form acoustical spacer grid.

D. Board Wall Insulation: Extend board insulation in thickness indicated to cover entire wall. Hold in place by metal wall panels fastened to secondary framing. Comply with manufacturers' written instructions.

1. Retainer Strips: Install retainer strips at each longitudinal insulation joint, straight and taut, nesting with secondary framing to hold insulation in place.

3.8 DOOR AND FRAME INSTALLATION

A. General: Install doors and frames plumb, rigid, properly aligned, and securely fastened in place according to manufacturers' written instructions. Coordinate installation with wall flashings and other components. Seal perimeter of each door frame with elastomeric sealant used for metal wall panels.

B. Personnel Doors and Frames: Install doors and frames according to NAAMM-HMMA 840. Fit non-fire-rated doors accurately in their respective frames, with the following clearances:

1. Between Doors and Frames at Jambs and Head: 1/8 inch.
2. Between Edges of Pairs of Doors: 1/8 inch.
3. At Door Sills with Threshold: 3/8 inch.
4. At Door Sills without Threshold: 3/4 inch
5. At fire-rated openings, install frames according to, and doors with clearances specified in, NFPA 80.

C. Sliding Service Doors: Bolt support angles to opening head members through factory-punched holes. Bolt door tracks to support angles at maximum 24 inches o.c. Set doors and operating equipment with necessary hardware, jamb and head mold stops, continuous hood flashing, anchors, inserts, hangers, and equipment supports.

D. Door Hardware:

1. Install surface-mounted items after finishes have been completed at heights indicated in DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
2. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
3. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
4. Set thresholds for exterior doors in full bed of sealant complying with requirements for concealed mastics specified in Section 079200 "Joint Sealants."

3.9 ACCESSORY INSTALLATION

A. General: Install accessories with positive anchorage to building and weather tight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal roof panel assembly, including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
2. Install components for a complete metal wall panel assembly, including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
3. Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with corrosion-resistant coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by manufacturer.

B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without excessive oil-canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

C. Gutters: Join sections with riveted-and-soldered or lapped-and-sealed joints. Attach gutters to eave with gutter hangers spaced as required for gutter size, but not more than 36 inches o.c.

using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.

D. Downspouts: Join sections with 1-1/2-inchtelescoping joints. Provide fasteners designed to hold downspouts securely 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c. in between.

1. Provide elbows at base of downspouts to direct water away from building.
2. Tie downspouts to underground drainage system indicated.

E. Circular Roof Ventilators: Set ventilators complete with necessary hardware, anchors, dampers, weather guards, rain caps, and equipment supports. Mount ventilators on flat level base. Install preformed filler strips at base to seal ventilator to metal roof panels.

F. Continuous Roof Ventilators: Set ventilators complete with necessary hardware, anchors, dampers, weather guards, rain caps, and equipment supports. Join sections with splice plates and end-cap skirt assemblies where required to achieve indicated length. Install preformed filler strips at base to seal ventilator to metal roof panels.

G. Louvers: Locate and place louver units level, plumb, and at indicated alignment with adjacent work.

1. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weather tight connection.
2. Provide perimeter reveals and openings of uniform width for sealants and joint fillers.
3. Protect galvanized- and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of corrosion-resistant paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.
4. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weather tight louver joints are required. Comply with Section 079200 "Joint Sealants" for sealants applied during louver installation.

H. Roof Curbs: Install curbs at locations indicated on Drawings. Install flashing around bases where they meet metal roof panels.

I. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to panel as recommended by manufacturer.

3.10 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform field quality control special inspections and to submit reports.

B. Product will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.11 ADJUSTING

A. Doors: After completing installation, test and adjust doors to operate easily, free of warp, twist, or distortion.

B. Door Hardware: Adjust and check each operating item of door hardware and each door to ensure proper operation and function of every unit. Replace units that cannot be adjusted to operate as intended.

3.12 CLEANING AND PROTECTION

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780/A 780M and manufacturer's written instructions.

B. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

C. Touchup Painting: After erection, promptly clean, prepare, and prime or re-prime field connections, rust spots, and abraded surfaces of prime-painted structural framing, bearing plates, and accessories.

1. Clean and prepare surfaces by SSPC-SP 2, "Hand Tool Cleaning," or by SSPC-SP 3, "Power Tool Cleaning."
2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.

D. Touchup Painting: Cleaning and touchup painting are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

E. Metal Panels: Remove temporary protective coverings and strippable films, if any, as metal panels are installed. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

1. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

F. Doors and Frames: Immediately after installation, sand rusted or damaged areas of prime coat until smooth and apply touchup of compatible air-drying primer.

1. Immediately before final inspection, remove protective wrappings from doors and frames.

END OF SECTION 13 34 19

SECTION 21 13 13 – FIRE SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies the minimum requirements for designing, furnishing, installing, inspecting, and testing of all equipment, materials, controls, devices, and appurtenances by a state licensed Fire Protection Installer for a fully automatic single-interlocked preaction (multi-cycle, on/off) fire sprinkler system. This specification applies only to the aboveground part of the system, starting from the existing branch line piping.

1. Existing Viking FireCycle III systems are currently installed and protecting the Control Wing Basement Area. Modification to the fire suppression system protecting the Host Mechanical Room B119, the system protecting the Electronic Equipment Room B120A, and the system protecting the NEOF Area (Rooms B81, B86 and B88) will be required to be coordinated with any impact of architectural, mechanical or electrical changes in those areas. The modification includes removing armovers and drops from branch lines to pendent heads so they can be replaced with sprigs and upright sprinkler heads in the area where a drop ceiling is to be removed and not being reinstalled. Where a dropped ceiling is being installed or re-installed, the system will need to be modified to avoid mechanical and electrical obstructions. The branch piping and sprinklers in the Mezzanine will be demolished. No materials shall be provided that will negate the listing or approval of the FireCycle systems as a whole, in accordance with NFPA 13. Thermal detectors shall be removed and reinstalled as appropriate and additional detectors shall be provided required by the manufacturers' listing.

B. The sprinkler systems shall be designed, installed, and tested in accordance with NFPA 13, International Building Code, and this Section. The sprinkler systems shall be provided with alarm and supervisory devices in accordance with NFPA 13, NFPA 72 and Section 28 31 00 "Fire Detection and Alarm".

C. The sprinkler systems shall be hydraulically designed in accordance with the hazard classifications indicated in NFPA 13, but no less than Ordinary Hazard Group 1.

D. Supports, seismic bracing, and brackets shall be designed and installed in accordance with NFPA 13.

E. Conflicting requirements: In the case of a conflict between this specification, applicable codes, accompanying drawings, and other supplemental specifications, the Contractor shall submit the matter in writing to the Contracting Officers Representative (COR), who will provide written clarification.

F. Electronic alarm initiating equipment shall be provided under this Section. Connection of control panels and thermal detectors shall be performed in accordance with Section 28 31 00 "Fire Detection and Alarm."

1.2 AIR TRAFFIC CONTROL EQUIPMENT RESTRICTIONS

A. Job conditions: Do not permit interference with the air traffic control function at the Air Route Traffic Control Center (ARTCC). Schedule and plan work to permit normal facility operations to continue with a minimum of disruption. Access to the facility shall be kept unobstructed at all times. If interference with the existing facility operations seems to be unavoidable, advise the COR at least ten (10) days prior to such interference. Proceed as directed by the COR.

B. Equipment Shutdown: Each ARTCC maintains air traffic control continuously without shutdown. Various techniques are employed to achieve maximum system availability. Mechanical and electrical systems in direct support of air traffic operation and environmental systems have redundant configurations. Shutdown of equipment shall be scheduled with the COR at least ten (10) days prior to the contractor's need. The reliability of mechanical and electrical systems is compromised when redundant equipment is not available. Every effort will be made by the Government to allow work to be accomplished during the Contractor's normal working hours; however, the COR may require that certain equipment be shut down during off-normal hours and be restored to service immediately after this period. Only government personnel or those specifically appointed by said personnel, shall accomplish shutdown of equipment.

C. Interruptions of the existing fire suppression systems shall be requested in writing to the COR at least five (5) days prior to the Contractor’s needs. The fire suppression systems, or portions thereof, shall only be taken out of service during off-normal hours, for intervals of no more than four (4) hours out of every eight (8) hours. The COR shall be contacted if these criteria can not be met, so alternate protection can be provided.

1.3 RELATED SECTIONS

A. Section 07 84 13, "Penetration Firestopping" for fire resistance rated construction firestopping.

B. Section 09 91 23, “Interior Painting” for painting of fire protection piping.

C. Section 23 05 48, ‘Vibration and Seismic Controls for HVAC Piping and Equipment” for the seismic design criteria to be followed.

D. Section 28 31 00, "Fire Detection and Alarm" for coordinating monitoring equipment of the sprinkler systems and detection devices that relate to this Section.

1.4 REFERENCE STANDARDS

A. General: Unless a specific edition is indicated, the current issues of the following documents, in effect on the date of the invitation for bid, form a part of this specification and are applicable to the extent specified herein. NFPA Appendices shall be considered mandatory for the purposes of this specification. In referenced NFPA publications, the advisory provisions are mandatory, as though the word “shall” had been substituted for “should” wherever it appears.

B. International Code Council

1. International Building Code (IBC) (2015 Edition)

2. International Fire Code (IFC) (2015 Edition)

C. American Society for Testing and Materials (ASTM)

1. A53: Specification for Welded and Seamless Steel Pipe.
2. A153: Specification for Electrical Resistance Welded Steel Pipe.
3. A795: Specification for Black and Hot-Dipped Zinc Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.
4. E119: Standard Test Methods for Fire Tests of Building Construction and Materials.

D. National Fire Protection Association (NFPA)

1. 13: Installation of Sprinkler Systems (2016 Edition).
2. 25: Standard for Inspection, Testing and Maintenance of Water Based Fire Protection Systems (2017 Edition).
3. 51B: Fire Prevention During Welding, Cutting, and Other Hot Work (2014 Edition)
4. 70: National Electrical Code (2017 Edition).
5. 72: National Fire Alarm Code (2016 Edition).

E. American National Standards Institute (ANSI)

1. B31.1: Power Piping.
2. B16.3: Malleable Iron Threaded Fittings.
3. B16.5: Steel Pipe Flanges and Flanged Fittings.
4. B16.9: Factory Made Wrought Steel Buttwelding Fittings.
5. B16.21: Nonmetallic Flat Gaskets for Pipe Flanges.
6. B1.20.1: Pipe Threads, General Purpose.
7. B36.10M: Wrought Steel Pipe.

F. National Electrical Manufacturers Association (NEMA)

1. 250: Enclosures for Electrical Equipment

G. Underwriters Laboratories (UL)

1. Fire Protection Equipment Directory.

H. Factory Mutual (FM)

1. Factory Mutual Approval Guide.

1.5 DEFINITIONS

A. Working plans as used in this Section refer to documents (including drawings and calculations) prepared pursuant to requirements in NFPA 13 for obtaining approval of authority having jurisdiction.

B. Other definitions for fire protection systems are included in referenced NFPA standards.

1.6 SYSTEM DESCRIPTIONS

A. Sprinkler System Protection Limits: Maintain that the ARTCC building is fully sprinklered throughout.

1.7 SYSTEM PERFORMANCE REQUIREMENTS

A. Design and obtain approval from COR for fire protection systems specified.

B. As system piping is modified, perform a hydrant flow test, and hydraulic calculations for each system modification. The fire protection system shall be hydraulically designed to operate within the limitations of the available water supply. Base hydraulic calculations on the results of water flow test with a safety factor of 7 psi. Utilize any area increases required by NFPA 13 during the design of the preaction system modifications.

C. Hydraulically Design Sprinkler Systems per Sprinkler System Occupancy Hazard Classifications:

1. Host Computer Room and Electronic Equipment Room - Ordinary Hazard, Group 1.

D. Minimum Density Requirements for Automatic Sprinkler System Hydraulic Design:
1. Ordinary Hazard, Group 1: 0.15 GPM over 1500 sq. ft. area.

E. Maximum Protection Area of Coverage per Sprinkler shall be in Accordance with the Value indicated in NFPA 13:
1. Ordinary Hazard, Group 1: 130 sq. ft. per sprinkler.

F. Components and Installation: UL listed for the following maximum working pressure ratings except where indicated otherwise.

1. Sprinkler Systems: 175 psig.

1.8 SUBMITTALS

A. Annotated Product Data for Fire Protection System Components:

1. Sprinkler piping and fittings.
2. Specialty valves, accessories, and devices.
3. Thermal detector, detector cable and conduit.
4. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other data.
5. Hangers and seismic bracing.

B. Installer qualification: Submit proof that the installer meets the specified qualifications.

C. Shop Drawings: Submit piping layout, hydraulic calculations, and releasing panel battery calculations for approval. Show dimensions, locations of sprinklers, fittings, hangers, seismic bracing, accessories and other similar items of the system. Show instrumentation and piping schematics. In addition, show thermal detector layout on sprinkler shop drawings including all

thermal detector locations, conduit paths, conduit sizes and quantity of conductors. Drawings shall conform to the requirements of NFPA 13 for Working Plans. Hydraulic calculations shall conform to requirements of NFPA 13 for Hydraulic Calculation Forms. Drawings shall be sealed by a NICET (National Institute for Certification of Engineering Technologies) Level IV suppression systems technician or registered Professional Engineer in Fire Protection. All shop drawings shall be based on the existing facility As-Built drawings. The shop drawings shall be an update of the existing As-Built drawings. Obtain existing As-Built drawings from the COR.

D. Material and Equipment Conformance: Where materials and equipment are specified to conform to requirements of ANSI, ASTM, FM, NFPA or UL, submit proof of such conformance. The label or listing of the specified agency will be acceptable evidence.

E. Welders Certification: Submit welders certification in accordance with ANSI B31.1, Chapter V.

F. Welding Procedures: Submit welding procedures qualified in accordance with ANSI B31.1, Chapter V.

G. Piping Hanger Schedule: Submit schedule showing location and details of pipe supports, including seismic bracing. Submit calculations by a registered Professional Engineering in Structural Engineering as applicable. Utilize seismic requirements in NFPA 13 for design.

H. Documentation of NICET Level IV certification as a sprinkler designer or registration as a registered Professional Engineer in Fire Protection for the design calculations.

I. Test Plan: Provide a detailed testing plan to the COR thirty (30) days prior to any testing. At a minimum the test plan shall include areas and dates of testing and safety precautions required during testing.

J. Test reports and certificates as described in NFPA 13 and Part 3 of this Section. Include "Contractor's Material & Test Certificate for Aboveground Piping".

K. Record Drawings: Contractor shall provide one set of Record Drawings immediately upon completion of sprinkler system installation as part of Operating and Maintenance Manuals, red-lining any field modifications made. Include layout of piping mains and branches, instrumentations, valves, sprinklers, and other components.

1.9 QUALITY ASSURANCE

A. Manufacturer Qualifications: Firms whose equipment, specialties, and accessories are listed by product name and manufacturer in UL Fire Protection Equipment Directory or FM Approval Guide and that conform to other requirements indicated.

B. Listing/Approval Stamp, Label, or Other Marking: On equipment, specialties, and accessories made to specified standards.

C. Sprinkler system design and calculations shall be prepared by a NICET (National Institute for Certification of Engineering Technologies) Level IV technician in Water Based Layout, or a registered Professional Engineer in Fire Protection.

D. Sprinkler piping shall be shop welded per NFPA 13. If this is unavoidable, notify the COR immediately and wait to follow his/her direction with the requirements of NFPA 51B.

E. Listing and Labeling: Equipment, specialties, and accessories that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in "National Electrical Code," Article 100 and NFPA 13.
2. Listing and Labeling Agency Qualifications: “Nationally Recognized Testing Laboratory” (NRTL) as defined in OSHA Regulation 1910.7.

F. Installers Qualifications: Firms qualified to install and alter fire protection piping, equipment, specialties, and accessories, and repair and service equipment. A qualified firm is one that is experienced (minimum of 5 previous projects similar in size and scope to this Project) in such work, familiar with precautions required, and in compliance with the requirements of the authority having jurisdiction. Submit evidence of qualification to the COR upon request.

1.10 OPERATION

A. In non-operational conditions, the system piping shall be air pressurized to the check valve outlet side. Pressurized water from the trim priming line is employed in the top chamber of the flow control valve to maintain a closed clapper. Detection circuits are energized at all times maintaining solenoid valves in the normal position in the trim lines. Should a thermal detector actuate (140° Fahrenheit), the break contact circuit action energizes and alters the solenoid valves in the fire sprinkler system trim lines. This releases the top chamber pressure, the clapper opens, water enters piping from the discharge chamber and the resulting increase in piping system pressure activates the pressure switches for alarm purposes. Once the temperature is sufficient (either 165° or 205° Fahrenheit), sprinklers activate as normal, and water is discharged over the affected area. When the temperature drops sufficiently, the thermal detector resets itself energizing the timer unit. Water continues to flow from the system until all detectors have reset and the set time period (soak timer) is exceeded. At that time, the solenoid valves return to normal condition and the flow control valve clapper is closed as the air pressure builds up, stopping the flow of water. Alarm resetting shall be done manually on the control panel. This cycle shall repeat until such time as the fire condition is eliminated. Loss of air pressure in sprinkler system piping network shall not open the solenoid valve, but shall still initiate a low air supervisory condition at the FACP.

1.11 COORDINATION

A. Coordinate layout and installation of sprinklers with other construction that is installed from the slabs, including light fixtures, HVAC equipment, and partition assemblies.

1.12 EXTRA MATERIALS

A. Materials are existing to remain. Only pipe, sprinkler heads, thermal detectors, conduit and wire shall be needed. Furnish extra materials as needed (i.e. manufacturer recommended spare parts).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers offering products meeting the requirements of this specification and that are listed by UL or approved FM Global shall be used.

2.2 MATERIALS

A. Materials: Materials and equipment shall be new, and shall conform to the types and sizes required by NFPA 13 for uses shown. The sprinkler system shall be listed as a complete assembly in the UL Fire Protection Directory under the classification “Special System Water Control Valve - Flow Cycling Assemblies (VLLA). Other components shall be UL listed or FM approved. Each item shall function for extended periods of time with limited maintenance.

B. Thermal Detectors: Sprinkler system thermal detectors shall be the rate compensating fixed temperature, normally closed, automatic resetting type. Nominal temperature rating shall be per the manufacturer recommendation for the temperature rating of the sprinklers used. The detector shall have an aluminum conduit connection housing, stainless steel heat probe and zinc alloy telltale. Electrical rating shall be 125 VAC, 4 amps.

1. Only Known Acceptable Source: Viking Model B. Set point temperature 140° Fahrenheit.

C. Thermal Detector Cable: 2-hour CI, High temperature, flame resistant detector cable shall be a UL listed Power Limited Fire Protection Signaling Cable and shall be installed in conduit. Conductor shall be two (2) 16 AWG solid bare soft copper. Insulation shall be silicon rubber and jacket shall be thermoplastic with zero halogen for use in rigid steel conduit.

1. Known Acceptable Source: Viking Detector PLFA-FPL Cable.

D. Sprinklers:

1. Sprinkler shall be upright or concealed pendent type for the specific application. Pendent sprinklers shall be piped using return bend arrangement. Where conditions require, temperature ratings shall be increased to intermediate or high levels as indicated in NFPA 13.
2. Sprinklers shall be quick response fusible link type with a temperature rating of 165° degrees F for the areas with finished drop ceiling and 205° F for the areas with no dropped ceiling. Sprinklers shall 1/2 inch NPT standard thread connection, brass construction, and nominal K-factor 5.6. Sprinklers in areas without ceilings to be natural finish.

a. Known Acceptable Source: Viking Quick Response Fusible Element Upright and Pendent Sprinklers models F1 and G4 (VK301 and VK303).

3. Spare sprinklers and sprinkler wrenches shall be provided as required by NFPA 13 for each type of sprinkler installed. A storage cabinet for spare sprinklers and wrenches shall be provided at each riser, if they differ at all from what is currently provided.

E. Sprinkler guards: Sprinklers below 7 ft above finish floor level or subject to the possibility of physical damage, shall be provided with listed or approved sprinkler guards.

2.3 PIPE AND FITTINGS

A. Above ground system pipe shall be black steel and shall also be used in portions of the system that are "wet" standard weight, schedule 40. Pipe 2 inches and smaller shall be threaded to ANSI B1.20.1. Pipe 2 1/2 inches and larger may be joined with mechanical grooved couplings, or flanged in accordance with ANSI B16.5. Main piping may incorporate butt-welded fittings.

B. Fittings shall Conform as Indicated:

1. Threaded fittings: Black malleable iron, Class 150, ANSI B16.3.
2. Grooved couplings and mechanical fittings: Malleable iron, 300 psi working pressure. Coupling gasket material shall be butyl rubber. Grooved couplings and mechanical fittings shall be UL listed or FM approved for the intended use. Provide flexible couplings as required by NFPA 13 for seismic protection of piping. Grooved couplings shall be flush seal type.
3. Flanged fittings: Steel 150-lb. class to B16.5. Cast iron is not acceptable. Gaskets to be red rubber 1/16 inch to ANSI B16.21.
4. Welded fittings: Wrought steel manufactured to ANSI B16.9.
5. Flexible pipe couplings required for Seismic Criteria: Shall permit 1 degree or more of angular movement at the grooved connection without harm to the pipe.

2.4 HANGERS AND SUPPORTS

A. Hangers shall be of ferrous material and shall conform to the requirements of NFPA 13.

B. Support all horizontal piping as outlined in NFPA 13. Provide swivel split ring hangers with rod supports.

C. Support furred-in vertical piping by means of heavy wrought iron clamps on wall bracket or at floors. Where vertical piping is exposed, supports shall be from wrought iron clamps suspended from the underside of the slab with hanger rods.

D. Hangers shall be of a type approved by NFPA and UL, and be approved and acceptable to the COR for use in this type of installation.

E. Seismic bracing and all appurtenances shall be listed by UL and shall be supplied as required by NFPA 13. Submit seismic bracing calculations as necessary.

2.5 PIPE SLEEVES AND PLATES

A. For concrete walls and floors provide ASTM A53, Type E, Grade A, schedule 40 galvanized pipe with plain ends.

B. Pipe sleeves shall be sized in accordance with seismic requirements of NFPA 13.

C. Where sleeves are installed in floors or walls with membranes provide membrane clamp

D. Provide chrome plated brass set screw flanges at finished floors, walls and ceilings.

2.6 SPRINKLER SPECIALTY PIPE FITTINGS

A. Branch Outlet Fittings:

1. Standard: UL 213.
2. Pressure Rating: 175 psig minimum.
3. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
4. Type: Mechanical-T and -cross fittings.
5. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
7. Branch Outlets: Grooved or threaded.

2.7 SPRINKLERS

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating for Automatic Sprinklers: 175 psig minimum.

B. Automatic Sprinklers with Heat-Responsive Element:

1. Nonresidential Applications: UL 199.
2. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

C. Sprinkler types, features, and options as follows:

1. Quick-response sprinklers.
2. Concealed pendent sprinklers with brass finish and white coverplate.
3. Upright sprinklers with brass finish.
4. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler where sprinklers are installed less than 7 feet above finished floor or where subject to mechanical damage.

PART 3 - EXECUTION

3.1 GENERAL

A. All parts of the fire sprinkler system shall be installed so that the systems may be thoroughly drained and in accordance with commercial practices and the equipment manufacturers

recommendations. Auxiliary drains at the end of branch lines are not allowed. Piping shall be sloped so that the system drains at the main drain, or the existing auxiliary drains/inspectors test connection. Piping shall be sloped per NFPA 13 requirements for preaction systems. Exception for heated areas does not apply. Branch lines shall be pitched at least ½ inch per 10 feet and mains shall be pitched at least ¼ inch per 10 feet. If it is determined that auxiliary drains are required, they shall be piped back to a location approved by the COR. Piping shall be sloped per NFPA 13 requirements for dry pipe systems. Exception for heated areas does not apply.

B. Install seismic restraints on piping as required by code. Comply with requirements for seismic-restraint device materials and installation in NFPA 13.

C. Install work in such a manner that it will conform to the structure, avoid obstructions, preserve headroom, and keep openings and passageways clear.

D. Fire protection work shall in all cases, consider the work of other trades so that the best arrangement of equipment, piping, and conduit will be obtained.

E. Cutting, channeling, chasing, or drilling of floor, walls, partitions, ceilings or other surfaces, if necessary for the proper installation, support, or anchorage of the piping or other work, shall be done to prevent damage to the existing structure. Damage to building, piping, or equipment shall be repaired or refinished.

F. Pipe used shall be free of corrosion and be clean. Cut pipe ends shall be burred to a smooth finish. No damaged pipe is to be installed. Grooved pipe shall be cut grooved and not rolled. Pipe welding shall be carried out at the shop. When approved, welding shall conform to requirements of NFPA 51B. The piping system shall be thoroughly flushed clean upon completion of installation. Auxiliary drains at the end of branch lines are not allowed unless approved by the COR.

3.2 PIPE INSTALLATION

A. Piping shall be protected from damage in accordance with NFPA 13 requirements. Metal pipe supports, hangers, clamps, brackets, bracing and other pipe support accessories for sprinkler system piping shall meet the requirements of NFPA 13, and shall be suitable for forces imposed by system pressures, thermal expansion and contraction, and other external forces.

B. Fire sprinkler system piping shall be installed to the slope requirements stipulated for preaction systems in NFPA 13, as listed in Part 3.1.A. Installation of all materials and equipment shall be in accordance with NFPA 13, this specification, and as indicated.

C. Care shall be taken when installing piping to avoid possible restrictions due to foreign matter. All piping shall be installed so that the system may be drained and flushed in accordance with NFPA 13.

D. For penetrations of concrete floors or walls sleeves shall be provided. Wall sleeves shall be cut flush with wall surfaces, and shall project 3 inches above and below floor surfaces. Sleeves may be galvanized steel or cast iron pipe, or galvanized sheet metal with longitudinal locking seam. The clearance between sprinkler piping and pipe sleeves through walls and floors shall be not less than that allowed by NFPA 13 for protection of piping against damage from earthquakes. Comply with the requirements of NFPA 13 for sleeve diameter sizes as related to pipe diameter.

E. UL listed through-penetration firestop systems: Provide at sprinkler pipe penetrations through fire and smoke resistance rated floors and walls in accordance with requirements of Section 07 84 13 “Penetration Firestopping”.

3.3 SPRINKLERS

A. Sprinklers shall be located to obtain the specified density and area coverage requirements for the area hazard classification. Sprinklers shall be installed only in the position for which they are designed. Sprinklers shall not be altered in any respect or have any type of ornamentation or coatings applied after shipment from the manufacturer. Sprinklers installed where they might receive mechanical damage shall be protected with listed or approved guards. Install quick response sprinklers only.

3.4 TEST AND DRAIN CONNECTIONS

A. Test connections shall be provided and installed on sprinkler systems in accordance with NFPA 13 requirements for preaction systems. The test connection valve shall be readily accessible. Provisions shall be made for piping the drain connection to the exterior or approved receptors. Splash blocks shall be provided at all drain exit locations discharging outside the building.

3.5 THERMAL DETECTORS

A. Thermal detectors: Thermal detectors and thermal detector wiring shall be installed in accordance with manufacturer recommendations and NFPA 72 requirements. Support detectors from building structure. Provide pipe nipples (12 inches long), couplings, escutcheons, and appurtenances for each detector. Thermal detectors shall be located to cover an area no greater than recommended by the manufacturer for the detector furnished.

B. Coverage by a detector shall not exceed a maximum area of 1600 sq. ft. for smooth, flat ceilings (40 ft. by 40 ft.) that are 10 feet high or less above finished floor (such as a raised floor). Provide coverage as indicated on the drawings. Spacing shall be reduced in areas where required by the manufacturer and by NFPA 72 based on ceiling height being greater than 10 feet. Coordinate detector locations with baffles, grilles, diffusers, registers, light fixtures, and other equipment. Install thermal detector wiring in conduit. The minimum size conduit, for detector wiring only, shall be 1/2 inch. All other conduit shall be a minimum of 3/4 inch. Detectors shall be installed within 12 inches and 18 inches of a sprinkler head unless small room exception is met per manufacturer guidelines and as required by NFPA 72.

3.6 WIRING

A. Wiring: Wiring shall be installed in accordance with NFPA 72 for Class A circuits as provided in Section 28 31 00 “Fire Detection and Alarm” and the manufacturers’ recommendations. Wire all thermal detectors in series, T-Tapping and splicing are not allowed. Viking porcelain wire nuts are the only acceptable means of connecting wires. All wiring shall be installed in conduit.

3.7 PAINTING

A. Painting of piping is specified in Section 09 91 23, “Interior Painting.” Sprinklers shall be covered with plastic sandwich-type bags to ensure that no sprinklers are painted. Bags shall be removed after painting. All exposed piping shall be painted red, piping concealed above finished ceilings and in chases shall be have a 2-inch red stripe painted every twenty feet and on each side of wall where a wall is penetrated.

3.8 TESTING

A. General:

1. Tests shall be static compressed air test, and the system shall be made tight such that no loss of pressure occurs during a 24-hour period when the system is pressurized at 40 psi gauge.
2. Following the air test, the piping shall be hydrostatically tested at the greater of 200 psi or the system pressure plus 50 psi for a period of not less than 2 hours.
3. Comply with the requirements of NFPA 13, and test the system at only the working pressure if the new portions of the systems cannot be isolated from the existing systems.
4. All material and equipment furnished and work done will be continuously inspected by the COR. Any material, equipment, or work approved and later found to be defective shall be replaced by the Contractor at his own expense. The Contractor shall ask for approval only after his own inspection and after he is satisfied that he has met all specified requirements.
5. All tests shall be conducted as required by and in accordance with NFPA 13 requirements.
6. All tests shall be performed in the presence of the COR. Test date shall occur not sooner than seven (7) days after approval of test procedure by the Government. Test procedure review period required by the Government shall be not less than thirty (30) days. Test date scheduling shall not be submitted until test procedures have been approved.
7. Perform sprinkler system tests per manufacturers test procedures.

B. Complete system acceptance tests, including all detectors and cycling of both systems, are required.

C. Testing Equipment: Equipment, material, and labor for the tests shall be provided by the Contractor. If tests, or portion thereof, fail, the Contractor shall undertake repairs immediately and retest to the satisfaction of the COR.

D. Piping System Acceptance Test

1. The Sprinkler system piping shall be compressed air tested and hydrostatically tested. The pressure shall be measured at the low point of each system or zone being tested.
2. A thorough visual inspection of the installed system and hazard area shall be performed. The piping, operational equipment and sprinklers shall be inspected for proper size, supports, and location.
3. Upon completion of the work and tests, secure approval from the COR.

E. Electrical system acceptance test:

1. Verify proper operation of the automatic sprinkler system control system including valves, pressure switches, indicator lights, backup power supply, thermal detectors, alarm detection circuits, solenoid releasing control panels and alarm outputs to the Fire Alarm Control Panel (FACP) per manufacturer's written test procedures, related specifications, and NFPA requirements.

3.9 CLEANING

A. Clean dirt and debris from sprinklers. Replace sprinklers having paint other than factory finish with new sprinklers. Cleaning and reuse of painted sprinklers is prohibited.

3.10 COMMISSIONING

A. Starting Procedures: Follow manufacturer's written procedures.

B. Coordinate with fire alarm system tests. Operate systems as required.

3.11 WARRANTY

A. Include a service and parts guarantee of the system for a minimum period of one year and provide any services and equipment incidental to the proper performance of the system under warranty at no additional cost to the Government. Warranty service shall be available twenty-four (24) hours, seven (7) days a week. Response to warranty requests shall be verbally responded to within one hour and on site response within four (4) hours.

3.12 FIRE WATCH

A. Contractor shall provide a fire watch program in accordance with NFPA 51B, utilizing facility-familiar and trained personnel who have knowledge of the inherent hot-work hazards ongoing during construction and who shall have portable fire extinguishing equipment ready at all times. The fire watch shall ensure that conditions are maintained safe during all operations whilst the fire suppression system is non-functional and shall stop any unsafe practice. During a cease work called by the fire watch, the watchman shall determine whether the best first action is to either extinguish the fire or sound the building fire alarm and perform the action immediately.

END OF SECTION 21 13 13

SECTION 22 05 00 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Dielectric fittings.
3. Escutcheons.
4. Equipment installation requirements common to equipment sections.
5. Painting and finishing.
6. Supports and anchorages.

1.2 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces, above drop ceilings, below raised access floors, attics and crawl spaces containing mechanical equipment that require access/maintenance, and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop and cooling tower yard locations and within unheated shelters in areas exposed to building occupant contact.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above inaccessible hard ceilings and within inaccessible chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:

1. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.3 SUBMITTALS

A. Product Data: For the following:

1. Dielectric fittings.
2. Escutcheons.

B. Welding certificates.

1.4 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.6 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Known Acceptable Source: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 22 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

1. Known Acceptable Source:

a. Capitol Manufacturing Co.
b. Central Plastics Company.
c. Eclipse, Inc.
d. Epco Sales, Inc.
e. Hart Industries, International, Inc.
f. Watts Industries, Inc.; Water Products Div.
g. Zurn Industries, Inc.; Wilkins Div.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

1. Known Acceptable Source:

a. Capitol Manufacturing Co.
b. Central Plastics Company.
c. Epco Sales, Inc.
d. Watts Industries, Inc.; Water Products Div.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Known Acceptable Source:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Central Plastics Company.
d. Pipeline Seal and Insulator, Inc.

2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

1. Known Acceptable Source:

a. Calpico, Inc.
b. Lochinvar Corp.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain or threaded ends; and 300-psig minimum working pressure at 225 deg F.

1. Known Acceptable Source:

a. Perfection Corp.
b. Precision Plumbing Products, Inc.
c. Sioux Chief Manufacturing Co., Inc.

2.5 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.

1. Finish: Polished chrome-plated.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.

1. Finish: Polished chrome-plated.

E. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chrome-plated finish.

G. One-Piece, Floor-Plate Type: Cast-iron floor plate.

H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
c. Insulated Piping: One-piece, stamped-steel type with spring clips.
d. Bare Piping: One-piece, cast-brass type with polished chrome-plated finish.

M. Sleeves are not required for core-drilled holes.

N. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

O. Verify final equipment locations for roughing-in.

P. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.3 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.5 PAINTING

A. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.

B. Field Welding: Comply with AWS D1.1.

END OF SECTION 22 05 00

SECTION 22 05 17 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.
3. Grout.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral water stop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Carbon steel.
3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Non shrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:

   a. Piping Smaller Than NPS 6: Cast-iron wall sleeves.
   b. Piping NPS 6 and Larger: Cast-iron wall sleeves.

2. Exterior Concrete Walls below Grade:

   a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system.

      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

   b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system.

      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:

   a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system.

      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

   b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system.

      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade:

   a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
   b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.

5. Interior Partitions:

a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 22 05 17

SECTION 22 05 19 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Thermometers.
2. Gages.
3. Test plugs.

B. Related Sections:

1. Section 22 11 16 "Domestic Water Piping" for domestic and fire-protection water service meters inside the building.

1.2 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated; include performance curves.

B. Shop Drawings: Schedule for thermometers and gages indicating manufacturer's number, scale range, and location for each.

PART 2 - PRODUCTS

2.1 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS

A. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Palmer - Wahl Instruments Inc.
2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.
4. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Case: Die-cast aluminum, 7 inches long.

C. Tube: Red or blue reading, mercury or organic-liquid filled, with magnifying lens.

D. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.

E. Window: Plastic.

F. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.

G. Stem: Copper-plated steel, aluminum, or brass for thermowell installation and of length to suit installation.

H. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.2 THERMOWELLS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Palmer - Wahl Instruments Inc.
2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.
4. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Known Acceptable Source: Same as manufacturer of thermometer being used.

C. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

2.3 PRESSURE GAGES

A. Known Acceptable Source:

1. AMETEK, Inc.; U.S. Gauge Div.
2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
3. Ernst Gage Co.
4. Eugene Ernst Products Co.
5. KOBOLD Instruments, Inc.
6. Marsh Bellofram.
7. Miljoco Corp.
8. Noshok, Inc.
9. REO TEMP Instrument Corporation.
10. Trerice, H. O. Co.

B. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.

1. Case: Liquid filled type, drawn steel or cast aluminum, 4-1/2-inch diameter.
2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
6. Pointer: Red metal.
7. Window: Plastic.
8. Ring: Metal.
9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.
10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.
11. Range for Fluids under Pressure: Two times operating pressure.

C. Pressure-Gage Fittings:

1. Valves: NPS 1/4 brass or stainless-steel needle type.
2. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.4 TEST PLUGS

A. Known Acceptable Source:

1. Peterson Equipment Co., Inc.
2. Sisco Manufacturing Co.
3. Trerice, H. O. Co.
4. Watts Industries, Inc.; Water Products Div.

B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

C. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

D. Core Inserts: One or two self-sealing rubber valves.

1. Insert material for water service at 20 to 200 deg F shall be CR.
2. Insert material for water service at minus 30 to plus 275 deg F shall be EPDM.

E. Test Kit: Furnish one test kit(s) containing one pressure gage and adaptor, one thermometer(s), and carrying case. Pressure gage, adapter probes, and thermometer sensing elements shall be of diameter to fit test plugs and of length to project into piping.

1. Pressure Gage: Small bourdon-tube insertion type with 2- to 3-inch- diameter dial and probe. Dial range shall be 0 to 200 psig.
2. Low-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial ranges shall be 25 to 125 deg F.
3. High-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial ranges shall be 0 to 220 deg F.
4. Carrying case shall have formed instrument padding.

PART 3 - EXECUTION

3.1 THERMOMETER APPLICATIONS

A. Install liquid-in-glass thermometers in the outlet of each domestic, hot-water storage tank.

B. Provide the following temperature ranges for thermometers:

1. Domestic Hot Water: 30 to 180 deg F, with 2-degree scale divisions.
2. Domestic Cold Water: 0 to 100 deg F, with 2-degree scale divisions.

3.2 GAGE APPLICATIONS

A. Install dry-case-type pressure gages for discharge of each pressure-reducing valve.

B. Install dry-case-type pressure gages at suction and discharge of each pump.

3.3 INSTALLATIONS

A. Install direct-mounting thermometers and adjust vertical and tilted positions.

B. Install remote-mounting dial thermometers on panel, with tubing connecting panel and thermometer bulb supported to prevent kinks. Use minimum tubing length.

C. Install thermowells with socket extending a minimum of 2 inches into fluid and in vertical position in piping tees where thermometers are indicated.

D. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.

E. Install needle-valve and snubber fitting in piping for each pressure gage.

F. Install test plugs in tees in piping.

G. Install permanent indicators on walls or brackets in accessible and readable positions.

H. Install connection fittings for attachment to portable indicators in accessible locations.

I. Install thermometers and gages adjacent to machines and equipment to allow service and maintenance for thermometers, gages, machines, and equipment.

J. Adjust faces of thermometers and gages to proper angle for best visibility.

END OF SECTION 22 05 19

SECTION 22 05 23 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bronze ball valves.
2. Iron swing check valves.

B. Related Sections:

1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
2. Section 22 05 53 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
3. Division 22 and 23 water distribution piping Sections for general-duty and specialty valves for site construction piping.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

G. SWP: Steam working pressure.

1.3 SUBMITTALS

A. Product Data: For each type of valve indicated.

1.4 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 for valve materials for potable-water service.

D. Special FAA requirements: Lockout/Tagout (LO/TO) per FAA Order 3900.19B

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces and weld ends.
3. Set ball valves open to minimize exposure of functional surfaces.
4. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:

1. Handwheel: For valves other than quarter-turn types.
2. Handlever: For quarter-turn valves NPS 6 and smaller except plug valves.
3. Wrench: For plug valves with square heads. Furnish FAA with 1 wrench for every 5 plug valves, for each size square plug-valve head.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Solder Joint: With sockets according to ASME B16.18.
3. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Brass Ball Valves with Stainless-Steel Trim:

1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Hammond Valve.
d. Jamesbury; a subsidiary of Metso Automation.
e. Milwaukee Valve Company.

2. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Forged brass.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

2.3 BRONZE SWING CHECK VALVES

A. Class 150, Bronze Swing Check Valves with Bronze Disc:

1. Known Acceptable Source:

a. American Valve, Inc.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Crane Co.; Crane Valve Group; Stockham Division.
e. Kitz Corporation.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Red-White Valve Corporation.

i. Zy-Tech Global Industries, Inc.

2. Description:

a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 300 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Lift Check Valves: With stem upright and plumb.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball valves.
2. Pump-Discharge Check Valves:

a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
b. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: One piece, regular port, bronze with bronze trim.
3. Bronze Swing Check Valves: Class 150, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron Ball Valves: Class 150.

END OF SECTION 22 05 23

SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following hangers and supports for plumbing system piping and equipment:

1. Steel pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.

B. Related Sections include the following:

1. Section 05 50 00 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

1.2 DEFINITIONS

A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry Inc.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Steel pipe hangers and supports.
2. Thermal-hanger shield inserts.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers. Include Product Data for components.
2. Metal framing systems. Include Product Data for components.
3. Pipe stands. Include Product Data for components.

C. Welding certificates.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Known Acceptable Source: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.
2. Grinnell Corp.
3. Tolco Inc.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.
2. Power-Strut Div.; Tyco International, Ltd.
3. Tolco Inc.
4. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.5 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Manufacturers:

1. Carpenter & Paterson, Inc.
2. ERICO/Michigan Hanger Co.
3. PHS Industries, Inc.
4. Pipe Shields, Inc.

C. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with vapor barrier.

D. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass.

E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

G. Insert Length: Extend 2 inches beyond sheet metal shield.

2.6 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers:

a. B-Line Systems, Inc.; a division of Cooper Industries.
b. Hilti, Inc.
c. ITW Ramset/Red Head.

2.7 PIPE STAND FABRICATION

A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support piping.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use padded hangers for piping that is subject to scratching.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
7. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
2. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
3. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
4. C-Clamps (MSS Type 23): For structural shapes.
5. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
6. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
7. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
8. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
9. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
10. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

11. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
12. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
13. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
2. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.

3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.2 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb.

F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

H. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

I. Install lateral bracing with pipe hangers and supports to prevent swaying.

J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

K. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.

M. Insulated Piping: Comply with the following:

1. Attach clamps and spacers to piping.

   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

   a. Thermal-hanger shield inserts shall be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Shield Dimensions for Pipe: Not less than the following:

   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.

4. Insert Material: Length at least 2” longer than protective shield.
5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 22 05 29

SECTION 22 05 33 - HEAT TRACING FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes plumbing piping heat tracing for freeze prevention with the following electric heating cables:

1. Plastic insulated, series resistance.

B. Section includes heat tracing for freeze prevention with the following piping systems:

1. Outdoor temporary condenser water system pipes and pumps, temporary makeup water, temporary drain and overflow.

2. Outdoor permanent condenser water piping and valves.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For electric heating cable.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PLASTIC-INSULATED, SERIES-RESISTANCE HEATING CABLES

A. Known Acceptable Source:

1. Delta-Therm Corporation.
2. Pyrotenax; a brand of Tyco Thermal Controls LLC.
3. Raychem; a brand of Tyco Thermal Controls LLC.
4. Watts Radiant, Inc.; a subsidiary of Watts Water Technologies, Inc.

B. Comply with IEEE 515.1.

C. Heating Element: Single- or dual-stranded resistor wire. Terminate with waterproof, factory-assembled, nonheating leads with connectors at both ends.

D. Electrical Insulating Jacket: Minimum 4.0-mil Kapton with silicone, Tefzel, or polyolefin.

E. Cable Cover: Aluminum braid and silicone or Hylar outer jacket.

F. Maximum Operating Temperature (Power On): 300 deg F.

G. Maximum Exposure Temperature (Power Off): 185 deg F.

H. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

I. Capacities and Characteristics:

1. Maximum Heat Output: 6 W/ft

2.2 CONTROLS

A. Pipe-Mounted Thermostats for Freeze Protection:

1. Remote bulb unit with adjustable temperature range from 30 to 50 deg F.
2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.
3. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.
4. Corrosion-resistant, waterproof control enclosure.
5. Provide relay with contacts to indicate operational status, on or off, for interface with central HVAC control-system workstation.

2.3 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Warning Labels: Refer to Section 22 05 53 "Identification for Plumbing Piping and Equipment."

C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install electric heating cable across expansion, construction, and control joints according to manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.

B. Electric Heating-Cable Installation for Freeze Protection for Piping:

1. Install electric heating cables after piping has been tested and before insulation is installed.
2. Install electric heating cables according to IEEE 515.1.
3. Install insulation over piping with electric cables according to Section 22 07 19 "Plumbing Piping Insulation" and 23 07 19 “HVAC equipment and piping insulation.”
4. Install warning tape on piping insulation where piping is equipped with electric heating cables.

C. Set field-adjustable switches and circuit-breaker trip ranges.

D. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
2. Test cables for electrical continuity and insulation integrity before energizing.
3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

B. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

C. Cables will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

E. Remove and replace damaged heat-tracing cables.

END OF SECTION 22 05 33

SECTION 22 05 48 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Resilient pipe guides.
3. Elastomeric hangers.
4. Snubbers.
5. Restraint channel bracings.
6. Seismic-restraint accessories.
7. Mechanical anchor bolts.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Delegated-Design Submittal: For each vibration isolation and seismic-restraint device.

1. Include design calculations and details for selecting vibration isolators and seismic restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer.

B. Welding certificates.

C. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or

preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are unavailable, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:

1. Site Class as Defined in the IBC: D.

2. Seismic Design Category: C

2.2 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads:

1. Known Acceptable Source:

a. Ace Mountings Co., Inc.
b. California Dynamics Corporation.
c. Isolation Technology, Inc.
d. Kinetics Noise Control, Inc.
e. Mason Industries, Inc.
f. Vibration Eliminator Co., Inc.
g. Vibration Isolation.
h. Vibration Mountings & Controls, Inc.

2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
3. Size: Factory or field cut to match requirements of supported equipment.
4. Pad Material: Oil and water resistant with elastomeric properties.
5. Surface Pattern: Smooth pattern.
6. Infused nonwoven cotton or synthetic fibers.
7. Load-bearing metal plates adhered to pads.

2.3 RESILIENT PIPE GUIDES

A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch- thick neoprene.

1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.4 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:

1. Known Acceptable Source:

   a. Ace Mountings Co., Inc.
   b. California Dynamics Corporation.
   c. Isolation Technology, Inc.
   d. Kinetics Noise Control, Inc.
   e. Mason Industries, Inc.
   f. Vibration Eliminator Co., Inc.
   g. Vibration Mountings & Controls, Inc

2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
3. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.5 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:

1. Known Acceptable Source:

   a. Ace Mountings Co., Inc.
   b. California Dynamics Corporation.
   c. Kinetics Noise Control, Inc.
   d. Mason Industries, Inc.
   e. Vibration Eliminator Co., Inc.
   f. Vibration Isolation.
   g. Vibration Mountings & Controls, Inc.

2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.

5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
9. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.6 SNUBBERS

A. Known Acceptable Source:

1. Kinetics Noise Control, Inc.
2. Mason Industries, Inc.
3. Vibration Mountings & Controls, Inc.

B. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
3. Maximum 1/4-inch air gap, and minimum 1/4-inch- thick resilient cushion.

2.7 RESTRAINT CHANNEL BRACINGS

A. Known Acceptable Source:

1. Cooper B-Line, Inc.
2. Hilti, Inc.
3. Mason Industries, Inc.
4. Unistrut.

B. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.8 RESTRAINT CABLES

A. Known Acceptable Source:

1. Kinetics Noise Control, Inc.
2. Loos & Co., Inc.
3. Vibration Mountings & Controls, Inc.

B. Restraint Cables: ASTM A 603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

2.9 SEISMIC-RESTRAINT ACCESSORIES

A. Known Acceptable Source:

1. Cooper B-Line, Inc.
2. Kinetics Noise Control, Inc.
3. Mason Industries, Inc.
4. TOLCO.

B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.

C. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

D. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

E. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by OSHPD.

B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits.

3.2 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Installation of vibration isolators must not cause any change of position of equipment or piping, resulting in stresses or misalignment.

B. Equipment Restraints:

1. Install seismic snubbers on plumbing equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
3. Install seismic-restraint devices using methods approved by OSHPD that provides required submittals for component.

C. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
3. Brace a change of direction longer than 12 feet.

D. Install cables so they do not bend across edges of adjacent equipment or building structure.

E. Install seismic-restraint devices using methods approved by OSHPD that provides required submittals for component.

F. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

G. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

H. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

I. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.

5. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.3 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Section 22 11 16 "Domestic Water Piping" for piping flexible connections.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

END OF SECTION 22 05 48

SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Stencils.
5. Valve tags.
6. Warning tags.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

C. Valve numbering scheme.

D. Valve Schedules: For each piping system to include in maintenance manuals.

1.3 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel rivets.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: Black.
3. Background Color: White.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: Yellow.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater

viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

2.4 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.

1. Stencil Material: Fiberboard or metal.
2. Stencil Paint: Exterior, gloss, black unless otherwise indicated. Paint may be in pressurized spray-can form.
3. Identification Paint: Exterior, in colors according to ASME A13.1 unless otherwise indicated.

2.5 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches minimum.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Section 09 91 23 "Interior Painting."

B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, on each piping system.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

C. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings.

D. Pipe Label Color Schedule:

1. Domestic Water Piping:

   a. Background Color: Yellow.
   b. Letter Color: Blue.

2. Sanitary Waste and Storm Drainage Piping:

   a. Background Color: Yellow.
   b. Letter Color: Blue.

3.4 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

   a. Cold Water: 1-1/2 inches, round.
   b. Hot Water: 1-1/2 inches, round.

2. Valve-Tag Color:

   a. Cold Water: Natural.
   b. Hot Water: Natural.

3. Letter Color:

   a. Cold Water: Black.
   b. Hot Water: Black.

3.5 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 22 05 53

SECTION 22 07 19 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following plumbing piping services:

1. Domestic cold and hot-water piping.
2. Sanitary waste piping exposed to freezing conditions.

B. Related Sections:

1. Section 23 07 13 “HVAC Insulation.”

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

B. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Mineral-Fiber, Preformed Pipe Insulation:

1. Known Acceptable Source:

a. Johns Manville; Micro-Lok.
b. Knauf Insulation; 1000 Pipe Insulation.
c. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Insulco, Division of MFS, Inc.; Triple I.
b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.

B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Insulco, Division of MFS, Inc.; Triple I.
    b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. PVC Jacket Adhesive: Compatible with PVC jacket.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.

3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
4. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: 60 percent by volume and 66 percent by weight.
4. Color: White.

2.5 SEALANTS

A. Joint Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 100 to plus 300 deg F.
4. Color: White or gray.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."Materials in first paragraph below are for sealing metal jacket seams and joints.

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Adhesive: As recommended by jacket material manufacturer.
2. Color: White.
3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

    a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
    b. Compac Corp.; 104 and 105.
    c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
    d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
8. Tensile Strength: 40 lbf/inch in width.
9. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
    b. Compac Corp.; 130.
    c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
    d. Venture Tape; 1506 CW NS.

2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.

6. Tensile Strength: 18 lbf/inch in width.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Width: 2 inches.
2. Thickness: 3.7 mils.
3. Adhesion: 100 ounces force/inch in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch in width.

2.9 SECUREMENTS

A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

C. Wire: 0.080-inch nickel-copper alloy soft-annealed, stainless steel 0.062-inch soft-annealed, galvanized steel.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

    a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Cleanouts.

3.3 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

3.4 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.5 INSTALLATION OF MINERAL-FIBER PREFORMED PIPE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.

2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.6 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.7 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect pipe, fittings, strainers, and valves, randomly selected by COR, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.9 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold: Insulation shall be the following:

1. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

B. Sanitary Waste Piping Where Heat Tracing Is Installed: Mineral-fiber, preformed pipe insulation, Type I, 1-1/2 inches thick.

3.10 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. Piping, Concealed:

1. None.

C. Piping, Exposed:

1. PVC, Color-Coded by System: 20 mils thick.

3.11 OUTDOOR, PIPING INSULATION SCHEDULE

A. Domestic Cold With Heat Tracing Installed: Insulation shall be the following:

1. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

B. Sanitary Waste Piping Where Heat Tracing Is Installed: Mineral-fiber, preformed pipe insulation, Type I, 1-1/2 inches thick.

3.12 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. Permanent Piping, Concealed:

1. None.

C. Permanent Piping, Exposed:

1. PVC, Color-Coded by System: 20 mils thick.

D. Temporary Piping, Concealed:

1. None.

E. Temporary Piping, Exposed:

1. PVC, Color-Coded by System: 20 mils thick.

END OF SECTION 22 07 19

SECTION 22 11 16 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Piping materials
   2. Flexible connectors.
   3. Escutcheons.

1.2 SUBMITTALS

A. Product Data: For the following products:

   1. Dielectric fittings.
   2. Escutcheons.

B. Field quality-control reports.

1.3 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 61 for potable domestic water piping and components.

1.4 PROJECT CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by FAA or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

   1. Notify COR no fewer than fifteen (15) calendar days in advance of proposed interruption of water service.
   2. Do not proceed with interruption of water service without COR’s written permission.

1.5 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.

1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.3 METAL PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.4 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

B. Dielectric Unions:

1. Known Acceptable Source:

a. Capitol Manufacturing Company.
b. Central Plastics Company.
c. EPCO Sales, Inc.
d. Hart Industries International, Inc.
e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
f. Zurn Plumbing Products Group; Wilkins Water Control Products.

2. Description:

a. Pressure Rating: 150 psig at 180 deg F.
b. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Known Acceptable Source:

a. Capitol Manufacturing Company.
b. Central Plastics Company.
c. EPCO Sales, Inc.
d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Factory-fabricated, bolted, companion-flange assembly.
b. Pressure Rating: 150 psig.
c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Kits:

1. Known Acceptable Source:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Central Plastics Company.
d. Pipeline Seal and Insulator, Inc.

2. Description:

a. Nonconducting materials for field assembly of companion flanges.
b. Pressure Rating: 150 psig.
c. Gasket: Neoprene or phenolic.
d. Bolt Sleeves: Phenolic or polyethylene.
e. Washers: Phenolic with steel backing washers.

E. Dielectric Couplings:

1. Known Acceptable Source:

a. Calpico, Inc.
b. Lochinvar Corporation.

2. Description:

a. Galvanized-steel coupling.
b. Pressure Rating: 300 psig at 225 deg F.
c. End Connections: Female threaded.
d. Lining: Inert and noncorrosive, thermoplastic.

F. Dielectric Nipples:

1. Known Acceptable Source:

a. Perfection Corporation; a subsidiary of American Meter Company.
b. Precision Plumbing Products, Inc.
c. Victaulic Company.

2. Description:

a. Electroplated steel nipple complying with ASTM F 1545.
b. Pressure Rating: 300 psig at 225 deg F.
c. End Connections: Male threaded or grooved.
d. Lining: Inert and noncorrosive, propylene.

2.5 ESCUTCHEONS

A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.

B. One Piece, Cast Brass: Polished, chrome-plated finish with setscrews.

C. One Piece, Deep Pattern: Deep-drawn, box-shaped brass with chrome-plated finish.

D. One Piece, Stamped Steel: Chrome-plated finish with setscrew or spring clips.

E. Split Casting, Cast Brass: Polished, chrome-plated finish with concealed hinge and setscrew.

F. Split Plate, Stamped Steel: Chrome-plated finish with concealed hinge,.

G. One-Piece Floor Plates: Cast-iron flange.

H. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 METAL PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install shutoff valve immediately upstream of each dielectric fitting.

C. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.

D. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

G. Install piping adjacent to equipment and specialties to allow service and maintenance.

H. Install piping to permit valve servicing.

I. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.

J. Install piping free of sags and bends.

K. Install fittings for changes in direction and branch connections.

L. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

M. Install pressure gages on suction and discharge piping from each plumbing pump. Comply with requirements in Section 22 05 19 "Meters and Gages for Plumbing Piping" for pressure gages.

N. Install thermostats in hot-water circulation piping.

O. Install thermometers on outlet piping from each water heater. Comply with requirements in Section 22 05 19 "Meters and Gages for Plumbing Piping" for thermometers.

3.2 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

E. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.3 VALVE INSTALLATION

A. General-Duty Valves: Comply with requirements in Section 22 05 23 "General-Duty Valves for Plumbing Piping" for valve installations.

B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball valves for piping NPS 2 and smaller.

C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Section 22 11 16 "Domestic Water Piping Specialties."

1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.

3.4 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.

1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet If Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support vertical piping and tubing at base and at each floor.

C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.

E. Install supports for vertical copper tubing every 10 feet.

F. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
2. NPS 1-1/2: 108 inches with 3/8-inch rod.
3. NPS 2: 10 feet with 3/8-inch rod.
4. NPS 2-1/2: 11 feet with 1/2-inch rod.
5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.

G. Install supports for vertical steel piping every 15 feet.

H. CONNECTIONS

I. Drawings indicate general arrangement of piping, fittings, and specialties.

J. Install piping adjacent to equipment and machines to allow service and maintenance.

K. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

L. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 plumbing fixture Sections for connection sizes.
2. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.6 ESCUTCHEON INSTALLATION

A. Install escutcheons for penetrations of walls, ceilings, and floors.

B. Escutcheons for New Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
4. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish.
5. Bare Piping in Equipment Rooms: One piece, cast brass.
6. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

3.7 SLEEVE INSTALLATION

A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.

B. Sleeves are not required for core-drilled holes.

C. Permanent sleeves are not required for holes formed by removable PE sleeves.

D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.

E. Install sleeves in new partitions, slabs, and walls as they are built.

F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Section 07 92 00 "Joint Sealants" for joint sealants.

G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Section 07 92 00 "Joint Sealants" for joint sealants.

H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals specified in this Section.

I. Seal space outside of sleeves in concrete slabs and walls with grout.

J. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.

K. Install sleeve materials according to the following applications:

1. Sleeves for Piping Passing through Concrete Floor Slabs: Steel pipe.
2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Steel pipe.

    a. Extend sleeves 2 inches above finished floor level.
    b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to

extend sleeve to 2 inches above finished floor level. Comply with requirements in Section 07 62 00 "Sheet Metal Flashing and Trim" for flashing.

3. Sleeves for Piping Passing through Gypsum-Board Partitions:

   a. Galvanized steel for pipes smaller than NPS 6.
   b. Exception: Sleeves are not required for water supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.

4. Sleeves for Piping Passing through Concrete Roof Slabs: Steel.
5. Sleeves for Piping Passing through Exterior Concrete Walls:

   a. Steel pipe sleeves for pipes smaller than NPS 6.
   b. Install sleeves that are large enough to provide 1-inch annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.
   c. Do not use sleeves when wall penetration systems are used.

6. Sleeves for Piping Passing through Interior Concrete Walls:

   a. Steel pipe Insert type sleeves for pipes smaller than NPS 6.

L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Section 07 84 13 " Penetration Firestopping" for firestop materials and installations.

3.8 IDENTIFICATION

A. Identify system components. Comply with requirements in Section 22 05 53 "Identification for Plumbing Piping and Equipment" for identification materials and installation.

B. Label pressure piping with system operating pressure.

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Piping Inspections:

1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

   a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

C. Piping Tests:

1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and for corrective action required.

D. Domestic water piping will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.10 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

    a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
    b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Fill and isolate system according to either of the following:

        1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
        2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

    c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
    d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

B. Clean non-potable domestic water and industrial water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:

    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.12 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Aboveground domestic water and industrial water piping, NPS 2-1/2 to NPS 4, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L; cast- or wrought- copper solder-joint fittings; and soldered joints.

E. Aboveground domestic water and industrial piping, NPS 2 and smaller, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L; cast- or wrought- copper solder-joint fittings; and soldered joints.

3.13 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use ball valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
2. Drain Duty: Hose-end drain valves.

END OF SECTION 22 11 16

SECTION 22 11 19 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following domestic water piping specialties:

1. Backflow preventers.
2. Strainers.
3. Water pressure-reducing valves.
4. Drain valves.
5. Balancing valves
6. Water-hammer arresters.

B. Related Sections include the following:

1. Section 22 05 19 "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
2. Section 22 11 16 "Domestic Water Piping" for water meters.

1.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. NSF Compliance:

1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.1 BACKFLOW PREVENTERS

A. Intermediate Atmospheric-Vent Backflow Preventers:

1. Known Acceptable Source:

   a. Cash Acme.
   b. Conbraco Industries, Inc.
   c. FEBCO; SPX Valves & Controls.
   d. Honeywell Water Controls.
   e. Legend Valve.
   f. Watts Industries, Inc.; Water Products Div.
   g. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1012.
3. Operation: Continuous-pressure applications.
4. Size: NPS 1/2 or NPS 3/4.
5. Body: Bronze.
6. End Connections: Solder joint.
7. Finish: Rough bronze.

B. Beverage-Dispensing-Equipment Backflow Preventers
1. Standard: ASSE 1022.
2. Operation: Continuous-pressure applications.
3. Size: NPS 1/4 or NPS 3/8.
4. Body: Stainless steel.
5. End Connections: Threaded.

C. Dual-Check-Valve Backflow Preventers:
1. Standard: ASSE 1024.
2. Operation: Continuous-pressure applications.
3. Size: NPS 1/2.
4. Body: Bronze with union inlet.

2.2 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.

4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:

    a. Strainers NPS 2 and Smaller: 0.020 inch.
    b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
    c. Strainers NPS 5 and Larger: 0.10 inch.

6. Drain: Factory-installed, hose-end drain valve.

2.3 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Gate-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-80 for gate valves.
2. Pressure Rating: Class 125.
3. Size: NPS 3/4.
4. Body: ASTM B 62 bronze.
5. Inlet: NPS 3/4 threaded or solder joint.
6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.4 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:

1. Known Acceptable Source:

    a. Cash Acme.
    b. Conbraco Industries, Inc.
    c. FEBCO; SPX Valves & Controls.
    d. Honeywell Water Controls.
    e. Watts Industries, Inc.; Water Products Div.
    f. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig (1035 kPa).
4. Size: 1 NPS and 2 NPS.

5. Design Flow Rate: 25 gpm and 80 gpm respectively.
6. Design Inlet Pressure: 65 psig.
7. Design Outlet Pressure Setting: 55 psig.
8. Body: Bronze with chrome-plated finish for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3.
9. Valves for Booster Heater Water Supply: Include integral bypass.
10. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

B. Water-Control Valves:

1. Known Acceptable Source:

    a. CLA-VAL Automatic Control.
    b. Flomatic Corporation.
    c. OCV Control Valves.
    d. Watts; a Watts Water Technologies Company.
    e. Zurn Industries, LLC.

2. Description: Pilot-operated, diaphragm-type, single-seated, main water-control valve.
3. Pressure Rating: Initial working pressure of 150 psig minimum with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot-control valve, restrictor device, specialty fittings, and sensor piping.
4. Main Valve Body: Cast- or ductile-iron body with AWWA C550 or FDA-approved, interior epoxy coating; or stainless-steel body.

    a. Size: 1 NPS and 2 NPS.
    b. Pattern: Globe-valve design.
    c. Trim: Stainless steel.

5. Design Flow: 25 gpm and 80 gpm.
6. Design Inlet Pressure: 65 psig.
7. Design Outlet Pressure Setting: 55 psig.
8. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.

2.5 BALANCING VALVES

A. Memory-Stop Balancing Valves:
1. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 2 or smaller.
4. Body: Copper alloy.
5. Port: Standard or full port.
6. Ball: Chrome-plated brass.
7. Seats and Seals: Replaceable.
8. End Connections: Solder joint or threaded.
9. Handle: Vinyl-covered steel with memory-setting device.

2.6 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters WHA:
1. Standard: ASSE 1010 or PDI-WH 201.
2. Type: Copper tube with piston.
3. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
3. Do not install bypass piping around backflow preventers.

B. Install water control valves with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.

C. Install Y-pattern strainers for water on supply side of each control valve, water pressure-reducing valve, solenoid valve, and pump.

D. Install balancing valves in locations where they can easily be adjusted.

E. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.

F. Install water-hammer arresters in water piping according to PDI-WH 201.

3.2 ACCESS PANELS

A. Install access panels in toilet rooms for shut-off valves, water hammer arrestors and other plumbing specialties located inside chases, behind walls or above inaccessible ceilings.

B. Locate access panels in location behind plumbing fixtures out of eye level view.

C. Locate access panels below counter top sinks.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.

B. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.4 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Intermediate atmospheric-vent backflow preventers.
2. Double-check backflow-prevention assemblies.
3. Temperature-actuated, water mixing valves.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:

1. Test each pressure vacuum breaker reduced-pressure-principle backflow preventer double-check backflow-prevention assembly according to authorities having jurisdiction and the device's reference standard.

B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.6 ADJUSTING

A. Set field-adjustable flow set points of balancing valves.

B. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION 22 11 19

SECTION 22 45 00 - EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
   1. Domestic Plumbing

1.2 SUMMARY

A. Section Includes:

   1. Emergency shower and eyewash Unit.
   2. Supplemental equipment.
   3. Water-tempering equipment.

1.3 DEFINITIONS

A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.

C. Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid-solution supply.

D. Tepid: Moderately warm.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.

B. Shop Drawings: Diagram power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Product Certificates: Submit certificates of performance testing specified in "Source Quality Control" Article.

B. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For emergency plumbing fixtures to include in operation and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.8 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."

C. ANSI Standard: Comply with Z358.1 Tepid Water Requirements.

D. NSF Standard: Comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects," for fixture materials that will be in contact with potable water.

E. Regulatory Requirements: Comply with requirements in ICC/ANSI A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

PART 2 - PRODUCTS

2.1 EMERGENCY SHOWERS AND EYEWASH UNIT WITH DUST COVER

A. Freestanding, Plumbed Emergency Showers and Eyewash with Dust Cover Combination Unit: Basis of Design is Bradley S19-310DC, however any manufacturer meeting the requirements of the specifications are acceptable:
   1. Emergency Drench Shower component:
      a. Capacity: Not less than 20 gpm for at least 15 minutes.
      b. Supply Piping: NPS 1-1/4 stainless steel with flow regulator and stay-open control valve.
      c. Control-Valve Actuator: Pull rod.
      d. Shower Head: Manufacturers standard size capable of providing capacity requirement, chrome-plated brass, stainless steel, or plastic.
      e. Mounting: Pedestal.

      a. Capacity: Not less than 0.4 gpm for at least 15 minutes.
      b. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
      c. Control-Valve Actuator: Highly visible stainless steel push handle.
      d. Spray-Head Assembly: Two receptor-mounted spray heads.

e. Eyewash Bowl and Hinged Dust Cover: 10 ¾ inch Chrome-plated brass or stainless-steel bowl.
f. Drain Piping: NPS 1-1/4 minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2. Include galvanized-steel indirect connection to drainage system.
g. Mounting: Bracket on Pedestal.
h. Special Construction: Comply with ICC/ANSI A117.1.
i. Meet American National Standard ANSI/ISEA Z358.1-2014

2.2 EMERGENCY WATER-TEMPERING EQUIPMENT

A. Outdoor Water-Tempering Equipment:
1. Known Acceptable Sources: Subject to compliance with requirements, provide products by one of the following:
a. Bradley Corporation
b. Encon Safety Products
c. Haws Corporation
d. Hubbell Water Heaters
e. Hughes North America Inc.-BASIS OF DESIGN
f. ThermOmega Tech, Inc.
2. Description: Factory-fabricated intended for outdoor use with thermostatic mixing valve. Packaged outdoor water heater system designed to meet the requirements of ANSI Z358.1 2009 for tepid water delivery as an emergency drench system.
a. Water Heater: Electric Water Heater with 120 gallon capacity:
1) Vertical carbon steel tank. Heater shall not require any type of anodic protection.
2) Heater traced and fully insulated with polyurethane foam to minimize stand-by heat loss.
3) Outer protective casting shall be a dent resistant composite jacket to resist rust, corrosion and weather protect equipment. The unit shall be labelled to identify with high visible signage to BS EN ISO 7010-ANSI Z358.1 2014.
4) Tank inlet water connection shall be a minimum of male 1-1/4” NPT SS.
b. Thermostatic Mixing Valve: Designed to provide 85 deg F, tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F throughout required 15 minute test period, and in case of unit electrical failure to continue water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.
c. Temperature Safety System: Shall consist of a valve actuator to ensure a continuous delivery of tepid water. The valve shall monitor pressure on both cold and hot water inlets. On loss of cold water pressure the valve shall prevent delivery of hot water to avoid scalding. On loss of hot water pressure, the valve shall allow the full ANSI required flow of cold water to the emergency safety fixture.
d. Supply Connections: For cold water.
e. Water pressure drop across the system must not exceed 5 psi at 20 GPM flow, mixing valve must have a Cv rating not less than 10.0.
f. Controls: The system shall be supplied complete with all electrical operating controls. Safety devices and accessories shall include but not be limited to:
1) 3kW immersion temperature controller.
2) Adjustable immersion temperature controller

3) Safety high limit switch with manual reset.
4) Dial temperature and pressure gauge
5) ASME temperature and pressure relief valve
6) Automatic air vent valve.
7) Lighted Sign Box: Incorporating “Emergency Shower” and “Eye Wash” signs. Automatic air vent valve.

2.3 SOURCE QUALITY CONTROL

A. Certify performance of emergency plumbing fixtures by independent testing organization acceptable to authorities having jurisdiction.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EMERGENCY PLUMBING FIXTURE INSTALLATION

A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.

B. Install fixtures level and plumb.

C. Fasten fixtures to substrate.

D. Install shutoff valves in water-supply piping to fixtures. Use ball or gate valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Comply with requirements for valves specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."

1. Exception: Omit shutoff valve on supply to group of plumbing fixtures that includes emergency equipment.
2. Exception: Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.

E. Install shutoff valve and strainer in steam piping and shutoff valve in condensate return piping. Comply with requirements for steam and condensate piping specified in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Piping Specialties."

F. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals. Comply with requirements for dielectric fittings specified in Section 221116 "Domestic Water Piping."

G. Install thermometers in supply and outlet piping connections to water-tempering equipment. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."

H. Install trap and waste piping on drain outlet of emergency equipment receptors that are indicated to be directly connected to drainage system. Comply with requirements for waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."

I. Install indirect waste piping on drain outlet of emergency equipment receptors that are indicated to be indirectly connected to drainage system. Comply with requirements for waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."

J. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 CONNECTIONS TO EXISTING PLUMBING

A. Connect cold-water-supply piping to plumbed emergency plumbing fixtures not having water-tempering equipment. Comply with requirements for cold-water piping specified in Section 221116 "Domestic Water Piping."

B. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary waste and vent piping. Comply with requirements for waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."

C. Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to sanitary waste or storm drainage piping.

D. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

3.4 IDENTIFICATION

A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment. Comply with requirements for identification materials specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Emergency plumbing fixtures and water-tempering equipment will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust or replace fixture flow regulators for proper flow.

B. Adjust equipment temperature settings.

END OF SECTION 224500

SECTION 224713 - DRINKING FOUNTAINS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes drinking fountains and related components.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of drinking fountain.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include operating characteristics, and furnished specialties and accessories.
3. Documentation that the Drinking Fountain complies with the lead free definition in the safe drinking Act of 1986 and Lead Contamination Control Act of 1988

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For drinking fountains to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 DRINKING FOUNTAINS

A. Manufacturer: Basis of Design is Elkay Manufacturing Company product EZS8WS(VR), EZH2O Bottle Filling Station with Single EZ Cooler. Other manufacturers meeting the specifications herein are also acceptable which may include:
1. Halsey Manufacturing Company
2. Haws Corporation
3. Oasis International
4. Stern Williams Company, Inc.

B. Drinking Fountains: Stainless Steel ADA/wheelchair accessible wall mounted.

1. Standards: Comply with ICC A117.1 and NSF/ANSI 61 Annex G.

2. Bottle filler stainless steel with ABS plastic alcove

a. Fill Rate 1.1 gpm

3. Receptor/Bubbler:

a. Number: One
b. Material: Flexi-Guard Safety Bubbler pliable polyester elastomer.

4. Chilling Capacity 8.0 GPH.
5. Controls: Push bar or Push button.
6. Access to Internal Components: Per Manufacturer.
7. Supply Piping: NPS 3/8 minimum with shutoff valve.
8. Drain Piping: NPS 1-1/4 minimum trap and waste.
9. Drinking Fountain Mounting Height**:** ADA/Handicapped/elderly according to ICC A117.1.

2.2 SUPPORTS

A. Type I Water Cooler Carrier:
1. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.

B. Examine walls and floors for suitable conditions where fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fixtures level and plumb according to roughing-in drawings.

B. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.

C. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball or gate valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."

D. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

E. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

F. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Install ball or gate shutoff valve on water supply to each fixture. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."

D. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

3.5 CLEANING

A. After installing fixtures, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

C. Provide protective covering for installed fixtures.

D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224713

SECTION 23 05 00 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Dielectric fittings.
4. Mechanical sleeve seals.
5. Sleeves.
6. Grout.
7. Mechanical Demolition.
8. Equipment installation requirements common to equipment sections.
9. Painting and finishing.
10. Concrete bases.
11. Supports and anchorages.

1.2 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces, above drop ceilings, below raised access floors, attics and crawl spaces containing mechanical equipment that require access/maintenance, and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop and cooling tower yard locations and within unheated shelters in areas exposed to building occupant contact.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above inaccessible hard ceilings and within inaccessible chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:

1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. PE: Polyethylene plastic.
4. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.3 SUBMITTALS

A. Product Data: For the following:

1. Transition fittings.
2. Dielectric fittings.
3. Mechanical sleeve seals.

B. Welding certificates.

1.4 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 , "Building Services Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

1.6 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces.

D. Coordinate installation, startup, testing and balancing of equipment with commissioning work. Refer to Section 01 91 13, “General Commissioning Requirements.”

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Known Acceptable Source: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Divisions 23 Piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Divisions 23 Piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

G. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.4 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

1. Known Acceptable Source:

a. Cascade Waterworks Mfg. Co.
b. Dresser Industries, Inc.; DMD Div.
c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
d. JCM Industries.
e. Smith-Blair, Inc.
f. Viking Johnson.

2. Underground Piping (NPS 2) and Larger: AWWA C219, metal sleeve-type coupling.
3. Aboveground Pressure Piping: Pipe fitting.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

1. Known Acceptable Source:

a. Capitol Manufacturing Co.
b. Central Plastics Company.
c. Eclipse, Inc.
d. Epco Sales, Inc.
e. Hart Industries, International, Inc.
f. Watts Industries, Inc.; Water Products Div.
g. Zurn Industries, Inc.; Wilkins Div.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

1. Known Acceptable Source:

a. Capitol Manufacturing Co.
b. Central Plastics Company.
c. Epco Sales, Inc.
d. Watts Industries, Inc.; Water Products Div.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Known Acceptable Source:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Central Plastics Company.
d. Pipeline Seal and Insulator, Inc.

2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

1. Known Acceptable Source:

a. Calpico, Inc.
b. Lochinvar Corp.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

1. Known Acceptable Source:

a. Perfection Corp.
b. Precision Plumbing Products, Inc.
c. Sioux Chief Manufacturing Co., Inc.
d. Victaulic Co. of America.

2.6 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Known Acceptable Source:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.
d. Linkseal, a division of Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Stainless steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

2.8 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 MECHANICAL DEMOLITION

A. Refer to Division 1 Sections "Cutting and Patching" and "Selective Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove mechanical systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material. Piping located below concrete floor slabs on grade shall be filled with concrete slurry.
3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
5. Equipment to Be Removed: Disconnect and cap services and remove equipment, including bases, hangers, supports, etc.
6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

B. Be aware that the space beneath the access floor will be used as an air delivery plenum and as such the installer shall take the necessary precautions when installing work so as not to impact the integrity of the plenum space specific to air leakage and cleanliness. Any penetrations or holes in the underfloor plenum created for or resulting from the work performed under this division shall be properly sealed to prevent air leakage.

C. Be aware that the sound control within this facility is required and as such the installer shall take the necessary precautions when installing work so as not to impact the integrity of sound rated partitions around critical spaces, fan rooms, mechanical rooms and boiler rooms. Any penetrations or holes in floors or partitions created for or resulting from the work performed under this division shall be properly sealed with acoustical joint sealant (or fire rated ceiling where the partition is also fire rated) to prevent the transfer of noise. Refer to Section 07 92 00 “Joint Sealants.”

D. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Install piping to permit valve servicing.

H. Install piping at indicated slopes.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Install piping to allow application of insulation.

L. Select system components with pressure rating equal to or greater than system operating pressure.

M. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
c. Insulated Piping: One-piece, stamped-steel type with spring clips.

d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type and set screw.
h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed hinge and set screw or spring clips.
j. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw or spring clips.
l. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

N. Sleeves are not required for core-drilled holes.

O. Permanent sleeves are not required for holes formed by removable PE sleeves.

P. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

Q. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.

1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Section 07 92 00 "Joint Sealants" for materials and installation.

R. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

S. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

T. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

U. Verify final equipment locations for roughing-in.

V. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.6 PAINTING

A. Painting of HVAC systems, equipment, and components is specified in Section 09 91 23 "Interior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.7 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions.

1. Construct concrete bases of sizes indicated, but not less than 6 inches larger in both directions than supported unit. Height of concrete base shall be as indicated on plans. Where no height is indicated, base shall be 4 inches high.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement.

3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Section 05 50 00 "Metal Fabrications."

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.9 GROUTING

A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION 23 05 00

SECTION 23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.

B. Comply with NEMA MG 1 unless otherwise indicated.

C. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 5400 feet above sea level.

B. Derating: Motors shall be design/rated to account for altitude at site elevation of 5400 feet above sea level without reducing effective service factor to 1.0 and/or reducing ambient temperature.

C. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

H. Temperature Rise: Match insulation rating.

I. Insulation: Class H.

J. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Premium-Efficient, Inverter-Duty Motors: TEFC, Class F temperature rise; Class H insulation.
3. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
4. Shaft Static Ground Ring: Aegis SGR or approved equal.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 23 05 13

SECTION 23 05 19 - METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Thermometers.
2. Gages.
3. Test plugs.
4. Flowmeters.

1.2 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated; include performance curves.

B. Shop Drawings: Schedule for thermometers gages and flowmeters indicating manufacturer's number, scale range, and location for each.

C. Product Certificates: For each type of thermometer gage and flowmeter, signed by product manufacturer.

D. Operation and Maintenance Data: For Thermometer and gages to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS

A. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Palmer - Wahl Instruments Inc.
2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.
4. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Case: Die-cast aluminum or brass, 7 inches long.

C. Tube: Red or blue reading, organic-liquid filled, with magnifying lens.

D. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.

E. Window: Glass.

F. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.

G. Stem: Copper-plated steel, aluminum, or brass for thermowell installation and of length to suit installation.

H. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.2 THERMOWELLS

A. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
2. Palmer - Wahl Instruments Inc.
3. Trerice, H. O. Co.
4. Weiss Instruments, Inc.
5. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Manufacturers: Same as manufacturer of thermometer being used.

C. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

2.3 PRESSURE GAGES

A. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
2. Palmer - Wahl Instruments Inc.
3. Trerice, H. O. Co.
4. Weiss Instruments, Inc.
5. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.

1. Case: Liquid type, drawn steel or cast aluminum, 4-1/2-inch diameter.
2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
6. Pointer: Red or other dark-color metal.
7. Window: Glass.
8. Ring: Metal.
9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.
10. Range for Fluids under Pressure: Two times operating pressure.

C. Pressure-Gage Fittings:

1. Valves: NPS 1/4 brass or stainless-steel needle type.
2. Syphons: NPS 1/4 coil of brass tubing with threaded ends.
3. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.4 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Peterson Equipment Co., Inc.
2. Sisco Manufacturing Co.
3. Trerice, H. O. Co.
4. Watts Industries, Inc.; Water Products Div.

B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

C. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

D. Core Inserts: One or two self-sealing rubber valves.

1. Insert material for air, water, oil, or gas service at 20 to 200 deg F shall be CR.
2. Insert material for air or water service at minus 30 to plus 275 deg F shall be EPDM.

E. Test Kit: Furnish one test kit(s) containing one pressure gage and adaptor, two thermometer(s), and carrying case. Pressure gage, adapter probes, and thermometer sensing elements shall be of diameter to fit test plugs and of length to project into piping.

1. Pressure Gage: Small bourdon-tube insertion type with 2- to 3-inch- diameter dial and probe. Dial range shall be 0 to 200 psig.
2. Low-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial ranges shall be 25 to 125 deg F.
3. High-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial ranges shall be 20 to 220 deg F.
4. Carrying case shall have formed instrument padding.

PART 3 - EXECUTION

3.1 THERMOMETER APPLICATIONS

A. Install liquid-in-glass thermometers in the following locations:
   1. Inlet and outlet of each hydronic chiller.
   2. Inlet and outlet of each hydronic boiler.

B. Install dry -case-type, vapor -actuated dial thermometers at suction and discharge of each pump.

C. Provide the following temperature ranges for thermometers:
   1. Condenser Water: 0 to 160 deg F, with 2-degree scale divisions.
   2. Chilled Water: 0 to 100 deg F, with 2-degree scale divisions.
   3. Hot Water: 0 to 250 deg F, with 2-degree scale divisions

3.2 GAGE APPLICATIONS

A. Install dry-case-type pressure gages for discharge of each pressure-reducing valve.

B. Install dry -case-type pressure gages at chilled- and condenser-water inlets and outlets of chillers.

C. Install dry -case-type pressure gages at hot water inlets and outlets of boilers.

D. Install dry -case-type pressure gages at suction and discharge of each pump.

3.3 INSTALLATIONS

A. Install direct-mounting thermometers and adjust vertical and tilted positions.

B. Install remote-mounting dial thermometers on panel, with tubing connecting panel and thermometer bulb supported to prevent kinks. Use minimum tubing length.

C. Install thermowells with socket extending a minimum of 2 inches into fluid and in vertical position in piping tees where thermometers are indicated.

D. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.

E. Install remote-mounting pressure gages on panel.

F. Install needle-valve and snubber fitting in piping for each pressure gage for fluids (except steam).

G. Install needle-valve and syphon fitting in piping for each pressure gage for steam.

H. Install test plugs in tees in piping.

I. Install flow indicators, in accessible positions for easy viewing, in piping systems.

J. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters as prescribed by manufacturer's written instructions.

K. Install flowmeter elements in accessible positions in piping systems. Flow meter to Power Service Building and in main Chilled Water bypass will require hottap installation.

L. Install flowmeter elements with at least minimum straight lengths of pipe upstream and downstream from element as prescribed by manufacturer's written instructions.

M. Install permanent indicators on walls or brackets in accessible and readable positions.

N. Install connection fittings for attachment to portable indicators in accessible locations.

O. Assemble components and install thermal-energy meters.

P. Mount meters on wall if accessible; if not, provide brackets to support meters.

3.4 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance for meters, gages, machines, and equipment.

B. Connect flowmeter-system elements to meters.

C. Connect flowmeter transmitters to meters.

3.5 ADJUSTING

A. Calibrate meters according to manufacturer's written instructions, after installation.

B. Adjust faces of meters and gages to proper angle for best visibility.

END OF SECTION 23 05 19

SECTION 23 05 23 - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Brass ball valves.
2. Bronze ball valves.
3. Iron ball valves.
4. Iron, single-flange butterfly valves.
5. Bronze swing check valves.
6. Iron swing check valves.
7. Iron, center-guided check valves.
8. Slow closing solenoid valves
9. Chainwheels.

B. Related Sections:

1. Division 23 HVAC piping Sections for specialty valves applicable to those Sections only.
2. Section 23 05 53 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

G. SWP: Steam working pressure.

H. LO/TO: Lockout/Tagout

1.3 SUBMITTALS

A. Product Data: For each type of valve indicated.

1.4 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.9 for building services piping valves.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces and weld ends.
3. Set angle and globe valves closed to prevent rattling.
4. Set ball valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to HVAC valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
2. Handwheel: For valves other than quarter-turn types.
3. Handlever: For quarter-turn valves NPS 6 and smaller.
4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
2. Butterfly Valves: With extended neck.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Solder Joint: With sockets according to ASME B16.18.
3. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE ANGLE VALVES

A. Class 150, Bronze Angle Valves with Bronze Disc:

1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Crane Co.; Crane Valve Group; Stockham Division.
b. Kitz Corporation.

2. Description:

a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 300 psig.
c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
d. Ends: Threaded.
e. Stem and Disc: Bronze.
f. Packing: Asbestos free.
g. Handwheel: Malleable iron, bronze, or aluminum.

2.3 BRASS BALL VALVES

A. Two-Piece, Full-Port, Brass Ball Valves with Stainless-Steel Trim:

1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Hammond Valve.
d. Jamesbury; a subsidiary of Metso Automation.
e. Milwaukee Valve Company.

2. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Forged brass.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

2.4 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Conbraco Industries, Inc.; Apollo Valves.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Hammond Valve.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

2.5 IRON BALL VALVES

A. Class 125, Iron Ball Valves:

1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. American Valve, Inc.
b. Conbraco Industries, Inc.; Apollo Valves.
c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-72.
b. CWP Rating: 200 psig.
c. Body Design: Split body.
d. Body Material: ASTM A 126, gray iron.
e. Ends: Flanged.
f. Seats: PTFE or TFE.
g. Stem: Stainless steel.
h. Ball: Stainless steel.
i. Port: Full.

2.6 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze or Nylon Coated Iron Disc:

1. Known Acceptable Source: Subject to compliance with requirements, available Manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Bray Controls; a division of Bray International.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. DeZurik Water Controls.
e. Hammond Valve.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Tyco Valves & Controls; a unit of Tyco Flow Control.
i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 150 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: EPDM.
f. Stem: One-piece stainless steel.
g. Disc: Aluminum bronze or nylon coated iron.

B. 150 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Aluminum-Bronze or Nylon Coated Iron Disc:

1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Bray Controls; a division of Bray International.
    b. Conbraco Industries, Inc.; Apollo Valves.
    c. Cooper Cameron Valves; a division of Cooper Cameron Corp.
    d. Crane Co.; Crane Valve Group; Jenkins Valves.
    e. Crane Co.; Crane Valve Group; Stockham Division.
    f. DeZurik Water Controls.
    g. Hammond Valve.
    h. Milwaukee Valve Company.
    i. NIBCO INC.
    j. Tyco Valves & Controls; a unit of Tyco Flow Control.
    k. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

    a. Standard: MSS SP-67, Type I.
    b. CWP Rating: 150 psig.
    c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
    d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
    e. Seat: NBR.
    f. Stem: One-piece stainless steel.
    g. Disc: Aluminum bronze or nylon coated iron.

2.7 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

A. Class 125, Iron Swing Check Valves with Lever- and Spring-Closure Control:

1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. NIBCO INC.

2. Description:

    a. Standard: MSS SP-71, Type I.
    b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
    c. NPS 14 to NPS 24, CWP Rating: 150 psig.
    d. Body Design: Clear or full waterway.
    e. Body Material: ASTM A 126, gray iron with bolted bonnet.
    f. Ends: Flanged.
    g. Trim: Bronze.
    h. Gasket: Asbestos free.
    i. Closure Control: Factory-installed, exterior lever and spring.

2.8 IRON, CENTER-GUIDED CHECK VALVES

A. Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:

1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Hammond Valve.
b. Metraflex, Inc.
c. Milwaukee Valve Company.
d. Mueller Steam Specialty; a division of SPX Corporation.
e. NIBCO INC.
f. Spence Strainers International; a division of CIRCOR International.
g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-125.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. NPS 14 to NPS 24, CWP Rating: 150 psig.
d. Body Material: ASTM A 126, gray iron.
e. Style: Compact wafer.
f. Seat: Bronze.

2.9 SOLENOID VALVES (Blow down valves)

A. General service, normally closed UL listed solenoid valve.

1. Body: Brass
2. Seals and Disc: PTFE or NBR
3. Core tube: Stainless Steel
4. Core and Plugnut: Stainless steel
5. Springs: Stainless steel
6. Shading Coil: Copper:
7. Temperature Rating: 32 F to 125 F.
8. Minimum differential pressure: 0 psi
9. Maximum operating pressure: 125 psi
10. Actuator: Watertight with voltage selected to match control system.

2.10 SLOW CLOSING SOLENOID VALVES (Make-up water valves)

A. Pilot operated, normally closed UL listed solenoid valve with snubber to slow down disc closing speed to reduce pressure spikes and water hammer in the piping system.

1. Body: Brass
2. Disc: NBR
3. Seals: PTFE and NBR
4. Core tube: Stainless Steel

5. Core and Plugnut: Stainless steel
6. Springs: Stainless steel
7. Piston: Stainless steel or brass
8. Shading Coil: Copper:
9. Temperature Rating: 32 F to 125 F.
10. Minimum differential pressure: 5 psi
11. Maximum operating pressure: 125 psi
12. Actuator: Watertight with voltage selected to match control system.
13. Known Acceptable Source: Asco series 8221.

2.11 CHAINWHEELS

A. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Babbitt Steam Specialty Co.
2. Roto Hammer Industries.
3. Trumbull Industries.

B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.

1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
2. Attachment: For connection to ball or butterfly valve stems.
3. Sprocket Rim with Chain Guides: Ductile or cast iron Aluminum Bronze, of type and size required for valve.
4. Chain: Hot-dip, galvanized steel , of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for ball butterfly valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.

F. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Center-Guided Check Valves: In horizontal or vertical position, between flanges.
3. Lift Check Valves: With stem upright and plumb.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball or butterfly valves.
2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
3. Pump-Discharge Check Valves:

    a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
    b. NPS 2-1/2 and Larger: Iron, center-guided, metal -seat check valves.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Steel Piping, NPS 2 and Smaller: Threaded ends.
4. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
5. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.5 CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Angle Valves: Class 150, bronze disc.
3. Ball Valves: Two piece, full port, brass or bronze with stainless-steel trim.
4. Bronze Swing Check Valves: Class 150, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron Ball Valves, NPS 2-1/2 to NPS 10: Class 150.
3. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: 200 CWP, EPDM or NBR seat, aluminum-bronze or nylon coated iron disc.
4. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12: Class 125, lever and spring.

3.6 CONDENSER-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Two piece, full port, brass or bronze with stainless-steel trim.
3. Bronze Swing Check Valves: Class 150, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron Ball Valves, NPS 2-1/2 to NPS 10: Class 150.
3. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: 200 CWP, EPDM or NBR seat, aluminum-bronze disc.
4. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12: Class 125, lever and spring.

3.7 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2-1/2 and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Angle Valves: Class 125, bronze disc.
3. Ball Valves: Class 125, two piece, full port, ductile iron or bronze with stainless-steel trim.
4. Bronze Swing Check Valves: Class 125, bronze disc.

B. Pipe NPS 3 and Larger:

1. Iron Valves: May be provided with threaded ends instead of flanged ends.
2. Ball Valves: Class 125, two piece, full port, ductile iron or bronze with stainless-steel trim.
3. Iron, Single-Flange Butterfly Valves, NPS 3 to NPS 12: 200 CWP, EPDM or NBR seat, aluminum-bronze or corrosion resistant steel disc.
4. Iron Swing Check Valves with Closure Control, NPS 3 to NPS 12: Class 125, lever and spring.

END OF SECTION 23 05 23

SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following hangers and supports for HVAC system piping and equipment:

1. Steel pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Equipment supports.

B. Related Sections include the following:

1. Section 05 50 00 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 23 05 48 "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation devices.
3. Section 23 31 13 "Metal Ducts" for duct hangers and supports.

1.2 DEFINITIONS

A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry Inc.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Steel pipe hangers and supports.

2. Thermal-hanger shield inserts.

B. Shop Drawings: Signed and sealed by a qualified Licensed Professional Engineer. Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers. Include Product Data for components.
2. Metal framing systems. Include Product Data for components.
3. Pipe stands. Include Product Data for components.
4. Equipment supports.

C. Welding certificates.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Known Acceptable Source: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Known Acceptable Source:

1. B-Line Systems, Inc.; a division of Cooper Industries.
2. Grinnell Corp.
3. Tolco Inc.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Known Acceptable Source:

1. B-Line Systems, Inc.; a division of Cooper Industries.
2. Power-Strut Div.; Tyco International, Ltd.
3. Tolco Inc.
4. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.5 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Known Acceptable Source:

1. Carpenter & Paterson, Inc.
2. ERICO/Michigan Hanger Co.
3. PHS Industries, Inc.
4. Pipe Shields, Inc.

C. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with vapor barrier.

D. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass.

E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

G. Insert Length: Extend 2 inches beyond sheet metal shield.

2.6 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Known Acceptable Source:

    a. B-Line Systems, Inc.; a division of Cooper Industries.
    b. Hilti, Inc.
    c. ITW Ramset/Red Head.

2.7 PIPE STAND FABRICATION

A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support piping.

2.8 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.9 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use padded hangers for piping that is subject to scratching.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.

4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.
7. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
8. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
9. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
10. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
11. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
12. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

J. Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
2. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.2 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:

1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

H. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

J. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.

L. Insulated Piping: Comply with the following:

1. Attach clamps and spacers to piping.

   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

   a. Thermal inserts: Thermal-hanger shield inserts shall be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Shield Dimensions for Pipe: Not less than the following:

   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
   d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.

4. Insert Material: Length at least 2 inches longer than protective shield.
5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to maximum of 1 inch. Cover ends of support rods and other sharp edges with padding where sharp edges are hazard to operating personnel.

3.6 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 9 painting Sections.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 23 05 29

SECTION 230533 - HEAT TRACING FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes heat tracing for HVAC piping with the following electric heating cables:

1. Plastic insulated, series resistance.
2. Self-regulating, parallel resistance.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

B. Shop Drawings: For electric heating cable.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.

1. Warranty Period: Three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PLASTIC-INSULATED, SERIES-RESISTANCE HEATING CABLES

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Known Acceptable Source: Subject to compliance with the requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

B. Manufacturers:

1. Delt-Therm Corporation.
2. Nuheat Industries LTd.
3. Raychem; Tyco Thermal Controls.

C. Comply with IEEE 515.1.

D. Heating Element: Single- or dual-stranded resistor wire. Terminate with waterproof, factory-assembled, nonheating leads with connectors at both ends.

E. Electrical Insulating Jacket: Minimum 4.0-mil Kapton with silicone, Tefzel, or polyolefin.

F. Cable Cover: Aluminum braid and silicone or Hylar outer jacket.

G. Maximum Operating Temperature (Power On): 150 deg F.

H. Maximum Exposure Temperature (Power Off): 185 deg F.

I. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Manufacturers:

1. Delt-Therm Corporation.
2. Trazor Corp.
3. Raychem; Tyco Thermal Controls.

B.

C. Comply with IEEE 515.1.

D. Heating Element: Pair of parallel No. 16 AWG, tinned, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.

E. Electrical Insulating Jacket: Flame-retardant polyolefin.

F. Cable Cover: Tinned-copper braid and polyolefin outer jacket with ultraviolet inhibitor.

G. Maximum Operating Temperature (Power On): 150 deg F.

H. Maximum Exposure Temperature (Power Off): 185 deg F.

I. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 CONTROLS

A. Remote bulb unit with adjustable temperature range from 30 to 50 deg F.

B. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable, with a soft start capability.

C. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.

D. Corrosion-resistant, waterproof control enclosure.

2.4 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Warning Labels: Refer to Section 230553 "Identification for HVAC Piping and Equipment."

C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install electric heating cable across expansion joints according to manufacturer's written instructions; use slack cable to allow movement without damage to cable.

B. Install electric heating cables after piping has been tested and before insulation is installed.

C. Install electric heating cables according to IEEE 515.1.

D. Install insulation over piping with electric cables according to Section 230719 "HVAC Piping Insulation."

E. Install warning tape on piping insulation where piping is equipped with electric heating cables.

F. Set field-adjustable switches and circuit-breaker trip ranges.

3.3 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.

2. Test cables for electrical continuity and insulation integrity before energizing.
3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

D. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

E. Cables will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.5 PROTECTION

A. Protect installed heating cables, including nonheating leads, from damage during construction.

B. Remove and replace damaged heat-tracing cables.

END OF SECTION 230533

SECTION 23 05 48 - VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Isolation pads.
2. Restrained elastomeric isolation mounts.
3. Restrained spring isolators.
4. Housed spring mounts.
5. Elastomeric hangers.
6. Spring hangers.
7. Spring hangers with vertical-limit stops.
8. Resilient pipe guides.
9. Restraining braces and cables.

1.2 PERFORMANCE REQUIREMENTS

A. Mechanical equipment, piping and ductwork as noted on the equipment schedule or in the specification shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonably uniform deflections

B. Facility is an essential air traffic control facility. Design equipment, equipment bracing, and anchorage per International Building Code (IBC- 2015) and ASCE 7-10. The design shall also be in accordance with ASHRAE Chapter 46, ASHRAE “A Practical Guide to Seismic Restraint,” and SMACNA. The most stringent shall govern. The requirements for seismic protection measures to be applied to mechanical equipment and systems specified herein are in addition to any other items called for in other Sections of the Specifications. Provide seismic bracing for equipment and systems within the project area. Seismic forces shall be calculated by a qualified Licensed Professional Engineer.

C. Rigidly supported piping and ductwork shall be braced in accordance with SMACNA Seismic Restraint Manual. SMACNA requirements are not applicable to equipment or to piping and ductwork that are supported with vibration isolators. SMACNA seismic hazard level will vary depending on the elevation of the duct or pipe. Alternate bracing methods and details may be used as long as the braces and anchorages have design capacities that exceed the forces calculated in accordance with IBC-2015 requirements. Where concrete expansion anchors are used to anchor bracing for ducts or piping, 50 percent of the expansion anchors shall be proof tested in accordance with SMACNA Table 8-2.

D. Seismic data:

ARTCC Location	Site Class	Seismic Design Category (SDC)	SDs (g)	SD1 (g)
ZDV – Longmont, CO Importance Factor = 1.5	D	**C**	0.203	0.095

1.3 SUBMITTALS

A. Product Data: For each product indicated.

B. Delegated-Design Submittal: For vibration isolation and seismic-restraint calculations and details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Welding certificates.

D. Qualification Data: For professional engineer.

E. Field quality-control test reports.

1.4 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Know Acceptable Source:

1. Ace Mountings Co., Inc.

2. Amber/Booth Company, Inc.
3. California Dynamics Corporation.
4. Isolation Technology, Inc.
5. Kinetics Noise Control.
6. Mason Industries.
7. Vibration Eliminator Co., Inc.
8. Vibration Isolation.
9. Vibration Mountings & Controls, Inc.

B. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

1. Resilient Material: Oil- and water-resistant neoprene or natural rubber.

C. Restrained Mounts: All-directional mountings with seismic restraint.

1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

D. Spring Isolators: Freestanding, laterally stable, open-spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

E. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

F. Housed Spring Mounts: Housed spring isolator with integral seismic snubbers.

1. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.
2. Base: Factory drilled for bolting to structure.
3. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch travel up or down before contacting a resilient collar.

G. Elastomeric Hangers: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.

H. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

I. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

J. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch- thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.2 SEISMIC-RESTRAINT DEVICES

A. Known Acceptable Source:

1. Amber/Booth Company, Inc.
2. California Dynamics Corporation.
3. Cooper B-Line, Inc.; a division of Cooper Industries.
4. Hilti, Inc.
5. Kinetics Noise Control.
6. Loos & Co.; Cableware Division.
7. Mason Industries.
8. TOLCO Incorporated; a brand of NIBCO INC.
9. Unistrut; Tyco International, Ltd.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by OSHPD.

1. Structural Safety Factor: Refer to Section 1.3, Performance Requirements.

C. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

D. Restraint Cables: ASTM A 603 galvanized-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections, or reinforcing steel angle clamped to hanger rod.

F. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

G. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

H. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by OSHPD.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.2 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment Restraints:

1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
2. Install seismic-restraint devices using methods approved by OSHPD providing required submittals for component.

B. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
3. Brace a change of direction longer than 12 feet.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install seismic-restraint devices using methods approved by OSHPD providing required submittals for component.

E. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

F. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

G. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.3 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 23 Section "Hydronic Piping" for piping flexible connections.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with the COR before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least fifteen (15) days advanced notice.
3. Obtain CORs approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by COR.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.6 DEMONSTRATION AND TRAINING

A. Demonstration and Training: Provide demonstration and training in accordance with Section 01 79 00 “Demonstration and Training.”

3.7 HVAC VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE SCHEDULE

Equipment Schedule	Vibration Isolation	Seismic Restraint
Air Handling Units – All	Spring Isolators Internal to AHU with minimum static deflection of 1 inch - Provided by AHU Manufacturer	Anchor unit to concrete pad. Cable brace suspended units
Direct Digital Control Panels – All	Not Required	Required
Variable Frequency Drive Panels	Not Required	Required
Piping	For suspended piping, provide spring/neoprene isolators with 1.25 inch static deflection for minimum of 50 feet from vibrating equipment. Top of spring isolator shall be within 3/8” of structure. For floor supported piping, provide spring isolators with 1.0 inch static deflection for minimum of 50 feet from vibrating equipment.	2-1/2” and Larger: Provide seismic restraint for piping in accordance with ASCE-07 and SMACNA requirements.
Ductwork	For suspended ducts, provide spring/neoprene isolators with 1.25 inch static deflection for minimum of 50 feet from vibrating equipment. Top of spring isolator shall be within 3/8 inch of structure.	Provide seismic restraint for ducts in accordance with ASCE-07 and SMACNA requirements.
Fans and Unit heaters	As Specified	Required

Equipment Schedule	Vibration Isolation	Seismic Restraint
Pumps and water filtration systems.	Not Required	Base mounted units shall be anchored to concrete pads.
Cooling Towers	Not Required	Required
Chillers	Required	Required
Boilers	Required	Anchored to concrete pads
Temporary Equipment	Not Required	Required

END OF SECTION 23 05 48

SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Stencils.
5. Valve tags.
6. Warning tags.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

C. Valve numbering scheme.

D. Valve Schedules: For each piping system to include in maintenance manuals.

1.3 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inch Stainless steel, 0.025-inch Aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Red.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

2.4 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.

1. Stencil Material: Fiberboard or metal.
2. Stencil Paint: Exterior, gloss, acrylic enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.

2.5 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch Stainless steel, 0.025-inch Aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches minimum.
2. Fasteners: Reinforced grommet and wire or string.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels with painted, color-coded bands or rectangles, complying with ASME A13.1, on each piping system.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Pipe Label Color Schedule:

1. Chilled-Water Piping:

   a. Background Color: Black.
   b. Letter Color: White.

2. Condenser-Water Piping:

   a. Background Color: Black.
   b. Letter Color: White.

3. Refrigerant Piping:

   a. Background Color: Black.
   b. Letter Color: White.

4. Heating Water Piping:

   a. Background Color: Black.
   b. Letter Color: White.

3.4 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

   a. Chilled Water: 1-1/2 inches, round.
   b. Condenser Water: 1-1/2 inches, round.
   c. Refrigerant: 1-1/2 inches, round.
   d. Hot Water: 1-1/2 inches 2 inches, round.

2. Valve-Tag Color:

a. Chilled Water: Green.
b. Condenser Water: Green.
c. Refrigerant: Natural.
d. Hot Water: Natural.

3. Letter Color:

a. Chilled Water: White.
b. Condenser Water: White.
c. Refrigerant: White.
d. Hot Water: White.

3.5 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 23 05 53

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Balancing Air Systems:

    a. Constant-volume air systems.

2. Balancing Hydronic Piping Systems:

    a. Variable-flow hydronic systems.

3. Balancing Hydronic Cooling Coils:

    a. All Facility Air Handling Units.

4. HVAC equipment quantitative-performance settings.
5. Reporting results of activities and procedures specified in this Section.
6. Coordinate with Commissioning.

1.2 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An entity engaged to perform TAB Work.

F. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

G. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.

H. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.

I. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

J. NC: Noise criteria.

K. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

L. RC: Room criteria.

M. Report Forms: Test data sheets for recording test data in logical order.

N. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

O. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

P. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

Q. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

R. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

S. Test: A procedure to determine quantitative performance of systems or equipment.

T. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.3 SUBMITTALS

A. Qualification Data: Within 45 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 45 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within 90 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

D. Certified TAB reports.

E. Sample report forms.

F. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.4 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC NEBB or TABB.

1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC NEBB or TABB.
2. TAB Technician: Employee of the TAB contractor and who is certified by AABC NEBB or TABB as a TAB technician.

B. TAB Conference: Meet with FAA**,** COR and Commissioning Authority on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items:

a. The Contract Documents examination report.
b. The TAB plan.
c. Coordination and cooperation of trades and subcontractors.
d. Coordination of documentation and communication flow.

C. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard TAB contractor's forms approved by FAA, COR and Commissioning Authority.

E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

1.5 PROJECT CONDITIONS

A. Full FAA Occupancy: FAA will occupy the site and existing building during entire TAB period. Cooperate with FAA during TAB operations to minimize conflicts with FAA's operations.

1.6 COORDINATION

A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

G. Examine test reports specified in individual system and equipment Sections.

H. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

I. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

J. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

K. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

L. Examine system pumps to ensure absence of entrained air in the suction piping.

M. Examine operating safety interlocks and controls on HVAC equipment.

N. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:

1. Permanent electrical-power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" ASHRAE 111 NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" or SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.

1. Comply with requirements in ASHRAE 62.1-2004, Section 7.2.2, "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, install test ports and duct access doors.
2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 23 07 13 "HVAC Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

C. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

D. Verify that motor starters are equipped with properly sized thermal protection.

E. Check dampers for proper position to achieve desired airflow path.

F. Check for airflow blockages.

G. Check condensate drains for proper connections and functioning.

H. Check for proper sealing of air-handling-unit components.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

    a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

2. Measure fan static pressures as follows to determine actual static pressure:
    a. Measure static pressure directly at the fan outlet or through the flexible connection.
    b. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
    c. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

    a. Report the cleanliness status of filters and the time static pressures are measured.

4. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
5. Obtain approval from FAA COR and Commissioning Authority for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.

6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

3.6 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check liquid level in expansion tank.
3. Check makeup water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation.
5. Set differential-pressure relief control valves at the specified differential pressure.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load initially to confirm non-overloading operation during balancing operations. Check final balance motor load. If motor is overloaded, trim pump impeller so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.7 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

B. Check pump-motor load initially to confirm non-overloading operation during balancing operations. Check final balance motor load. If motor is overloaded, trim pump impeller so motor nameplate rating is not exceeded.

C. Balancing of the hydronic system will include a rebalance of the existing facility air handling units chilled water coils. Table 3.7 identifies the existing air handling units throughout the facility that will also require balancing in addition to the new units installed.

3.8 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.

4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.9 PROCEDURES FOR HEAT-TRANSFER COILS

A. Water Coils: Measure the following data for each coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

3.10 PROCEDURES FOR TEMPERATURE MEASUREMENTS

A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.

B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of one eight-hour day, on first floor, to prove correctness of final temperature settings.

C. Measure outside-air, wet- and dry-bulb temperatures.

3.11 TEMPERATURE-CONTROL VERIFICATION

A. Coordinate with commissioning work required to verify temperature control system operation.

3.12 PROCEDURES FOR CHILLERS

A. Coordinate with controls programmer for balanced water flow through each evaporator and condenser to within specified tolerances of indicated flow with all variety of pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:

1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
2. For water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.

3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
4. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
6. Capacity: Calculate in tons of cooling.

3.13 PROCEDURES FOR COOLING TOWERS

A. Shut off makeup water for the duration of the test, and verify that makeup and blowdown systems are fully operational after tests and before leaving the equipment. Perform the following tests and record the results:

1. Measure condenser-water flow to each cell of the cooling tower.
2. Measure entering- and leaving-water temperatures.
3. Measure wet- and dry-bulb temperatures of entering air.
4. Measure wet- and dry-bulb temperatures of leaving air.
5. Adjust water level and feed rate of makeup water system.
6. Measure flow through bypass.

3.14 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: minus 5 to plus 10 percent.
2. Air Outlets and Inlets: minus 5 to plus 10 percent.
3. Heating-Water Flow Rate: minus 5 to plus 10 percent.
4. Cooling-Water Flow Rate: 0 to plus 10 percent.

3.15 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: Prepare monthly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.16 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB contractor.
3. Project name.
4. Project location.
5. FAA's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.

2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Air-Handling Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data: Include the following:

   a. Unit identification.
   b. Location.
   c. Make and type.
   d. Model number and unit size.
   e. Manufacturer's serial number.
   f. Unit arrangement and class.
   g. Discharge arrangement.
   h. Sheave make, size in inches, and bore.
   i. Sheave dimensions, center-to-center, and amount of adjustments in inches.
   j. Number of belts, make, and size.
   k. Number of filters, type, and size.

2. Motor Data:

   a. Make and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches, and bore.
   f. Sheave dimensions, center-to-center, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

   a. Total airflow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan rpm.
   d. Discharge static pressure in inches wg.
   e. Filter static-pressure differential in inches wg.
   f. Preheat coil static-pressure differential in inches wg.
   g. Cooling coil static-pressure differential in inches wg.
   h. Heating coil static-pressure differential in inches wg.
   i. Outside airflow in cfm.
   j. Return airflow in cfm.
   k. Outside-air damper position.
   l. Return-air damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

a. System identification.
b. Location.
c. Coil type.
d. Number of rows.
e. Fin spacing in fins per inch o.c.
f. Make and model number.
g. Face area in sq. ft..
h. Tube size in NPS.
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm.
b. Average face velocity in fpm.
c. Air pressure drop in inches wg.
d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
e. Return-air, wet- and dry-bulb temperatures in deg F.
f. Entering-air, wet- and dry-bulb temperatures in deg F.
g. Leaving-air, wet- and dry-bulb temperatures in deg F.
h. Water flow rate in gpm.
i. Water pressure differential in feet of head or psig.
j. Entering-water temperature in deg F.
k. Leaving-water temperature in deg F.
l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig.
n. Refrigerant suction temperature in deg F.
o. Inlet steam pressure in psig.

G. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

    a. Total airflow rate in cfm.
    b. Total system static pressure in inches wg.
    c. Fan rpm.
    d. Discharge static pressure in inches wg.
    e. Suction static pressure in inches wg.

H. Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

    a. System and air-handling unit number.
    b. Location and zone.
    c. Traverse air temperature in deg F.
    d. Duct static pressure in inches wg.
    e. Duct size in inches.
    f. Duct area in sq. ft.
    g. Indicated airflow rate in cfm.
    h. Indicated velocity in fpm.
    i. Actual airflow rate in cfm.
    j. Actual average velocity in fpm.
    k. Barometric pressure in psig.

I. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

    a. System and air-handling-unit identification.
    b. Location and zone.
    c. Room or riser served.
    d. Coil make and size.
    e. Flowmeter type.

2. Test Data (Indicated and Actual Values):

    a. Air flow rate in cfm.
    b. Entering-water temperature in deg F.
    c. Leaving-water temperature in deg F.
    d. Water pressure drop in feet of head or psig.
    e. Entering-air temperature in deg F.
    f. Leaving-air temperature in deg F.

J. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:

    a. Unit identification.
    b. Location.

c. Service.
d. Make and size.
e. Model number and serial number.
f. Water flow rate in gpm.
g. Water pressure differential in feet of head or psig.
h. Required net positive suction head in feet of head or psig.
i. Pump rpm.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):

a. Static head in feet of head or psig.
b. Pump shutoff pressure in feet of head or psig.
c. Actual impeller size in inches.
d. Full 60Hz flow rate in gpm.
e. Full 60Hz pressure in feet of head or psig.
f. Final discharge pressure in feet of head or psig.
g. Final suction pressure in feet of head or psig.
h. Final total pressure in feet of head or psig.
i. Final water flow rate in gpm.
j. Voltage at each connection.
k. Amperage for each phase.

K. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.17 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:

a. Measure airflow of at least 10 percent of air outlets.
b. Measure water flow of at least 5 percent of terminals.

c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
d. Verify that balancing devices are marked with final balance position.
e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by COR and Commissioning Authority.
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of COR and Commissioning Authority.
3. COR and Commissioning Authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, FAA may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

3.18 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 23 05 93

SECTION 23 07 13 - DUCT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following duct services:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
4. Indoor, exposed exhaust between isolation damper and penetration of building exterior.

B. Related Sections:
1. Section 230719 "HVAC Equipment and Piping Insulation."
2. Section 233113 "Metal Ducts" for duct liners.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
3. Detail application of field-applied jackets.
4. Detail application at linkages of control devices.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type II, 2-inch thick blanket, 1.0 pcf density, 0.31 BTU by inch/hour by square foot by deg F at 75 deg F. mean temperature, with factory-applied aluminum foil and kraft paper laminate (FSK) jacket and self sealing lap. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Known Acceptable Source:

a. CertainTeed Corp.; SoftTouch Duct Wrap, Type 100
b. Johns Manville; Microlite.
c. Knauf Insulation; Friendly Feel Duct Wrap.
d. Manson Insulation Inc.; Alley Wrap.
e. Owens Corning; SOFTR All-Service Duct Wrap.

D. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IB ASTM C 612, Type 1B, 2-inch thick semi-rigid jacketed board, 3.0 pcf density, 0.26 BTU by inch/hour by square foot by deg F. average maximum at 75 deg F. mean temperature with factory applied aluminum foil and kraft paper laminate (FSK) facing. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Known Acceptable Source:

a. CertainTeed Corp.; Commercial Board, Type CB300
b. Fibrex Insulations Inc.; FBX.
c. Johns Manville; 800 Series Spin-Glas.
d. Knauf Insulation; Insulation Board.
e. Manson Insulation Inc.; AK Board.
f. Owens Corning; Fiberglas 700 Series.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Known Acceptable Source:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.

b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Known Acceptable Source:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.

1. Known Acceptable Source:

a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

2.4 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Known Acceptable Source:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
b. Eagle Bridges - Marathon Industries; 405.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
d. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.5 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.6 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

2.7 TAPES

A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Known Acceptable Source:

a. ABI, Ideal Tape Division; 491 AWF FSK.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
c. Compac Corporation; 110 and 111.
d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.8 SECUREMENTS

A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.

1. Known Acceptable Source:

a. ITW Insulation Systems; Gerrard Strapping and Seals.
b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

B. Insulation Pins and Hangers:

1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

2. Known Acceptable Source:

1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
2) GEMCO; Perforated Base.
3) Midwest Fasteners, Inc.; Spindle.

b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
c. Spindle: Aluminum or Stainless steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

3. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

4. Known Acceptable Source:

1) GEMCO; Nylon Hangers.
2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.

b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
c. Spindle: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.

d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

a. Known Acceptable Source:

1) AGM Industries, Inc.; Tactoo Self-Adhering Insul-Hangers.
2) GEMCO; Peel & Press.
3) Midwest Fasteners, Inc.; Self Stick.

b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
c. Spindle: Aluminum or Stainless steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
d. Adhesive-backed base with a peel-off protective cover.

6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, aluminum or stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

a. Known Acceptable Source

1) AGM Industries, Inc.; RC-150.
2) GEMCO; R-150.
3) Midwest Fasteners, Inc.; WA-150.
4) Nelson Stud Welding; Speed Clips.

b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

a. Known Acceptable Source:

1) GEMCO.
2) Midwest Fasteners, Inc.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

D. Wire: 0.080-inch (2.0-mm) nickel-copper alloy or 0.062-inch (1.6-mm) soft-annealed, stainless steel.

1. Known Acceptable Source:

a. C & F Wire.

2.9 CORNER ANGLES

A. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.3 PENETRATIONS

A. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

D. Insulation Installation at Floor Penetrations:

1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.4 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.5 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.6 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

B. Insulate duct access panels and doors to achieve same fire rating as duct.

C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Section 078413 "Penetration Firestopping."

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect ductwork, randomly selected by COR, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location for each duct system defined in the "Duct Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.8 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
4. Indoor, exposed exhaust between isolation damper and penetration of building exterior.

B. Items Not Insulated:

1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
2. Factory-insulated flexible ducts.
3. Factory-insulated plenums and casings.
4. Flexible connectors.
5. Vibration-control devices.
6. Factory-insulated access panels and doors.

3.9 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, Supply-, Return-, Outdoor-, Exhaust-, Air Duct and Plenum Insulation: Mineral-fiber blanket, 2 inches thick and 1.0-lb/cu. ft. nominal density.

B. Exposed, Supply-, Return-, Outdoor-, Exhaust-, Air Duct and Plenum Insulation: Mineral-fiber board, 2 inches thick and 3.0-lb/cu. ft. nominal density.

3.10 INDOOR, JACKET SCHEDULE

A. Install jacket over insulation material.

B. Ducts and Plenums, Concealed:

1. FSK with vapor barrier.

C. Ducts and Plenums, Exposed:

1. FSK with vapor barrier.

END OF SECTION 230713

SECTION 23 07 19 – HVAC EQUIPMENT AND PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Insulation Materials:

   a. Cellular glass.
   b. Flexible elastomeric.
   c. Mineral fiber.

2. Insulating cements.
3. Adhesives.
4. Mastics.
5. Lagging adhesives.
6. Sealants.
7. Factory-applied jackets.
8. Field-applied fabric-reinforcing mesh.
9. Field-applied cloths.
10. Field-applied jackets.
11. Tapes.
12. Securements.
13. Corner angles.

B. Related Sections:

1. Section 23 31 13 "Metal Ducts" for duct liners.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any). All jacketing shall be color coded as selected by COR at time of submittal.

B. Shop Drawings:

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.

6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.
8. Detail field application for each equipment type.
9. Colors of jacketing for each service as selected by COR.

C. Qualification Data: For qualified Installer.

D. Field quality-control reports.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.5 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.6 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall be asbestos, lead, mercury, and mercury compounds free.

C. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

D. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Cell-U-Foam Corporation; Ultra-CUF.
b. Pittsburgh Corning Corporation; Foamglas Super K.

2. Block Insulation: ASTM C 552, Type I.
3. Special-Shaped Insulation: ASTM C 552, Type III.
4. Board Insulation: ASTM C 552, Type IV.
5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
6. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

E. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Aeroflex USA Inc.; Aerocel.
b. Armacell LLC; AP Armaflex.
c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type II with factory-applied vinyl jacket. III with factory-applied FSK jacket. or III with factory-applied FSP jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. CertainTeed Corp.; Duct Wrap.
b. Johns Manville; Microlite.
c. Knauf Insulation; Duct Wrap.
d. Owens Corning; All-Service Duct Wrap.

G. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ or with factory-applied FSK jacket. For equipment applications, provide insulation with factory-applied ASJ or with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. CertainTeed Corp.; Commercial Board.
b. Johns Manville; 800 Series Spin-Glas.
c. Knauf Insulation; Insulation Board.
d. Owens Corning; Fiberglas 700 Series.

H. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Johns Manville; Micro-Lok.
b. Knauf Insulation; 1000 Pipe Insulation.
c. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ or with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

I. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ or FSK jacket complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. CertainTeed Corp.; CrimpWrap.
b. Johns Manville; MicroFlex.
c. Knauf Insulation; Pipe and Tank Insulation.
d. Owens Corning; Fiberglas Pipe and Tank Insulation.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Insulco, Division of MFS, Inc.; Triple I.
b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.

B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Insulco, Division of MFS, Inc.; SmoothKote.
b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.
c. Rock Wool Manufacturing Company; Delta One Shot.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Cellular-Glass, Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Products, Division of ITW; CP-96.
b. Foster Products Corporation, H. B. Fuller Company; 81-33.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Aeroflex USA Inc.; Aeroseal.
b. Armacell LCC; 520 Adhesive.
c. Foster Products Corporation, H. B. Fuller Company; 85-75.

d. RBX Corporation; Rubatex Contact Adhesive.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Products, Division of ITW; CP-82.
b. Foster Products Corporation, H. B. Fuller Company; 85-20.
c. ITW TACC, Division of Illinois Tool Works; S-90/80.

2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Products, Division of ITW; CP-82.
b. Foster Products Corporation, H. B. Fuller Company; 85-20.
c. ITW TACC, Division of Illinois Tool Works; S-90/80.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Dow Chemical Company (The); 739, Dow Silicone.
b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
c. P.I.C. Plastics, Inc.; Welding Adhesive.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Products, Division of ITW; CP-35.
b. Foster Products Corporation, H. B. Fuller Company; 30-90.
c. ITW TACC, Division of Illinois Tool Works; CB-50.

2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
5. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Products, Division of ITW; Encacel.
b. Foster Products Corporation, H. B. Fuller Company; 60-95/60-96.
c. Marathon Industries, Inc.; 570.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
5. Color: White.

D. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Products, Division of ITW; CP-10.
b. Foster Products Corporation, H. B. Fuller Company; 35-00.
c. ITW TACC, Division of Illinois Tool Works; CB-05/15.

2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 200 deg F.
4. Solids Content: 63 percent by volume and 73 percent by weight.
5. Color: White.

2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Childers Products, Division of ITW; CP-52.
    b. Foster Products Corporation, H. B. Fuller Company; 81-42.

3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.
4. Service Temperature Range: Minus 50 to plus 180 deg F.
5. Color: White.

2.6 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass, Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Childers Products, Division of ITW; CP-76.
    b. Foster Products Corporation, H. B. Fuller Company; 30-45.
    c. Pittsburgh Corning Corporation; Pittseal 444.

B. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Childers Products, Division of ITW; CP-76-8.
    b. Foster Products Corporation, H. B. Fuller Company; 95-44.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Flashing Sealants, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Childers Products, Division of ITW; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.

5. Color: White.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch for covering pipe and pipe fittings.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Vimasco Corporation; Elastafab 894.

B. Woven Glass-Fiber Fabric for Duct and Equipment Insulation: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. inch for covering equipment.

1. Products: Subject to compliance with requirements, :

    a. Childers Products, Division of ITW; Chil-Glas No. 5.

C. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch, in a Leno weave, for duct, equipment, and pipe.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Foster Products Corporation, H. B. Fuller Company; Mast-A-Fab.
    b. Vimasco Corporation; Elastafab 894.

2.9 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

2.10 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Johns Manville; Zeston.
b. P.I.C. Plastics, Inc.; FG Series.
c. Proto PVC Corporation; LoSmoke.
d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: Color-code jackets based on system. Color as selected by COR.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

5. Factory-fabricated tank heads and tank side panels.

C. Metal Jacket:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Products, Division of ITW; Metal Jacketing Systems.
b. PABCO Metals Corporation; Surefit.
c. RPR Products, Inc.; Insul-Mate.

2. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.

a. Sheet and roll stock ready for shop or field sizing.
b. Material, finish, and thickness are indicated in field-applied jacket schedules.
c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.

d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
e. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.11 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
b. Compac Corp.; 104 and 105.
c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
b. Compac Corp.; 110 and 111.
c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.

6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
b. Compac Corp.; 130.
c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
d. Venture Tape; 1506 CW NS.

2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

2.12 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Products; Bands.
b. PABCO Metals Corporation; Bands.
c. RPR Products, Inc.; Bands.

2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing or closed seal.
3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) AGM Industries, Inc.; CWP-1.
2) GEMCO; CD.
3) Midwest Fasteners, Inc.; CD.
4) Nelson Stud Welding; TPA, TPC, and TPS.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) AGM Industries, Inc.; CWP-1.
        2) GEMCO; Cupped Head Weld Pin.
        3) Midwest Fasteners, Inc.; Cupped Head.
        4) Nelson Stud Welding; CHP.

3. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) AGM Industries, Inc.; RC-150.
        2) GEMCO; R-150.
        3) Midwest Fasteners, Inc.; WA-150.
        4) Nelson Stud Welding; Speed Clips.

    b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

4. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) GEMCO.
        2) Midwest Fasteners, Inc.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

D. Wire: 0.062-inch soft-annealed, galvanized steel.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. C & F Wire.
    b. Childers Products.
    c. PABCO Metals Corporation.

2.13 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. Color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Exterior Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

E. Insulation Installation at Floor Penetrations:

1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves

and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.

2. Pipe: Install insulation continuously through floor penetrations.
3. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

3.5 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

A. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

    a. Do not weld anchor pins to ASME-labeled pressure vessels.
    b. Select insulation hangers and adhesives that are compatible with service temperature and with substrate.
    c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
    d. Do not overcompress insulation during installation.
    e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
    f. Impale insulation over anchor pins and attach speed washers.
    g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Stagger joints between insulation layers at least 3 inches.
7. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
8. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
9. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

3.6 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.7 CELLULAR-GLASS INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.

2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

E. Heat Traced Piping:
1. Provide grove in cellular glass insulation as recommended by heat trace manufacturer.

3.8 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.9 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

F. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
d. Do not overcompress insulation during installation.
e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.10 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

D. Where PVDC jackets are indicated, install as follows:

1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
2. Wrap factory-presized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
3. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch- circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.11 FINISHES

A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 9 painting Sections.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by COR. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum.

3.12 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect ductwork, randomly selected by COR, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
2. Inspect field-insulated equipment, randomly selected by COR, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
3. Inspect pipe, fittings, strainers, and valves, randomly selected by COR, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.13 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.

C. Insulation of chilled water systems shall include a vapor barrier.

D. Heating hot water system sand-filter unit insulation shall be the following:

1. Mineral Fiber: 1-1/2 inches thick.

E. Chilled water system sand-filter unit insulation shall be one of the following:

1. Cellular Glass: 1-1/2 inches thick.

2. Flexible Elastomeric: 1 inch thick.

3.14 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.15 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F:

   1. Insulation shall be the following:

      a. Cellular Glass: 1-1/2 inches thick.
      b. Flexible Elastomeric: 1 inch thick for use on instrumentation, thermal wells, sensors and valve stems only.

B. Chilled Water, above 40 Deg F:

   1. Insulation shall be the following:

      a. Cellular Glass: 1-1/2 inches thick.
      b. Flexible Elastomeric: 1 inch thick may be used on instrumentation, thermal wells, sensors and valve stems only. Flexible elastomeric shall not be used to insulate indoor chilled water pipe.

C. Heating-Hot-Water Supply and Return, 200 Deg F and below:

   1. Insulation shall be the following:

      a. Mineral-Fiber: 1-1/2 inches thick.

D. Steam (Humidifier):

   1. Insulation shall be the following:

      a. Mineral-Fiber: 1 inch thick.

3.16 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Condenser-Water:

   1. Insulation shall be the following:

      a. Cellular Glass: 1-1/2 inches thick.

B. Temporary Condenser-, Makeup-, Drain- and Overflow-Water:

   1. Insulation shall be the following:

      a. Mineral-Fiber: 1-1/2 inches thick.

3.17 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket. Jacketing of equipment and insulation below raised access flooring and above drop ceilings are spaces defined as “Exposed”. “Concealed” shall only be applicable to spaces enclosed within hard wall, inaccessible shafts and ceilings.

B. Equipment, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. Aluminum, Corrugated: 0.024 inch thick.

2. Below ambient cold service equipment must include jacket with vapor barrier.

C. Piping, Concealed:

1. Piping insulation on piping above ambient temperature and with factory applied jacketing- None.

2. Below ambient cold service piping must include jacket with vapor barrier. PVC, Color-Coded by System: 20 mils thick.

D. Piping, Exposed:

1. PVC, Color-Coded by System: 20 mils thick.

2. Below ambient cold service piping must include jacket with vapor barrier. PVC, Color-Coded by System: 20 mils thick.

3.18 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. Piping, Exposed:

1. Stainless Steel, Type 304 or 316, Corrugated with Z-Shaped Locking Seam: 0.024 inch thick.

C. Temporary Piping, Exposed:

1. PVC jacket or 12 mil thick sheet polyethylene, with UV inhibitors, attached with stainless steel wire.

END OF SECTION 23 07 19

SECTION 23 09 00 - INSTRUMENTATION AND CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Provide a BACnet based Direct Digital Control System (DDCS) to control and monitor the Chiller Plant and HVAC equipment furnished and installed under this Major Mechanical Modernization and Sustain Project. This installation will replace components of the existing StruxureWare® /iNet equipment currently comprising the instrumentation and controls, and the building automation system throughout the ARTCC, as well as upgrade existing b3 and other controllers from the Andover family of Schneider Electric. In the near future, after this project is complete, or potentially to be organized concurrently, the FAA intends to replace the remainder of the existing building automation system and complete the upgrade of existing controls with Schneider Electric StruxureWare® hardware and software and Andover Continuum controllers. Existing instrumentation components that are not compatible with native BACnet controllers will be replaced.

B. A total of five Schneider Electric StruxureWare® operator work stations have been installed and are located respectively in the Power Service Building, 2 in the CCMS room, one is the PCMS switchgear room, and one in the DSR attic. Contractor shall add 2 more OWS, one in the pump house, and one in the chiller room for coherent coverage of control. The contractor shall also supply one laptop operator workstation that can be moved about the facility, but have the StruxureWare® software capable of the same operability. Additionally, the contractor shall provide additional LAN connections in critical controller cabinets (Chiller, Condenser pumps, AHU, etc.) so that a laptop with OWS capabilities can be connected to the control system and used to monitor/ change the system parameters.

C. The controls contractor shall configure the new BACnet system in a manner that will facilitate programmatic expandability without sacrificing interface or interoperability as older b3 controllers and existing building automation system hardware and software components of Schneider Electric are replaced. The new StruxureWare® OWS shall be configured and act as the primary access point for any new DDCS I/O modules installed as part of this project and any future expandability of system. New StruxureWare® Automation Servers (AS-1 and AS-3) are already installed in DDCP-03, DDCP-04, DDCP-05 and in DDCP-08 and serve the fuel system. Provide all necessary additional StruxureWare® Automation Servers, Automation Servers' I/O modules, BACnet local controllers, local terminal controllers and local connectors and expansion modules configured to allow programmatic and planned expandability of Schneider Electric building automation system. An operator shall be able to use the new graphical displays loaded on StruxureWare® OWS to control and monitor HVAC units, instruments or sensors regardless whether they are new Schneider Electric components or existing Schneider Electric controls. Contractor shall ensure that the most current version of the front-end software shall be loaded on all OWS to allow BACnet network configuration; to allow downloading control logic and programming; and for the purpose of general system maintenance. The local controls contractor as identified by the Schneider Electric (SE) ARTCC / CERAP Program Office in Columbia Maryland, supporting this project shall:

1. Be familiar with the new BACnet DDCS and be factory authorized servicer and installer;
2. Has received training on the new BACnet DDCS;

3. Be familiar with the existing building automation system and JCI controls and shall gather all background information about the existing building automation system and controls determined needed and are requisite for the new installation;
4. Has a minimum of 5 years of experience with installations similar in size, scope and complexity to the system specified on this project.

D. All necessary hardware and software including the specific components of StruxureWare® product(s) shall be provided by the Schneider Electric (SE) ARTCC / CERAP Program Office in Columbia Maryland, in conjunction with a local controls contractor or local SE office. This SE ARTCC / CERAP Program Office has been designated by the FAA to support the national control system replacement program, which will replace the legacy control system currently installed. The bidding contractors shall directly contact the SE ARTCC / CERAP Program Office to coordinate the control system requirements for this project in accordance with the RFP documents. In support of national standard required for the control system installation, the SE ARTCC / CERAP Program Office is responsible for overall coordination and contracting plan and will provide the following products and services for this project:

1. Preprogrammed and prefabricated Schneider Electric StruxureWare® native BACnet DDC system panels and UPS(s) in accordance with approved FAA ARTCC automation standards and application libraries, developed to meet and comply with the program design intent.
2. DDCS submittals, which will include: system architecture design diagrams for the new BACnet DDCS and site integration; specification sheets for the new BACnet DDC panels; new project graphics; and other related system product data.
3. Prefabricated and pre-configured network interface panel containing the communications components necessary to integrate the new BACnet controls into the existing site DDCS network for the purpose of a primary site operator access point for this part of the control system replacement.
4. Graphic cards and graphic editor for full graphic capability.
5. Supplemental support to the controls contractor to insure compliant project staffing.
6. Quality assurance and management in conjunction with the control contractor’s site management and the FAAs commissioning agent.
7. Site acceptance testing (SAT) and commissioning plan support.
8. Factory training support for the specified requirements of the new BACnet DDCS; the integration into the existing MetaSys DDCS; and the site applications
9. The controls contractor shall be responsible for coordination with the SE Program Office and for incorporation of the above as well as all other facets of this system and application for a fully functional turn-key DDCS.
10. The following is the contact information for the SE ARTCC Program Office:

Program Office and Program Management
Schneider Electric Buildings Critical Systems, Inc
8989 Herrmann Drive, Columbia MD 21045
Phone: 410-381-7655, Fax: 410-381-7654

Primary Point of Contact
Herb Walker, Program Manager
Herb.Walker@schneiderelectric-critical.com
Mobile: 443-832-8275

The BACnet based DDCS shall be a distributed control system in accordance with this specification. Provide all necessary hardware, software and control devices to execute the sequence of operation and comply with the Control Diagrams and DDCS Point

Function Schedule shown on the mechanical drawings. The OWS, Building Controllers (BC), Advanced Application Controllers (AAC), Application Specific Controllers (ASC) and all input/output devices shall communicate using the protocols and network standards as defined by ANSI/ASHRAE Standard 135–2004, BACnet. All controllers, including unitary controllers, shall be native BACnet-compliant and listed by the BACnet Testing Laboratory (BTL).

E. Only approved native BACnet controllers are acceptable, with the exception of controllers that are approved to conform with BACnet open protocol and are supplied by Schneider Electric. Any gateways for such units would be supplied by the respective manufacturer and be directly connected to the DDCS network using the BACnet communication protocol.

F. The StruxureWare® OWS already connected shall be able to communicate with existing SCI Controls until all have been removed and replaced.

1. Provide BC, AAC and ASC for monitoring and control of new and existing Chiller Plant equipment, including but not limited to chillers, chilled/condenser water system, motorized valves, air handling units and fans that are being removed and replaced in this project. Coordinate control system requirements with equipment manufacturer requirements.

   a. Chilled Water System (CH-100, CH-200, CH-300 and CH-400): Existing DDC controllers associated with CH-100, CH-200, CH-300, CH-400, P-1A, P-1B, P-1C and P-1D shall be replaced with new native BACnet controllers. Disconnect and remove existing controllers and control devices from the respective control panels, and provide new DDCS control panels for new equipment. Coordinate the sequence of controls replacement and installation of new controllers and panels with the COR. Existing sensors and control devices that are not compatible with new BACnet controllers shall be replaced with BACnet compatible devices. Turn over the controllers to the FAA for use as spare parts. The controls contractor shall coordinate with the FAA and Schneider Electric (SE) ARTCC / CERAP Program Office to provide necessary programming and graphics for all control and monitoring points. The controls contractor shall program and make necessary changes to the existing DDCS to continue to operate any equipment not affected by this project, such as, but not limited to, the Boiler system. Existing control and monitoring points that are not associated with the replacement equipment shall remain in operation and protected during construction.
   b. Provide new refrigerant alarm panel, sensing tube and associated alarm horn, light strobe and manual switches as indicated in the mechanical plans.
   c. Condenser Water System: Provide new controls for new cooling towers, condenser water pumps and other related equipment. Disconnect and remove existing controllers, control devices, control wiring and control panels when the associated equipment is demolished. Coordinate with the Schneider Electric (SE) ARTCC / CERAP Program Office to provide new controls for new cooling towers, condenser water pumps and other related equipment. When the installation of new equipment is complete and new BACnet controllers are installed, the controls contractor shall coordinate with the FAA and the Schneider Electric (SE) ARTCC / CERAP Program Office to provide necessary programming and graphics for all existing and new control and monitoring points. Remove existing control wiring and conduit associated with condenser water system from the existing control panel, tower pad and pump house. Remove existing DDCS panel, located in the pump house. Provide new control wiring and conduit from the pull boxes to pump

house and cooling towers as required. Coordinate locations of pull boxes and conduit routing with Division 26.

d. Room B120: Prior to demolition of each unit, remove existing controls associated with the existing air handling units, AHU-104, AHU-105, AHU-106, AHU-107, AHU-108 and AHU-109, including controllers, electric control devices, wiring and conduit. The controls associated with the replacement air handling units including unit controller, control devices and BACnet network interface shall be provided by the unit manufacturer. Provide new DDCP or utilize existing panel. Units shall be connected to an Ethernet switch and communicate with the new BACnet DDCS for remote control and monitoring. Coordinate with unit manufacturer and provide necessary control point mapping and software modification to the DDCS.

e. Room B119: Prior to demolition of AHU-22, remove existing controls associated with the unit, including controllers, electric control devices, wiring and conduit. The controls associated with the replacement air handling unit including unit controller, control devices and BACnet network interface shall be provided by the unit manufacturer. Integrate into existing panel for air handling units AHU-20, AHU-21, AHU-23. Unit shall be connected to an Ethernet switch and communicate with the new BACnet DDCS for remote control and monitoring. Coordinate with unit manufacturer and provide necessary control point mapping and software modification to the DDCS.

f. Room B95: Prior to demolition of the unit, remove existing controls from air handling unit AHU-400. Provide new DDC panel or utilize existing panel in Room B120, control valves, accessories, and wire to monitor and control new air handling unit, AHU-400.

2. BC, AAC and ASC shall be capable of accepting analog and digital inputs and shall provide analog and digital outputs in accordance with the control diagrams and the "DDCS Point Function Schedule."

3. Each BC, OWS AAC and network hardware such component such as Ethernet switch and/or router provided under this section shall be provided with an Uninterruptible Power Supply (UPS). The UPS shall be sized such that the controllers and network devices remain active during the power failure.

4. Any software provided shall be of the latest available version for the DDCS installed as part of this project. Coordinate with the Schneider Electric (SE) ARTCC / CERAP Program Office for information regarding the latest software version supported by the program office.

5. Provide separate controllers for redundant equipment in critical spaces to ensure that failure of any one controller will not cause the loss of the entire service to the critical space.

6. Refrigerant Leak Monitoring: Existing refrigerant leak monitoring panel will be removed and replaced. All refrigerant leak sensors will be removed and replaced and new sensor(s), new strobe light(s) and alarm horn(s) will be provided with new wiring. Refrigerant leak monitoring and alarm points will connect to new DDCS. See the "DDCS Point Function Schedule" for the list of refrigerant alarm monitoring points that must be provided.

7. Provide DDCS control wiring in raceway in accordance with Division 26. One 120 VAC power circuit is provided for each control panel under Division 26 as shown on the electrical plans. The control system installer shall make final connections as necessary to complete the system. Provide additional 120 VAC control power circuits from an essential branch circuit when required for proper operation of the DDCS. Coordinate requirements with Division 26 and the COR.

1.2 AIR TRAFFIC CONTROL EQUIPMENT RESTRICTIONS

A. Job Conditions: Do not permit interference with the air traffic control function at the Center. Schedule and plan work to permit normal facility operations to continue with minimum of disruption. Access to the facility shall be kept unobstructed at all times. If interference with the existing facility operations seems to be unavoidable, advise the COR 10 days prior to such interference. Proceed as directed by the COR.

B. Equipment Shutdown: Each ARTCC maintains air traffic control continuously without shutdown. Various techniques are employed to achieve maximum system availability. Mechanical and electrical systems in direct support of air traffic operation and environmental systems have redundant configurations. Shutdown of equipment shall be scheduled with the COR at least 10 days prior to the DDCS installer's need. The reliability of mechanical and electrical systems is compromised when redundant equipment is not available. Every effort will be made by the FAA to allow work to be accomplished during the installer's normal working hours; however, the COR may require that certain equipment be shut down during off normal hours and be restored to service immediately after this period. See sheet G005 for list of off normal hours. Shutdown shall be accomplished by FAA personnel.

C. Equipment Testing: Since equipment failures or unexpected shut downs may occur during new equipment start up and testing, this work shall be scheduled with the COR to take place during off normal hours. If power transfers are required during equipment testing, a sufficient amount of off normal hours shall be scheduled to assure that systems recover and perform properly after the power transfer occurs.

1.3 RELATED SECTIONS

A. Division 01, "General Requirements" contains requirements that relate to this Section.

B. The entirety of the Division 23 Specifications contains requirements which relate to this Section.

C. The entirety of the Division 26 Specifications contains requirements which relate to this Section.

D. Section 28 30 00 "Refrigerant Detection and Alarm" contains requirements that relate to this Section.

1.4 REFERENCE STANDARDS

A. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

1. 135-2004: BACnet - Data Communication Protocol for Building Automation and Control Networks, including all published addenda.

B. Electronic Industries Association/Telecommunications Industry Association (EIA/TIA)

1. EIA/TIA-232: Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Exchange.
2. EIA/TIA-485: Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multi-point Systems.

3. EIA/TIA-568: Commercial Building Telecommunications Wiring Standard.
4. EIA/TIA-606: Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.

C. Institute of Electrical and Electronics Engineers (IEEE)

1. IEEE-802.3: Standards for Local Area Networks - Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications.

D. International Organization for Standardization (ISO)

1. ISO-8802: Telecommunications and Information Exchange Between Systems

E. National Fire Protection Association (NFPA)

1. 70: National Electric Code
2. 72: National Fire Alarm Code
3. 90A: Standard for the Installation of Air Conditioning and Ventilating Systems
4. 262: Standard Method of Test for Fire and Smoke Characteristics of Wires and Cables

F. Underwriters Laboratories (UL)

1. 94: Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
2. 268: Smoke Detectors for Fire Protective Signaling Systems
3. 268A: Smoke Detectors for Duct Applications
4. 486A: Wire Connectors and Soldering Lugs for Use With Copper Conductors
5. 916: Energy Management Equipment Listing
6. 1449: Surge Protective Devices

G. Federal Communications Commission (FCC)

1. 47CFR Part 15, Subpart B - Unintentional Radiators

H. National Electrical Manufacturer's Association (NEMA)

1. ICS6: Enclosures for Industrial Control Systems.

1.5 DEFINITIONS

A. Modulating Control: Direct digital closed loop Proportional + Integral (PI) control which maintains the controlled variable (temperature, humidity, etc.) at a set-point by adjusting the position of a valve, damper or similar controlled device in small increments and decrements between fully open and fully closed positions. PI loop shall include an adjustable dead-band which is a range of the controlled variable around the set point in which no change in output to the controlled device is made. Dead-bands shall be initially set at plus or minus 0.5°F for temperature control loops and plus or minus 2 percent RH for humidity control loops.

B. 2-Position Control: On/off control in which the controlled device is either fully open or fully closed with no intermediate operating positions available.

C. Advanced Application Controller (AAC): A fully programmable control module. This control module may be capable of some of the advanced features found in Building Controllers (storing

trends, initiating read and write requests, etc.) but it does not serve as a master controller. Advanced Application Controllers may reside on either the BACnet/IP or on a subnet.

D. Application Specific Controller (ASC): A pre-programmed control module which is intended for use in a specific application. ASCs may be configurable, in that the user can choose between various pre-programmed options, but it does not support full custom programming. ASCs are often used on terminal equipment such as VAV boxes or fan coil units. In many vendors' architectures ASCs do not store trends or schedules but instead rely upon a Building Controller to provide those functions.

E. BACnet/IP: An approved BACnet network type, which uses an Ethernet carrier and Internet Protocol (IP) addressing.

F. BACnet MS/TP: An approved BACnet network type, which uses a Master-Slave Token Passing configuration. MS/TP networks are unique to BACnet and utilize EIA485 twisted pair topology running at 9600 to 76,800 bps.

G. BACnet Over ARCNET: An approved BACnet network type, which uses an ARCNET (attached resource computer network) carrier. ARCNET is an industry standard that can utilize several speeds and wiring standards. The most common configuration used by BACnet controllers is an EIA485 twisted pair topology running at 156,000 bps.

H. Building Controller (BC): A fully programmable control module, which is capable of storing trends and schedules, serving as a router to devices on a subnet, and initiating read and write requests to other controllers. Typically this controller is located on the Ethernet/IP backbone of the DDCS. In many vendors' architectures a Building Controller will serve as a master controller, storing schedules and trends for controllers on a subnet underneath the Building Controller.

I. Human-Machine Interface (HMI): Method by which operator communicates with HVAC control system. Allows operator to command, monitor, and program control system.

J. Last Commanded State (L.C.S.): A failure condition where, upon loss of control signal or power to a controlled device, the device continues to maintain the state or position of that device as it was last commanded by the DDCS.

K. Operator’s Workstation (OWS): A data processing system loaded with necessary hardware and software, which is intended to use as a primary access point for control and monitoring of BACnet system. The OWS shall directly communicate with BACnet controllers via BACnet network types as a BACnet device. It shall comply with the requirements of a BACnet device profile and shall support all BACnet services and functional groups.

L. PICS - Protocol Implementation Conformance Statement: A written document, created by the manufacturer of a device, which identifies the particular options specified by ANSI/ASHRAE Standard 135–2004, BACnet, that are implemented in the device.

1.6 SYSTEM DESCRIPTION

A. Provide a complete control system including DDC controllers, panels, raceways, wiring, thermostats, control valves, valve operators, control dampers, damper operators, temperature and humidity sensing elements, flow and pressure sensing elements, element wells and relays.

B. Contractor shall coordinate work with the COR and consult with the designated point of contact from program office who is working on replacing the building automation system nationally on configuration of system components which will be replaced in this project and on designation of new control panels that will be installed prior to commencement of any work.

C. Control system hardware consists of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories connected to direct digital controllers to operate mechanical systems according to sequences of operation specified.

D. Control system software consists of control software, communication software, alarm reporting software, and graphical operator interface software, programmed to operate mechanical systems according to sequences of operation specified.

E. New DDCS panels are to be fully constructed off-site and tested for correct electrical operation prior to their delivery on site. Note: electrical operation does not include the testing of field I/O or Sequence of Operation.

1.7 SEQUENCE OF OPERATION

A. Point Listing: See the DDCS Point Function Schedule shown on the drawings for a list of required hardware points and associated software functions. Points required to perform the specified sequence of operation but not listed shall be provided.

B. Set Point Adjustment: The set points listed in the Sequence of Operation are initial settings, which shall be adjustable. DDCS software data for the system, including but not limited to set points, differentials, alarm limits, and PID control parameters shall be adjustable through the OWS by operators who have received the Operator Training described in Part 3 of this Section. Control set points shall be included on the graphical displays for each system, along with the analog value of each controlled variable. An operator with the proper password shall be able to raise or lower these control set points through a pull-down menu while the system graphic is displayed on the OWS monitor. It shall not be necessary to revise the system control programs to adjust the control set points.

C. Alarm Limits: Alarm limits shall be set as shown on the DDCS Point Function Schedule on the mechanical plans. The alarm limits may be changed during start-up, if required, to meet actual operating conditions.

D. Alarm Monitoring: Alarms identified on the DDCS Point Function Schedule shall be enunciated on the display of the OWS and on the alarm printer.

E. Exhaust Fan (EF-310) – Chiller Room Ventilation

1. Exhaust Fan Hand-Off-Auto Operation: Provide a Hand-Off-Auto operation switch at the motor starter. In the Off mode, the isolation damper shall be closed and the exhaust fan shall be stopped. In the Hand mode, the isolation damper shall open. When the damper is fully open, the associated damper position switch DI-1 shall start the fan. In the Auto mode, the exhaust fan and isolation damper shall be controlled by the BAS as described below.
2. Automatic Mode Start/Stop Control: When the space temperature, as sensed by TS-B115, rises above the set point, initially set at 85 °F (adjustable), the DDCS shall open the isolation damper (CD-1). When the damper is fully open, the associated damper position switch DI-1 shall start the exhaust fan at low speed. If the space temperature rises above

88 °F (adjustable) while the fan is running at low speed, the DDCS shall run the exhaust fan at high speed. When the space temperature drops below the set point, the DDCS shall be returned to low speed operation. If the space temperature continues to fall, the DDCS shall close the associated damper and stop the exhaust fan.

3. Fan Status: A current relay shall be used to monitor the status of the fan. If the status indicated does not match the commanded output for the fan an alarm shall be generated and sent to the DDCS and the fan start command shall be canceled.

F. Hot Water Unit Heaters (Typical)

1. Hot Water Cabinet Heater: When the temperature drops below the set point, initially set at 55°F (adjustable), the two position hot water valve shall open and the fan shall operate. When the temperature rises above the set point, the hot water valve shall close and the fan shall stop. The hot water valve shall fail open. The hot water cabinet heater shall be controlled by unit mounted thermostat, not through the DDCS.

G. Water Leak Detection System Monitoring: The DDCS shall monitor alarms from the leak detection system.

H. Chilled Water System

1. Program modules to serve as a basis for programming the following Sequences of Operation are available from the Schneider Electric (SE) ARTCC / CERAP Program Office and may be modified by the contractor, in coordination with the Schneider Electric (SE) ARTCC / CERAP Program Office, to affect the desired Sequences of Operation as described below.

2. General

a. Two chillers, four chilled water pumps, three cooling towers, and three condenser water pumps are to be replaced as part of this project. The following sequences describe in detail the operation of the plant as a whole and make no distinction between existing and new equipment. The contractor shall coordinate with the ESU personnel and Schneider Electric (SE) ARTCC / CERAP Program Office to provide new control logic and DDC programming to meet the required operation of new and existing equipment as described here.

b. The equipment shall be distributed across multiple controllers in such a manner that no more than one chiller, one cooling tower, one chilled water pump, and one condenser water pump shall be controlled and monitored using a single controller. Loss of one controller shall not cause the loss of the entire chilled water system.

c. Any combination of chillers, chilled water pumps, cooling towers, and condenser water pumps may be selected and utilized. Provide an automatic program, that is Government re-programmable, to alternate the equipment monthly (adjustable) to maintain even use. It shall be possible for maintenance personnel to select the sequence and rotation of equipment through the associated graphical displays on the OWS.

1) One chiller shall be designated as the “First Stage” chiller; one chiller shall be designated as the “Second Stage” chiller; one chiller shall be designated as the “Standby” chiller; and one chiller shall be designated as the “Spare” chiller.

2) One chilled water pump shall be designated as the “First Stage” pump; one chilled water pump shall be designated as the “Second Stage” pump, one

chilled water pump shall be designated as the "Standby" pump; and one chilled water pump shall be designated as the "Spare" pump.

3) One cooling tower shall be designated as the "First Stage" cooling tower; one cooling tower shall be designated as the "Second Stage" cooling tower; and one cooling tower shall be designated as the "Standby" cooling tower.

4) One condenser water pump shall be designated as the "First Stage" pump; one condenser water pump shall be designated as the "Second Stage" pump; and one condenser water pump shall be designated as the "Standby" pump.

d. At least one chiller, one chilled water pump, one cooling tower and one condenser water pump shall be in operation at all times.

e. Additional Monitoring: In addition to the points mentioned in these sequences provide the additional monitoring points listed in the "DDCS Point Function Schedule."

f. Nomenclature: For the chilled water system sequence of operation, the following nomenclature will be used:

1) P-1x refers generically to chilled water pumps P-1A through P1-D.
2) P-3x refers generically to condenser water pumps P-3A through P-3C.
3) FCV-xA refers generically to chiller CWR isolation valves FCV-1A through FCV-4A.
4) FCV-xB refers generically to chiller CTS isolation valves FCV-1B through FCV-4B.
5) FCV-5x refers generically to cooling tower CTR isolation valves FCV-5A through FCV-5C.
6) FCV-6 refers to chilled water bypass valve.
7) FCV-7 refers to cooling tower bypass valve.
8) CH-x00 refers generically to chillers CH-100 through CH-400.
9) CT-1x refers generally to cooling towers CT-1A through CT-1C.

3. Chiller Loading: (Sequences presented here occur concurrently with the "Cooling Tower Water System Control" sequences.)

a. "First Stage" Chiller (Assumes Chilled Water System is off at Startup Conditions):

1) "First Stage" cooling tower isolation valve, FCV-5x, shall be opened by the DDCS, enabling the "First Stage" cooling tower CT-1x.
2) The isolation valve FCV-xB in the cooling tower water supply to the "First Stage" chiller, CH-x00, shall open. After a delay of two minutes (adjustable), the "First Stage" condenser water pump, P-3x, shall start. Once the pump is started, the DDCS shall increase the speed of pump VFD to meet the required cooling tower water flow for the chiller as indicated in the mechanical equipment schedule. This pump speed shall be determined in consulting with the balancing contractor during the TAB process.
3) The isolation valve FCV-xA in the chilled water return to the "First Stage" chiller, CH-x00, shall open. After a delay of two minutes (adjustable), the "First Stage" chilled water pump, P-1x, shall start. Once the pump is started, the DDCS shall increase the speed of pump VFD to meet the required chilled water flow for the chiller as indicated in the mechanical equipment schedule. This pump speed shall be determined in consulting with the balancing contractor during the TAB process.
4) When both the "First Stage" chilled water pump, P-1x, and the "First Stage" condenser water pump, P-3x, have been proven to be running through the

outputs from the pump VFDs, and both pumps are running at the required speed, as described above, the “First Stage” chiller, CH-x00, shall be enabled by the DDCS.

5) The “First Stage” chiller's self-contained control package shall start and operate the chiller.

b. “Second Stage” Chiller: The “Second Stage” chiller shall be enabled if the speed of VFD associated with “First Stage” chilled water pump exceeds the maximum speed of 90% (adjustable) for more than 10 minutes (adjustable), or the amperage of the “First Stage” chiller exceeds 90% (adjustable) of the total rated amperage of the chiller for more than 10 minutes (adjustable), the “Second Stage” chiller shall be started.

1) “Second Stage” cooling tower isolation valve, FCV-5x, shall be opened by the DDCS, enabling the “Second Stage” cooling tower CT-1x.
2) Once “Second Stage” cooling tower is enabled, the isolation valve FCV-xB in the cooling tower water supply to the “Second Stage” chiller, CH-x00, shall open.
3) The DDCS shall override the VFD speed control of the “First Stage” chilled water pump and maintain the last command speed until the “Second Stage” chiller is enabled.
4) When the “First Stage” chilled water pump is running at the last command speed, the “Second Stage” chilled water pump shall start. Once the pump is started, the DDCS shall increase the speed of pump VFD to match the speed of the “First Stage” chilled water pump.
5) During the transition, the DDCS shall override the differential control and modulate the chilled water bypass valve to maintain the differential pressure as described under “Chilled Water Bypass Valve Control.”
6) Once the “Second Stage” chilled water pump has been proven to be running through the output from the pump VFD and the pump is running at the required speed, the isolation valve FCV-xA in the chilled water return to the “Second Stage” chiller, CH-x00, shall open.
7) When both cooling tower water and chilled water isolation valves have been proven open through the valve position switches, the “Second Stage” chiller, CH-x00, shall be enabled by the DDCS.
8) The “Second Stage” chiller's self-contained control package shall start and operate the chiller.

c. Activate a critical alarm if the DDCS determines that another chiller is required to operate to meet the facility cooling load and no chiller is available for operation.

4. Chiller Unloading:

a. “Second Stage” Chiller: If “First Stage” and “Second Stage” chilled water pumps have been running at the minimum speed for more than 10 minutes (adjustable), and the total amperage of “First Stage” and “Second Stage” chillers is less than 40% (adjustable) of the total rated amperage of two chillers for more than 10 minutes (adjustable), the “Second Stage” chiller shall be disabled.

1) The DDCS shall disable the “Second Stage” chiller, CH-x00.
2) After a delay of two minutes (adjustable), the isolation valves, FCV-xA in the chilled water return to the “Second Stage” chiller and FCV-xB in the cooling tower water supply to the “Second Stage” chiller shall close.

3) Once both isolation valves associated with the “Second Stage” chiller have been proven to be closed through the valve position switches, the associated “Second Stage” chilled water pump, P-1x, shall be stopped.
4) The “Second Stage” cooling tower CT-1x shall then be disabled and the cooling tower isolation valve, FCV-5x shall be closed by the DDCS.

b. “First Stage” Chiller: When the chilled water system is manually disabled, the “First Stage” chiller shall be disabled.

1) The DDCS shall disable the “First Stage” chiller, CH-x00.
2) After a delay of two minutes (adjustable), the “First Stage” condenser water pump, P-3x, shall be stopped.
3) After an additional delay of two minutes (adjustable), the “First Stage” chilled water pump, P-1x, shall be stopped.
4) Once both the “First Stage” chilled water pump, P-1x, and the “First Stage” condenser water pump, P-3x, have been proven to be off through the outputs from the pump VFDs, the DDCS shall initiate a time delay, set at 1 minute (adjustable).
5) After the time delay has expired, the isolation valves, FCV-xA in the chilled water return to the “First Stage” chiller and FCV-xB in the cooling tower water supply to the “First Stage” chiller shall close.
6) Once the chiller isolation valves are closed, the “First Stage” cooling tower CT-1x shall then be disabled and the cooling tower isolation valve, FCV-5x shall be closed by the DDCS.

5. Chiller Cycle: Provide a time delay which prevents the unit controller from attempting to start or stop another chiller for an adjustable time period after a chiller is started or stopped. The time delay shall not prevent the unit controller from immediately starting equipment in response to an equipment failure. The time delay shall be initially set at 15 minutes (adjustable), to prevent rapid cycling of the units. Adjust the timing to provide a stable yet responsive fully operational system. In addition, adjust the timing of equipment startup with the opening and closing of flow control valves as required to ensure that the staging of equipment does not cause operating equipment to fail.
6. Chiller Rotation: When switching the “First Stage”, “Second Stage”, “Standby” and “Spare” units, the equipment in the next sequence shall be enabled or started before the previously enabled or started unit is disabled or stopped. During the chillers and chilled water pumps rotation, the “First Stage” equipment shall become the “Spare” equipment, the “Second Stage” equipment shall become the “First Stage” equipment, the “Standby” equipment shall become the “Second Stage” equipment, and the “Spare” equipment shall become the “Standby” equipment.

a. “Second Stage” Chiller (Assumes one chiller and one chilled water pump are in operation):

1) When there is a call for the “Second Stage” chiller during the chiller rotation, the “Second Stage” chiller and “Second Stage” chilled water pump shall be enabled as described under “Chiller Load – Second Stage Chiller.”
2) Once the “Second Stage” chiller and “Second Stage” chilled water pump are in operation, the DDCS shall disable the “First Stage” chiller, CH-x00.
3) After a delay of two minutes (adjustable), the isolation valves, FCV-xA in the chilled water return to the “First Stage” chiller and FCV-xB in the cooling tower water supply to the “First Stage” chiller shall close.

4) Once both isolation valves associated with the “First Stage” chiller have been proven to be closed through the valve position switches, the “First Stage” chilled water pump, P-1x, shall be stopped.
5) Once the chiller isolation valves are closed, the “First Stage” cooling tower CT-1x shall then be disabled and the cooling tower isolation valve, FCV-5x shall be closed by the DDCS.

7. Chiller Failure: If an enabled chiller should fail, an alarm shall be generated. Assuming the “Standby” chiller is idle and available for operation, the DDCS shall automatically enable that chiller to replace the failed chiller. After the newly started chiller is in operation, the failed chiller shall be disabled.

   a. A chiller that fails during operation shall automatically be assigned a designation of “Failed” by the DDCS. A chiller shall be considered “Failed” if: the DDCS senses a loss of status at the associated chiller or the DDCS receives a fault alarm from the chiller.
   b. The DDCS shall disable the “Failed” chiller, CH-x00.
   c. After the time delay has expired, the isolation valves, FCV-xA in the chilled water return to the “Failed” chiller and FCV-xB in the cooling tower water supply to the “Failed” chiller shall close.
   d. Any chiller that is taken out of operation for maintenance shall be assigned a “Failed” designation by the operator. The DDCS shall not attempt to start a chiller with an assigned designation of “Failed.”

8. Chiller Supply Water Temperature Control: Each chiller shall be controlled by its packaged controls to maintain the discharge water temperature at 44 °F. The set point shall be adjustable through the DDCS.
9. Chilled Water Valve Flow Control: The two modes of control described below for the chilled water flow control valves shall be provided through the DDCS. The mode shall be manually selected by the operator through graphical displays on the OWS. The selected mode shall apply to all chilled water isolation valves FCV-1A through FCV-4A.

   a. Pressure Control Mode: When a chiller is started by the chiller sequencing program, the chilled water flow control valve for that chiller is opened by the DDCS. When the valve reaches the fully open position, as sensed by the valve position indicator, the DDCS shall maintain the fully open position as long as the differential pressure across the evaporator of the chiller is within the minimum and maximum range. This minimum and maximum range of differential pressure settings shall initially be set at the values corresponding to the flow rates required for the chiller, which shall be provided by the chiller manufacturer. When the differential pressure across the evaporator of the chiller drops below the minimum setting while the valve is fully open, the DDCS shall reset the differential pressure set point in the chilled water loop as described in “Chilled Water Pump Speed Control” below. When the differential pressure across the evaporator of the chiller rises above the maximum setting while the valve is fully open, the DDCS shall modulate the valve towards to the closed position to maintain the differential pressure across the evaporator of the chiller within the range. When the chiller is stopped, the pressure control sequence shall terminate and the chilled water flow control valve shall close as described under chiller control sequence.
   b. Flow Control Mode: When a chiller is started by the chiller sequencing program, the chilled water flow control valve for that chiller is opened by the DDCS. When the valve reaches the fully open position, as sensed by the valve position indicator,

the DDCS shall maintain the fully open position as long as the chilled water flow rate, as sensed by the chilled water flow meter for that chiller, is within the minimum and maximum flow rate settings. This minimum and maximum range of flow rate settings shall initially be set at the values corresponding to the flow rates required for the chiller, which shall be provided by the chiller manufacturer. When the chilled water flow rate drops below the minimum setting while the valve is fully open, the DDCS shall reset the differential pressure set point for the chilled water as described in "Chilled Water Pump Speed Control" below. When the chilled water flow rises above the maximum setting while the valve is fully open, the DDCS shall modulate the valve towards to the closed position to maintain the flow rate within the range. When the chiller is stopped, the flow control sequence shall terminate and the chilled water flow control valve shall close as described under chiller control sequence.

10. Cooling Tower Water Valve Flow Control: The two modes of control described below for the cooling tower water flow control valves shall be provided through the DDCS. The mode shall be manually selected by the operator through graphical displays on the OWS. The selected mode shall apply to all cooling tower water isolation valves FCV-5A through FCV-5C.

    a. Pressure Control Mode: When a chiller is started by the chiller sequencing program, the cooling tower water flow control valve for that chiller is opened by the DDCS. When the valve reaches the fully open position, as sensed by the valve position indicator, the DDCS shall maintain the fully open position as long as the differential pressure across the condenser of the chiller is within the minimum and maximum range. This minimum and maximum range of differential pressure settings shall initially be set at the values corresponding to the flow rates required for the chiller, which shall be provided by the chiller manufacturer. When the differential pressure across the condenser of the chiller drops below the minimum setting while the valve is fully open, the DDCS shall reset the differential pressure set point in the condenser water loop as described in "Condenser Water Pump Speed Control" below. When the differential pressure across the condenser of the chiller rises above the maximum setting while the valve is fully open, the DDCS shall modulate the valve towards to the closed position to maintain the differential pressure across the condenser of the chiller within the range. When the chiller is stopped, the pressure control sequence shall terminate and the cooling tower water flow control valve shall close as described under chiller control sequence.

    b. Flow Control Mode: When a chiller is started by the chiller sequencing program, the cooling tower water flow control valve for that chiller is opened by the DDCS. When the valve reaches the fully open position, as sensed by the valve position indicator, the DDCS shall maintain the fully open position as long as the cooling tower water flow rate, as sensed by the cooling tower water flow meter for that chiller is within the minimum and maximum flow rate settings. This minimum and maximum range of flow rate settings shall initially be set at the values corresponding to the flow rates required for the chiller, which shall be provided by the chiller manufacturer. When the cooling tower water flow rate drops below the minimum setting while the valve is fully open, the DDCS shall reset the differential pressure set point for the cooling tower water as described in "Condenser Water Pump Speed Control" below. When the cooling tower water flow rises above the maximum setting while the valve is fully open, the DDCS shall modulate the valve towards to the closed position to maintain the flow rate within the range. When the chiller is stopped, the flow control sequence shall

terminate and the cooling tower water flow control valve shall close as described under chiller control sequence.

11. Chilled Water Pump Control (P-1A through P-1D):

    a. Chilled Water Pump Hand-Off-Auto Operation: Hand-Off-Auto settings shall be provided as part of the variable frequency drive through the drive's keypad. In the Off mode, the pump shall be stopped. In the Hand mode, the pump shall run continuously. In the Auto mode, the pump shall be started and stopped by the DDCS.
    b. Chilled Water Pump Local-Remote Speed Control: Local-Remote settings shall be provided as part of each variable frequency drive through the drive's keypad. In the Local mode, the pump's speed shall be controlled through a manual speed control located at the respective drive control panel. In the Remote mode, the pump's speed shall be controlled by the DDCS.
    c. Chilled Water Pump VFD Bypass: Each variable frequency drive is provided with an across the line starter (bypass) to allow the pump to be operated at full speed when the variable frequency drive is not available for operation. The bypass mode shall be manually enabled by the operator. If the pump is operated in the bypass mode, the pump shall start and the pump motor shall run at full speed using line voltage. When the bypass mode is enabled, the DDCS shall override the differential control and modulate the chilled water bypass valve, ~~FCV-6~~, to maintain the differential pressure as described under "Chilled Water Bypass Valve Control."
    d. Chilled water pumps (P-1x) shall be started and stopped according to the "Chiller Loading" and "Chiller Unloading" sequences above when a chiller is enabled or disabled.
    e. Chilled Water Pump Failure:

        1) If a chilled water pump should fail, an alarm shall be generated. Assuming the "Standby" chilled water pump is idle and available for operation. The DDCS shall automatically enable that pump to replace the failed pump. After the newly started pump is in operation, the failed pump shall be disabled.
        2) Chilled water pumps that fail during operation shall automatically be assigned a designation of "Failed". Chilled water pump failure shall include: loss of status.
        3) Any chilled water pump that is taken out of operation for maintenance shall be assigned a designation of "Failed" by the operator. The DDCS shall not attempt to start pumps with an assigned designation of "Failed".

    f. Chilled Water Pump Speed Control:

        1) The DDCS shall monitor the differential pressure between the chilled water supply and chilled water return piping through existing differential pressure sensors in multiple locations within the building.
        2) The DDCS shall control the speed of the chilled water pump VFD to maintain a minimum differential pressure in each location.
        3) If the differential pressure at any location drops below the differential pressure set point, which shall be initially set at 15 psi (adjustable), the VFD speed shall be increased. If the differential pressure at all location is above the differential pressure set point, the VFD speed shall be decreased. If the differential pressure sensors at all locations should fail, the DDCS shall run

the pump at the default speed of 80% (adjustable). This pump speed shall be determined in consulting with the balancing contractor during the TAB process.

4) If two or more pumps are in operation, all operating pumps shall be controlled to the same speed.
5) Initialization of multiple pump speed control for multiple pumps shall occur as described under "Chiller Loading" and "Chiller Rotation." Once the "Second Stage" chiller is enabled, the pumps shall be released to maintain differential pressure control while maintaining the same speed at each pump.
6) The chilled water pump VFD shall have minimum and maximum speed settings. The minimum and maximum speed shall be set based on the minimum and maximum chilled water flow rates as indicated in the mechanical equipment schedule. The maximum and minimum pump speed shall be determined in consulting with the balancing contractor during the TAB process.

12. Chilled Water Bypass Valve Control:

a. If the differential pressure at all locations exceeds the differential pressure set point, which shall be initially set at 15 psi (adjustable), while the chilled water pump VFD is running at the minimum speed, the DDCS shall modulate FCV-6 towards open position to maintain the differential pressure at set point. If the differential pressure at any location drops below the set point, the DDCS shall modulate FCV-6 towards closed position to maintain the differential pressure at set point.
b. When more than one chilled water pump is in operation and the pump speed control is locked out during the transition as described under "Chiller Loading" and "Chiller Rotation", the DDCS shall override the differential control and modulate FCV-6 to maintain the differential pressure at set point.
c. The outputs from the pump VFD shall be used to monitor the bypass status of the pump VFD. If the status indicates that the bypass mode is enabled by the operator, the DDCS shall override the differential pressure control and modulate FCV-6 to maintain the differential pressure at set point.

13. Heat Exchanger Control: (This control is designed to be site tested and tuned. It will require changes to the parameter to ensure this sequence works the most efficiently in Longmont.)

a. The DDCS shall monitor the Outdoor Air Conditions, as sensed by the Outdoor Air Temperature Sensor and Outdoor Air Humidity Sensor. When the Outdoor Air wet Bulb temperature drops below 35F (Adjustable) for 30 minutes (Adj.), the BAS shall automatically enable the heat exchanger mode as described below. Operator shall have the ability to manually Enable and Disable the heat exchanger mode through BAS.

b. When the Heat Exchanger mode is enabled, the chiller will receive colder than normal cooling tower water, which can create operational problems in the refrigerant process within the chiller. To compensate for this condition the chiller is equipped with an internal feature, used allow the chiller to modulate a cooling tower water control valve to restrict the flow of the cooling tower water to the chiller during the transition mode and any time the cooling tower water temperature is below 70 DEG F.

c. Transition from “Mechanical Cooling Mode” to “Heat Exchanger Mode”

1) DDCS shall Enable Heat Exchanger Mode
2) Change the cooling tower water temperature set point to 45F (adj.)
3) Enable the pressure control sequence for the cooling tower pump
4) The DDCS shall monitor the signal provided by the control valve analog output at the chillers control panel.
5) The DDCS shall modulate FCV-xx, at the “Lead” chiller from 30% (adj.) to 100% open in response to the 0V to 10V signal measured at the chillers control valve analog output.
6) CONCURRENTLY THE DDCS SHALL MODULATE THE COOLING TOWER WATER CONTROL VALVE, FCV-1D, AT THE HEAT EXCHANGER, HX-1 INVERSELY PROPORTIONAL TO THE "FIRST STAGE" CHILLER CONTROL VALVE. (ONCE THE CHILLER IS OFF THIS VALVE FCV-1D WILL REMAIN OPEN)
7) IF FCV-1D DOES NOT OPEN
   a) CLOSE FCV-1D AT THE HEAT EXCHANGER, HX-1
   b) LOCK OUT THE HEAT EXCHANGER MODE, AND GENERATE AND ALARM FOR THE FAILED CONTROL VALVE, FCV-1D
8) WHEN THE **COOLING TOWER WATER TEMPERATURE REACHES WITHIN 2 DEG F OF THE SET POINT DISABLE THE "FIRST STAGE" CHILLER, CH-X**
9) **WHEN THE "FIRST STAGE" CHILLER GOES BELOW 6% CAPACITY,** OPEN THE CHILLED WATER CONTROL VALVE, FCV-1C, AT THE HEAT EXCHANGER, HX-1, TO 10% IN ONE STEP
10) IF FCV-1C DOES NOT OPEN:
   a) CLOSE FCV-1C AT THE HEAT EXCHANGER, HX-1
   b) LOCK OUT THE HEAT EXCHANGER MODE, AND GENERATE AND ALARM FOR THE FAILED CONTROL VALVE, FCV-1C
11) CHANGE THE CHILLED WATER TEMPERATURE SET POINT TO 47 DEG F
12) OPEN FCV-1C AT THE HEAT EXCHANGER, HX-1, TO 30%, OVER A 40 SECOND TIME PERIOD
13) AFTER FCV-XA REACHES 30% OPEN FCV-1C AT THE HEAT EXCHANGER, HX-1 TO 60%, OVER A 60 SECOND TIME PERIOD
14) AFTER FCV-XA REACHES 60% OPEN FCV-1C AT THE HEAT EXCHANGER, HX-1, TO 100%, OVER A 30 SECOND TIME PERIOD
15) CONCURRENTLY WITH THE OPENING OF VALVE FCV-1C CLOSE THE "FIRST STAGE" CHILLED WATER CONTROL VALVE, FCV-XA, TO 60%, OVER A 30 SECOND TIME PERIOD
16) AFTER FCV-XA REACHES 60% CLOSE FCV-XA TO 35%, OVER A 60 SECOND TIME PERIOD
17) AFTER FCV-XA REACHES 35% CLOSE FCV-XA TO 0%, OVER A 30 SECOND TIME PERIOD
18) IF NOT ALREADY CLOSED, THE COOLING TOWER WATER CONTROL VALVE, FCV-XB, AT THE "FIRST STAGE" CHILLER SHALL CLOSE
19) FCV-1C AND FCV-1D SHALL REMAIN 100% OPEN, EXCEPT WHEN CALLED FOR BY THE TEMPERATURE CONTROL SEQUENCE

d. **TRANSITION FROM "HEAT EXCHANGER MODE" TO "MECHANICAL COOLING MODE": (**IF THE OUTDOOR AIR WET BULB TEMPERATURE RISES ABOVE 35F (ADJUSTABLE) FOR 30 MINUTES (ADJUSTABLE), THE DDCS SHALL AUTOMATICALLY DISABLE THE HEAT EXCHANGER MODE)

1) CHANGE THE COOLING TOWER WATER SUPPLY TEMPERATURE SET POINT CONTROL TO AUTOMATIC MODE
2) THE DDCS SHALL MONITOR THE SIGNAL PROVIDED BY THE CONTROL VALVE ANALOG OUTPUT AT THE CHILLERS CONTROL PANEL
3) THE DDCS SHALL MODULATE FCV-XB, AT THE "FIRST STAGE" CHILLER FROM 30% TO 100% OPEN IN RESPONSE TO THE 0V TO 10V SIGNAL MEASURED AT THE CHILLERS CONTROL VALVE ANALOG OUTPUT
4) IF THE "FIRST STAGE" COOLING TOWER WATER CONTROL VALVE, FCV-XB, DOES NOT OPEN:
   a) CLOSE FCV-XB AT THE "FIRST STAGE" CHILLER
   b) DISABLE "FIRST STAGE" CHILLER
   c) RESTART ROTATION SEQUENCE WITH THE "SECOND STAGE" CHILLER
5) OPEN THE CHILLED WATER CONTROL VALVE, FCV-XA, AT THE "FIRST STAGE" CHILLER TO 5% IN ONE STEP
6) IF THE "FIRST STAGE" CHILLED WATER CONTROL VALVE, FCV-XA, DOES NOT OPEN WITHIN 30 SECONDS:
   a) CLOSE FCV-XA AT THE "FIRST STAGE" CHILLER
   b) DISABLE "FIRST STAGE" CHILLER
   c) RESTART ROTATION SEQUENCE WITH THE "SECOND STAGE" CHILLER
7) OPEN THE "FIRST STAGE" CHILLED WATER CONTROL VALVE, FCV-XA, TO 30%, OVER A 40 SECOND TIME PERIOD
8) **ONCE CHILLED WATER MINIMUM FLOW IS MADE, ENABLE THE "FIRST STAGE" CHILLER AND SET THE CHS TEMPERATURE TO 45F**
9) MODULATE THE "FIRST STAGE" CHILLED WATER CONTROL VALVE FCV-XA TO MAINTAIN THE MINIMUM CHILLED WATER FLOW RATE, INITIALLY SET AT 400 GPM (ADJUSTABLE). DDCS SHALL MAINTAIN THE MINIMUM CHILLED WATER FLOW RATE AT THE "FIRST STAGE" CHILLER UNTIL THE CHS TEMPERATURE REACHES THE SET POINT.
10) IF THE "FIRST STAGE" CHILLER, CH-X, DOES NOT START:
   a) CLOSE FCV-XA AT THE "FIRST STAGE" CHILLER, AS DESCRIBED IN THE CHILLER UNLOADING SEQUENCE
   b) DISABLE "FIRST STAGE" CHILLER
   c) RESTART ROTATION SEQUENCE WITH THE "SECOND STAGE" CHILLER
11) AFTER THE "FIRST STAGE" CHILLER REACHES WITHIN 4 DEGREES OF THE CHS TEMPERATURE SET POINT, OPEN THE "FIRST STAGE" CHILLER CONTROL VALVE TO 60% OR THE FIRST INCREMENT MORE THAN 60%, OVER A 60 SECOND TIME PERIOD
12) OPEN THE "FIRST STAGE" CHILLER CONTROL VALVE TO 100%, OVER A 60 SECOND TIME PERIOD
13) ONCE THE CHILLER GOES OVER 6% CAPACITY ACCOMPLISH THE FOLLOWING STEPS CONCURRENTLY
   a) CLOSE THE HEAT EXCHANGER CHILLED WATER CONTROL VALVE, FCV-1C, TO 0% OVER A 240 SECOND TIME PERIOD.

b) CLOSE THE HEAT EXCHANGER COOLING TOWER WATER CONTROL VALVE, FCV-1D, TO 0% IN THE SAME TIME INCRIMENT BUT FROM WHERE IT IS IN RELATION TO THE CHILLERS CONTROL VALVE ANALOG OUTPUT

14) DISABLE HEAT EXCHANGER MODE

e. **VARIAIBLE FLOW CHS TEMPERATURE CONTROL SEQUENCE:**

1) DDCS SHALL MODULATE THE VFD SPEED OF COOLING TOWER WATER PUMP, CTP-X, TO MAINTAIN THE HEAT EXCHANGER CHS TEMPERATURE AT THE SET POINT, INITIALL Y SET AT 47F (ADJUSTABLE)
2) AS THE CHS TEMPERATURE RISES ABOVE THE SET POINT, THE DDCS SHALL INCREASE THE VFD SPEED OF COOLING TOWER WATER PUMP, CTP-X
3) AS THE CHS TEMPERATURE DROPS BELOW THE SET POINT, THE DDCS SHALL REDUCE THE VFD SPEED OF COOLING TOWER WATER PUMP, CTP-X

f. **HEAT EXCHANGER MODE LOCKOUT:**

1) PROVIDE A TIME DELAY WHICH PREVENTS THE DDCS FROM SWITCHING BETWEEN THE "MECHANICAL COOLING MODE" AND "HEAT EXCHANGER MODE" FOR AN ADJUSTABLE TIME PERIOD, INITIALLY SET AT 60 MINUTE, AFTER THE HEAT EXCHANGER MODE IS DISABLED, REGARDLESS OF OUTDOOR CONDITIONS

g. **HEAT EXCHANGER MODE FAILURE: (THIS MODE IS DISABLED FOR THE FIRST 30 MINUETS (ADJ.) ONCE HEAT EXCHANGER MODE IS ENABLED, TO GIVE THE SYSTEM TIME TO STABLIZE)**

1) THE DDCS SHALL CONTINUOUSLY MONITOR THE HEAT EXCHANGER CHILLED WATER SUPPLY TEMPERATURE, TS-1, AND THE COOLING TOWER WATER SUPPLY TEMPERATURE, TS-3. IF THE HEAT EXCHANGER CHILLED WATER SUPPLY TEMPERATURE OR THE COOLING TOWER WATER SUPPLY TEMPERATURE RISES ABOVE THE SET POINT FOR CERTAIN PERIOD OF TIME, INITIALLY SET AT 5 MINUTES (ADJUSTABLE), THE DDCS SHALL IMMEDIATELY DISABLE THE "HEAT EXCHANGER MODE" AND ENABLE THE "LEAD" CHILLERS AS DESCRIBED IN "TRANSITION FROM HEAT EXCHANGER MODE TO MECHANICAL COOLING MODE" ABOVE, AND AN ALARM SHALL BE GENERATED AT THE DDCS AND OWS

I. Cooling Tower Water System

1. General: The Cooling Tower Water System shall be activated when the Chilled Water System is enabled. The cooling towers shall be enabled and disabled as described under “Chiller Loading” and “Chiller Unloading.”
2. Cooling Tower Operation:

a. Cooling Tower Hand-Off-Auto Operation: Hand-Off-Auto settings shall be provided as part of the variable frequency drive through the drive’s keypad. In the Off mode, the cooling tower shall be stopped. In the Hand mode, the cooling tower

shall run continuously. In the Auto mode, the cooling tower shall be started and stopped by the DDCS.

b. Cooling Tower Local-Remote Speed Control: Local-Remote settings shall be provided as part of each variable frequency drive through the drive's keypad. In the Local mode, the cooling tower's speed shall be controlled through a manual speed control located at the respective drive control panel. In the Remote mode, the cooling tower's speed shall be controlled by the DDCS.

c. Cooling Tower Fan VFD Bypass: Each variable frequency drive is provided with an across the line starter (bypass) to allow the fan to be operated at full speed when the variable frequency drive is not available for operation. The bypass mode shall be manually enabled by the operator. If the fan is operated in the bypass mode, the fan shall start and run at full speed using line voltage. When the bypass mode is enabled, the DDCS shall modulate the condenser water bypass valve, FCV-7, to maintain the cooling tower water supply temperature at set point.

d. Cooling Tower Water Temperature Control: The DDCS shall start and stop the cooling tower fan and control the speed of the cooling tower fan in combination with modulating the condenser water bypass valve, FCV-7, to maintain the common cooling tower water supply temperature at the cooling tower water supply temperature set point. If more than two cooling tower fans are in operation, all operating fans shall be controlled to the same speed. When a cooling tower is disabled, the DDCS shall stop the cooling tower fan, set the VFD to a speed of zero and close the condenser water bypass valve, FCV-7.

    1) If, while the cooling tower fan is off and the cooling tower bypass valve is closed, the common cooling tower water supply temperature rises above set point, the DDCS shall start the cooling tower fan and initiate cooling tower fan speed control.
    2) If the common cooling tower water supply temperature continues to rise above set point, the VFD speed shall increase. If the common cooling tower water supply temperature falls below set point, the VFD speed shall decrease.
    3) If the common cooling tower water supply temperature falls below set point for more than 5 minutes (adjustable) while the cooling tower VFD is operating at its minimum speed, the DDCS shall stop the cooling tower fan, continuing to allow water to flow through the cooling tower.
    4) If the common cooling tower water supply temperature continues to fall below set point while the cooling tower fan is off, the cooling tower bypass valve shall modulate towards the open position.
    5) If the common cooling tower water supply temperature starts to rise above set point, while the cooling tower fan is off, the cooling tower bypass valve shall modulate towards the closed position.
    6) Control of the cooling tower fan and the cooling tower bypass valve shall be coordinated such that the bypass valve shall be completely in the closed position when the fan is on and the bypass valve shall only be allowed to modulate when the fan is off.

e. Provide two modes of cooling tower water supply temperature set point control, manual and automatic modes. In the manual mode, the cooling tower water supply temperature set point shall be manually adjustable by the DDCS operator between 65 °F and 85 °F, and initially set at 85 °F. In the automatic mode, the DDCS shall reset the cooling tower water supply temperature set point according to the following schedule. Outdoor air wet-bulb temperature shall be calculated by the DDCS using the new outdoor air temperature and outdoor air humidity sensors.

O.A. Wet-bulb Temperature	Cooling Tower Water Set Point
74 °F	85 °F
54 °F	65 °F

3. Cooling Tower Failure

   a. If a cooling tower should fail, an alarm shall be generated. Assuming "Standby" cooling tower is idle and available for operation, the DDCS shall automatically enable that cooling tower to replace the failed cooling tower. If no cooling towers are available to operate in place of the "Failed" cooling tower, the DDCS shall continue to flow water through the failed cooling tower.
   b. Cooling towers that fail during operation shall automatically be assigned a designation of "Failed." Cooling tower fan failure shall include the DDCS sensing a loss of status of the cooling tower fan, or the DDCS receiving a fault alarm from the cooling tower VFD or an alarm from the fan vibration switch.
   c. Any cooling tower that is taken out of operation for maintenance shall be assigned a designation of "Failed" by the operator. The DDCS shall not attempt to start cooling towers with an assigned designation of "Failed."

4. Condenser Water Pump Control (P-3A through P-3C):

   a. Condenser Water Pump Hand-Off-Auto Operation: Hand-Off-Auto settings shall be provided as part of the variable frequency drive through the drive's keypad. In the Off mode, the pump shall be stopped. In the Hand mode, the pump shall run continuously. In the Auto mode, the pump shall be started and stopped by the DDCS.
   b. Condenser Water Pump Local-Remote Speed Control: Local-Remote settings shall be provided as part of each variable frequency drive through the drive's keypad. In the Local mode, the pump's speed shall be controlled through a manual speed control located at the respective drive control panel. In the Remote mode, the pump's speed shall be controlled by the DDCS.
   c. Condenser Water Pump VFD Bypass: Each variable frequency drive is provided with an across the line starter (bypass) to allow the pump to be operated at full speed when the variable frequency drive is not available for operation. If the pump is operated in this mode, the pump shall start and the pump motor shall run at full speed using line voltage.
   d. Condenser water pumps (P-3x) shall be started and stopped according to the "Chiller Loading" and "Chiller Unloading" sequences above when a chiller is enabled or disabled.
   e. Condenser Water Pump Failure:

      1) If a condenser water pump should fail, an alarm shall be generated. Assuming "Standby" condenser water pump is idle and available for operation. The DDCS shall automatically enable that pump to replace the failed pump. After the newly started pump is in operation, the failed pump shall be disabled.
      2) Condenser water pumps that fail during operation shall automatically be assigned a designation of "Failed." Condenser water pump failure shall include: loss of status.
      3) Any condenser water pump that is taken out of operation for maintenance shall be assigned a designation of "Failed" by the operator. The DDCS shall not attempt to start pumps with an assigned designation of "Failed."

f. Condenser Water Pump Speed Control:

1) If two pumps are in operation, all operating pumps shall be controlled to the same speed.
2) Initialization of multiple pump speed control for multiple pumps shall occur as described under “Chiller Loading” and “Chiller Rotation.” Once the “Second Stage” pump has reached at the required speed, the pumps shall be released to maintain differential pressure control while maintaining the same speed at each pump.

g. Cooling Tower Water Sump Low Level Alarm: The DDCS shall monitor sump level transmitters, LS-1, LS-2 and LS-3, associated with condenser water pumps. When the pump pit level at any one of the level transmitters drops below the set point while the associated condenser water pump is running, that pump shall be stopped and a low sump level alarm shall be generated at the DDCS and OWS. Refer to M301 for the pump shut-off water level set points for cooling tower water sump.

5. Cooling Tower Water Level Control

a. City Water Control: Water level transmitter LS-4 in the cooling tower water transmits the water level to the DDCS. The DDCS shall maintain the cooling tower water sump level by opening and closing the level control valve, LCV-1. When the sump water level drops below the city water add level, the level control valve, LCV-1, shall open. When the tank water level is above the city water valve shut-off level, the level control valve, LCV-1, shall close. The sump level set points shall be adjustable through the DDCS. Low and high water level alarms shall be transmitted to the DDCS. Provide a manual lockout for the level control valve which shall allow the operator at the OWS to close the valve regardless of the water level. Existing city water level set points may be obtained from Metasys.

J. Refrigerant Leak Monitor System

1. The controller shall monitor the refrigerant level alarm and general fail/fault status from the refrigerant leak monitor system panel. When the alarm is activated, the controller shall generate an alarm to the DDCS and OWS.
2. Comply with ASHRAE 15.
3. Connect the control points associated with the new refrigerant ventilation fan, EF-310, to new controller and provide necessary programming to run the fan when the refrigerant leak alarm is activated. EF-310 DDCP shall close the ceiling duct grille dampers, and open the grille dampers located near the ground at all the chillers, and activate the 2nd stage of EF-310.

K. Computer Room Air Conditioners AHU-104 through AHU-109 (Room B120)

1. The Computer Room Air Conditioning Unit (CRAC) shall be controlled by a unit controller provided by the unit manufacturer. The unit shall communicate with the DDCS via a BACnet compatible network card at each unit provided by the unit manufacturer. The controls contractor shall coordinate with unit provider and provide necessary control point mapping and software modification to the DDCS for remote control and monitoring.

2. Manual-Auto Unit Operation: A toggle switch shall be provided to bypass the unit controls in the event of microprocessor board failure. When the toggle switch is placed in Manual position, switch shall fully open the control valve and energize the fan(s), which shall operate at a fixed value. This fixed value shall be determined in consulting with the CRAC's manufacturer and the balancing contractor during the TAB process. When the toggle switch is placed in Auto position, the unit controller will operate the unit as described below.
3. Supply Fan Operation Automatic Mode: The units shall be started and stopped by the unit controller. To start a unit, the unit controller shall send a signal and the fan shall be energized and operate at a fixed fan speed set point. The fan speed set point shall be determined in consulting with the CRAC's manufacturer and the balancing contractor during the TAB process. A status contact shall provide operating status of the fan. If one of the lead units does not start after a 60 second (adjustable) time delay, a unit failure alarm shall be issued, the unit start command shall be canceled, and the standby unit shall automatically start. To stop a unit, the unit controller shall send a stop signal to the motor starter, which shall stop the fan. Normal operation shall be for the fan to operate continuously, 24 hours a day, year round.
4. Cooling Control: The unit controller shall modulate the chilled water valve CV-1 between fully closed and fully open as required to maintain the space temperature, as sensed by return air temperature sensor TS-2 at or below the space cooling set point which shall be initially set at 74 °F (adjustable). When the unit supply fan is off, the cooling control valve CV-1 shall close.
5. Humidifier Control: The humidifier output shall be adjustable from 0 to 100 percent. The unit controller shall enable the humidifier and modulate the humidifier output as required to maintain the space humidity, as sensed by the space humidity sensor HS-XXX, at or above the humidification set point, which shall be initially set at 45 % RH (adjustable). When the fan is off the humidifier output shall be disabled.
6. Fire Alarm Shutdown: When particles of combustion are sensed by the return air duct smoke detector S-1, the smoke detector shall stop the fan via a hardwire interlock and a duct smoke alarm signal shall be sent to the fire alarm system through an addressable interface device (AID). When the smoke alarm condition has been cleared the unit shall be returned to normal operation.
7. Dirty Filter Alarm: Differential pressure switch DP-1 shall monitor the pressure drop at the filters. When the pressure exceeds an adjustable limit, an alarm signal will be sent to the unit controller and the DDCS. Pressure difference indicator (PDl-1) located at the filters shall indicate the differential pressure across the filters.
8. Fan Status: An auxiliary contact shall be used to monitor the status of the unit supply fan. If the status indicated does not match the commanded output for the fan an alarm shall be generated and sent to the OWS.
9. Condensate Pump Alarm: The CRAC controller shall monitor the safety overflow switch on the condensate pump and annunciate an alarm when safety overflow switch is activated. The DDCS shall receive an alarm via network interface.
10. Loss of Communication: Upon loss of communications between DDCS and CRAC units, each CRAC unit shall run independently at a predetermined fan speed set point and operate to maintain its own space temperature at a predefined temperature set point. The fan speed set point and temperature set point shall be determined in consulting with the CRAC's manufacturer and the balancing contractor during the TAB process.
11. Failure Mode: Upon loss of control signal the control devices shall fail in the manner indicated in the "DDCS Point Function Schedule" on the mechanical sheets.
12. Additional Monitoring: In addition to the points mentioned in these sequences provide the additional monitoring points listed in the "DDCS Point Function Schedule."

L. Computer Room Air Conditioner AHU-22 (Room B119)

1. AHU 22 shall operate in the same configuration as Computer Room Air Conditioners AHU 20,21,23 unless stated otherwise by ESU or the COR.
2. The Computer Room Air Conditioning Unit (CRAC) shall be controlled by a unit controller provided by the unit manufacturer. The unit shall communicate with the DDCS via a BACnet compatible network card at each unit provided by the unit manufacturer. The controls contractor shall coordinate with unit provider and provide necessary control point mapping and software modification to the DDCS for remote control and monitoring.
3. Manual-Auto Unit Operation: A toggle switch shall be provided to bypass the unit controls in the event of microprocessor board failure. When the toggle switch is placed in Manual position, the isolation damper CD-1 shall open. When the damper opens, the damper position switch DI-1 shall fully open the control valve and energize the fan(s), which shall operate at a fixed value. This fixed value shall be determined in consulting with the CRAC' s manufacturer and the balancing contractor during the TAB process. When the toggle switch is placed in Auto position, the unit controller will operate the unit as described below.
4. Supply Fan Operation Automatic Mode: The units shall be started and stopped by the unit controller. To start a unit, the unit controller shall send a signal and open the isolation damper CD-1. When the damper is fully open, as sensed by damper position switch DI-1, the fan shall be energized and operate at a fixed fan speed set point. The fan speed set point shall be determined in consulting with the CRAC's manufacturer and the balancing contractor during the TAB process. A status contact shall provide operating status of the fan. If one of the lead units does not start after a 60 second (adjustable) time delay, a unit failure alarm shall be issued, the unit start command shall be canceled, and the standby unit shall automatically start. To stop a unit, the unit controller shall send a stop signal to the motor starter, which shall close the isolation damper CD-1 and stop the fan. Normal operation shall be for the fan to operate continuously, 24 hours a day, year round.
5. Heating Control: For reheating purposes, the unit controller shall modulate the hot water valve CV-1 between fully closed and fully open as required to maintain the space temperature, as sensed by return air temperature sensor TS-2 at or above the space temperature lower limit which shall be initially set at 60 °F (adjustable). When the unit supply fan is off, the heating control valve CV-1 shall close.
6. Cooling Control: The unit controller shall modulate the chilled water valve CV-2 between fully closed and fully open as required to maintain the space temperature, as sensed by return air temperature sensor TS-2 at or below the space cooling set point which shall be initially set at 74 °F (adjustable). When the unit supply fan is off, the cooling control valve CV-2 shall close.
7. Humidifier Control: The humidifier output shall be adjustable from 0 to 100 percent. The unit controller shall enable the humidifier and modulate the humidifier output as required to maintain the space humidity, as sensed by the space humidity sensor HS-22, at or above the humidification set point, which shall be initially set at 45 % RH (adjustable). When the fan is off the humidifier output shall be disabled.
8. Fire Alarm Shutdown: When particles of combustion are sensed by the return air duct smoke detector S-1, the smoke detector shall stop the fan via a hardwire interlock and a duct smoke alarm signal shall be sent to the fire alarm system through an addressable interface device (AID). When the smoke alarm condition has been cleared the unit shall be returned to normal operation.
9. Dirty Filter Alarm: Differential pressure switch DP-1 shall monitor the pressure drop at the filters. When the pressure exceeds an adjustable limit, an alarm signal will be sent to the unit controller and the DDCS. Pressure difference indicator (PDl-1) located at the filters shall indicate the differential pressure across the filters.

10. Fan Status: An auxiliary contact shall be used to monitor the status of the unit supply fan. If the status indicated does not match the commanded output for the fan an alarm shall be generated and sent to the OWS.
11. Condensate Pump Alarm: The CRAC controller shall monitor the safety overflow switch on the condensate pump and annunciate an alarm when safety overflow switch is activated. The DDCS shall receive an alarm via network interface.
12. Loss of Communication: Upon loss of communications between DDCS and CRAC units, each CRAC unit shall run independently at a predetermined fan speed set point and operate to maintain its own space temperature at a predefined temperature set point. The fan speed set point and temperature set point shall be determined in consulting with the CRAC's manufacturer and the balancing contractor during the TAB process.
13. Failure Mode: Upon loss of control signal the control devices shall fail in the manner indicated in the "DDCS Point Function Schedule" on the mechanical sheets.
14. Additional Monitoring: In addition to the points mentioned in these sequences provide the additional monitoring points listed in the "DDCS Point Function Schedule."

M. Outdoor Air Handling Unit AHU-400 (Room B95)

1. Supply Fan Hand-Off-Auto Operation: A Hand-Off-Auto operation switch shall be provided as part of the motor starter. In the Off mode, the fan shall be stopped. In the Hand mode, the supply air damper CD-1 shall open. When the damper is fully open, the associated damper position switch DI-1 shall energize the fan. In the Auto position the unit controller will start/stop the unit as described below. Provide an adjustable delay-on-make relay, wired in both the Hand and Auto modes, stagger the restart of each unit after a power failure to prevent creating a spike in the facility electrical demand. Upon activation, safeties shall be wired to stop the supply fan and close the outside air damper in both the Hand and Auto modes.
2. Supply Fan Operation Automatic Mode: The unit shall be started and stopped by the DDCS. To start a unit, the unit controller shall send a start signal to the motor starter, which will open the supply air damper CD-1. When the damper is fully open, as sensed by damper position switch DI-1, the fan shall be energized. A current relay shall provide operating status of the fan. If the unit does not start after a 60 second (adjustable) time delay, a unit failure alarm shall be issued and the unit start command shall be canceled. To stop a unit, the unit controller shall send a stop signal to the motor starter, which shall close the supply air damper CD-1 and stop the fan. Normal operation shall be for the fan to operate continuously, 24 hours a day, year round.
3. Supply Air Temperature Set Point: The supply air temperature set point shall be set at 50 °F (adjustable).
4. Heating Control: When the supply air temperature, as sensed by supply air temperature sensor TS, drops below the supply air temperature set point, the unit controller shall modulate the HW control valve CV-1 between fully closed and fully open to maintain a supply air temperature TS-1 at the supply air temperature set point. When the unit status is off, the HW control valve CV-1 shall be closed.
5. Cooling Control: When the supply air temperature, as sensed by supply air temperature sensor TS-1, rises above the supply air temperature set point, the unit controller shall modulate the chilled water valve CV-2 between fully open and fully closed as required to maintain a supply air temperature TS-1 at the supply air temperature set point. The chilled water valve shall be modulated in coordination with the hot water valve so as to not be open when the hot water valve is open. When the unit status is off, the chilled water control valve CV-2 shall be closed.
6. Humidifier Control: The humidifier output shall be adjustable from 0 to 100 percent. The DDCS shall enable the humidifier controller and modulate the humidifier output as required to maintain the space humidity, as sensed by the space humidity sensor HS-400,

at or above the humidification set point, which shall be initially set at 45 % RH (manually adjustable). When the fan is off the humidifier output shall be disabled.

7. Freezestat: When a freeze condition occurs at the freezestat, FZ-1, the unit supply fan shall be stopped and outdoor air damper shall be closed. A signal shall be sent to the unit controller indicating a freeze alarm, and the unit controller shall fully open the hot water coil control valve and close the chilled water coil control valve. When the alarm is activated, the unit controller shall generate an alarm to the DDCS and OWS The freezestat shall be set to trip at 34°F (manually adjustable) and must be manually reset at the freezestat.
8. Smoke Detector: When particles of combustion are sensed by the supply air duct smoke detector S-1, a duct smoke alarm signal shall be sent to the fire alarm system. Upon receiving an alarm signal from duct smoke detector, S-1, the fire alarm system shall activate an addressable interface device (AID) to stop the unit supply fan. When the fire alarm condition has been cleared, and the fire alarm system has been reset, the unit shall be returned to normal operation.
9. Dirty Filter Alarm: Differential pressure switch DP-1 shall monitor the pressure drop at the filters. When the pressure exceeds an adjustable limit, an alarm signal will be sent to the unit controller and the DDCS. Pressure difference indicator (PDI-1) located at the filters shall indicate the differential pressure across the filters.
10. Fan Status: Current relay shall be used to monitor the status of the unit supply fan. If the status indicated does not match the commanded output for the fan an alarm shall be generated and sent to the OWS.
11. Failure Mode: Upon loss of control signal or electrical power the control devices shall fail in the manner indicated in the "DDCS Point Function Schedule" on the mechanical sheets.
12. Additional Monitoring: In addition to the points mentioned in these sequences provide the additional monitoring points listed in the “DDCS Point Function Schedule.”

1.8 SUBMITTALS

A. General: Submit each item in this Section according to the Conditions of the Contract and Division 1 specification sections. Drawings shall be prepared using a Computer Aided Design (CAD) system. Submittal shall be provided on half size 11 inch by 17 inch drawings. Upon successful installation, as-built drawings shall be delivered to the Government on CD ROM in DWG or DXF compatible electronic format, as well as on 22 inch by 34 inch reproducible drawings. Drawings prepared for or used for this work shall become the property of the Government. The Government reserves the right to reproduce, in part or whole, the delivered drawings for internal Government purposes.

B. Control Diagrams: Submit a control diagram for each system on an individual and separate sheet complete with a bill of material, a sequence of operation in a text format and tagging information. The diagram shall consist of a system flow diagram showing the location of each control device, a control schematic drawing showing the function of each item, scale drawings of the panel layouts of both inside and face plate, and a complete terminal drawing for electrical devices connected with the system controls. Submit DDCS point schedules with the control diagram. In addition to the above requirements, submittals shall include:

1. Control diagram with required variables, air flow diagrams, ladder diagrams, and wiring diagrams. Control diagrams shall include at least the following: set points, reset ranges, throttling ranges, differentials, operating ranges, normal positions, controller action, dial ranges, voltage, currents, mounting locations, indicators, and terminal strip points.

2. Composite Wiring Diagrams: Submit complete, detailed control and interlock wiring diagrams. Show mechanical and electrical equipment furnished and all electrical interlocks, indicating terminal designation for all equipment. Respective equipment manufacturers shall furnish, through the supplier, approved drawings of equipment to be incorporated in this diagram. Clearly differentiate between factory-installed and field-installed wiring.
3. Communication cable installation plans and network architecture diagram showing OWS location, controller locations, network router and switch locations (if applicable) and communication cable conductors and routing, distinguishing between different forms of media (i.e. Category 5e, shielded twisted pair, coaxial cable, etc.). Various types of LANs shall be identified and distinguished from each other. Each LAN shall be labeled according to its designated LAN address.
4. Damper Schedule: Provide damper schedule indicating duct size, damper size, damper type, damper model number, damper torque requirements, damper actuator type, quantity of actuators per damper, damper actuator model number and damper failure position. Contractor shall obtain required schedule information on dampers from the damper supplier.
5. Valve Schedule: Provide valve schedule indicating valve model number, body type, Cv factor, actual pressure drop, actuator model number, valve pressure shutoff rating and valve failure position.
6. Sequence of Operation: As a minimum, all control processes that are controlled by a digital signal shall be clearly shown in a text narrative form. Sequences shall be written in the contractor’s own words in order to demonstrate a clear understanding of how the system is to operate and be specific to the control system equipment used. Copying/duplication of the sequences presented in this specification is not acceptable.
7. Device Tag Schedule and Point List: Provide device tag schedule that at a minimum indicates device type, tag identifier, terminal connection points for wiring on the controller, DDCS software point name and complete DDCS point address. A separate listing shall be provided for each BC, AAC and ASC. Device tags used shall be the same as those used in the contract documents as shown on the associated flow control diagrams and the “DDCS Point Function Schedule”. DDCS software point names and associated DDCS expanded point descriptors shall incorporate the device tags used. Coordinate point-naming conventions with the FAA facility personnel.
8. Bill of Materials: Provide a complete listing of all parts and materials utilized. List shall include part name, original manufacturer of part and original manufacturer’s part number.
9. Sample Graphical Displays: Provide samples of OWS graphical displays that will be provided for each system.
10. Provide complete description and documentation of any proprietary (non-BACnet) services and/or objects used in the system.

C. Technical Specification Data Sheets: Documents supplied by the original manufacturer of the item. These documents include salient characteristics and shall be included in a special section of the instruction book titled Manufacturer's Literature:

1. Technical specification data for each type of product specified: Include manufacturer's technical product data for each control device furnished, indicating dimensions, capacities, performance characteristics, electrical characteristics, finishes of materials, installation instructions, startup instructions, and maintenance instructions.
2. Technical specification data sheets for raceway, wire, cable and installation materials.
3. Technical specification data sheets for each software module, including the system theory.

D. BACnet Capability Certification: Submit Protocol Implementation Conformance Statement (PICS) for every BACnet compliant hardware and software component to be installed as part to the Building Automation System. All devices conforming to the BACnet Protocol of ANSI/ASHRAE BACnet Standard 135-2004 are to have a PICS, created by the device manufacturer. The PICS describes the BACnet capabilities of a particular BACnet implementation for the device.

E. Software Documentation: Include descriptive data and sequence of operation, flow charts, and machine listings of operating, user, and application software including complete Programmer's Manual tailored to the project. Control process and control loop documentation shall be provided in logical, graphical flow diagram format to allow control sequence to be easily interpreted and modified at any time in the future.

F. Installer Qualifications: Submit resume listing installer's qualifications including manufacturer's certification as an approved system installer and a list of recently completed projects demonstrating 2 years of system installation experience in BACnet based systems. Provide name(s), address, and telephone numbers for installer supervisory personnel.

G. Startup Personnel Qualifications: Submit resume listing startup personnel qualifications including manufacturer's certification as an approved system technician and a list of recently completed projects demonstrating 2 years of system startup experience in BACnet based systems. Provide name(s), address, and telephone numbers for supervisory personnel.

H. Graphical Displays: Coordinate the final graphical displays and other functions with the Schneider Electric (SE) ARTCC / CERAP Program Office and the COR. Prior to the commissioning of this project, submit printed copies of all graphical displays that will be installed in the OWS for approval. Provide a separate graphic display screen for each system and each logical group of points, as indicated in the "Graphics" column of the "DDCS Point Function Schedule". The graphical displays shall be schematic representations of the as-built systems and shall include, as a minimum, a dynamic reading for each point listed in the "DDCS Point Function Schedule". Where floor plan graphics are indicated on the schedule include, as a minimum, a dynamic reading for each space sensor, at the location on the floor plan that represents the actual location of the sensor. Each piece of equipment shall be linked to the appropriate floor plan. Provide a main menu display with page navigation tools for easy access of each floor or a group of equipment, and a summary page of equipment that is found in a quantity of 3 or more in the building.

I. Operation and Maintenance Manual: Provide operation and maintenance manual for control systems equipment as specified in Division 1, "Operation and Maintenance Manual Data," which includes the following:

1. General troubleshooting and repair instructions;
2. Specific, explicit installation, troubleshooting, calibration, and repair instructions for each sensor, controller, interface device and controlled device;
3. Specific, explicit instructions for operation of each sensor, controller, interface device and controlled device;
4. Maintenance instructions and spare parts lists for each type of control device;
5. Interconnection wiring diagrams with identified and numbered system components and devices;
6. Keyboard illustrations and step-by-step procedures indexed for each operator function;
7. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances;

8. Calibration records, list of set points, differentials, alarm limits, alarm instructions, and time schedules;
9. Sequence of operation in computer flow chart format. The flow chart shall show how each control action is derived; and
10. As-built communication cable installation plans and as-built network architecture diagram.

J. Test plans and inspection reports specified in Part 3 of this Section.

K. As built drawing requirements specified in Part 3 of this Section.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: Engage an Installer specializing in BACnet based control system installations with a minimum of 5 years of experience installing systems of similar type, size and complexity. The SE ARTCC Program Office, as a representative of the control system manufacturer, shall certify that the installer has been authorized and trained on the proper installation of the specified system and that the firm is approved for the ARTCC control system replacement program.

B. Startup Personnel Qualifications: Engage specially trained personnel in BACnet based control system with a minimum of 2 years of experience programming, testing and commissioning systems of similar size and complexity. The SE ARTCC Program Office, as a representative of the control system manufacturer, shall certify that the startup personnel have been authorized and trained on the proper installation, programming, testing, and commissioning of the specified system and that the firm is approved for the ARTCC control system replacement program.

C. Contractor Qualifications: The controls contractor shall be a local branch office; a representative; or a qualified dealer of Schneider Electric. The contractor shall be regularly engaged in the installation and maintenance of BACnet based DDCS and shall have demonstrated technical expertise and experience in the fabrication, manufacture, installation, and maintenance of BACnet based DDCS. Materials and equipment shall be the latest standard design of Schneider Electric and/or the instrument and control device manufacturer that comply with the requirements specified in this Section. The contractor or the manufacturer must maintain, within 100 miles of the project site, a local service center or a qualified local dealer/representative office which is capable of providing training, parts, service/emergency maintenance and repairs.

D. Software Quality Assurance Plan: Provide a software quality assurance plan.

1. The contractor shall coordinate with SE ARTCC Program Office to describe in flow chart and/or narrative form, the quality assurance operations from contract award through final delivery which are utilized to assure the quality of the computer software, controller programming, computer graphic screens and related documentation such as Operation & Maintenance Manuals required for this project. The description shall include organizational responsibilities and planned inspection and test operations and shall be keyed or related to the major milestones or activities within each phase of the development process of the project.
2. Standards and Procedures: Describe the contractor’s standards and procedures (e.g., documentation, work, coding, testing) which will be used to support the software programming, controller programming and computer graphic screen development and associated documentation such as Operation & Maintenance Manuals required for this

project. The standards and procedures shall specify criteria for use, and shall have controlled conditions for release and change. As a minimum, the plan shall address those standards and procedures necessary for the requirements, design, implementation, test, and documentation of the software, controller programming and computer graphic screens provided.

3. Corrective Action, Reporting and Control: Describe the corrective action process used to assure the prompt reporting, tracking, analysis, and correction of problems and defects for all software, controller programming and computer graphic screens and related documentation such as Operation & Maintenance Manuals required for this project. Include those procedures and controls which shall assure that deficiencies are promptly documented and corrected and that appropriate action is taken to prevent repetition. The deficiency documentation shall identify problems or defects by severity (critical, major, minor), and by function (test, coding, programming, graphics, documentation).
4. Provide up to 120 hours of software tech support specified in Part 3 of this Section.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Store equipment and materials inside and protected from weather.

B. Factory-Mounted Components: Where control devices specified in this Section are factory mounted on equipment, arrange for shipping control devices to unit manufacturer.

1.11 EXTRA MATERIALS

A. Line Replaceable Unit (LRU) and Spares: Identify LRUs in the proposed systems by written description, part number, and manufacturer. An LRU is defined as the lowest unit to be replaced within the system during site corrective maintenance. It is a separate, physical package, performing a single function or a group of closely related functions. An example of an LRU is a plug-in printed circuit card. These units shall be identified as parts readily available from several commercial sources in addition to the manufacturer and parts available only from the manufacturer and shall indicate the exact source of each including price and lead time of each. Submit a unit price list for line replaceable units.

B. Re-procurement Package: Submit a re-procurement package that includes documentation required to re-procure parts available only from the manufacturer from alternate sources. This list shall identify:

1. Actual manufacturer of the part;
2. Unit cost;
3. Parts that are electrostatic sensitive;
4. Total usage for each unit LRU;
5. Historical failure rate; and
6. Schematics and board drawings.

C. Furnish extra (except as noted) LRUs of each type installed, packaged with protective covering for storage, and identified with labels clearly describing contents, as described below. Quantity shall be determined by taking 10% of the total quantity of the device used on the job and rounding up to the next highest whole number.

1. Space Temperature Sensor (one of each type)
2. Duct Temperature Sensor

3. Water Temperature Sensor
4. Water Differential Pressure Sensor
5. Water Level Sensor
6. Air Differential Pressure Switch
7. Valve Actuator (Each Type Used for AHU coil only)
8. Valve Repair Kit
9. Damper Actuator (Each Type Used)
10. Damper Position Switch
11. BC (One of each type)
12. AAC (One of each type)
13. Power Supply
14. Control Relays (One of each type)
15. Current Relays (One of each type)

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. The Direct Digital Control System (DDCS) shall be a StruxureWare® BACnet system by Schneider Electric, Inc.

2.2 BUILDING AUTOMATION SYSTEM PERFORMANCE

A. Performance Standards: At the completion of the project with all panels and system operational, the DDCS shall conform to the following:

1. Graphic Display: The DDCS shall display a graphic with 20 dynamic points/objects with all current data within 10 seconds;
2. Graphic Refresh: The DDCS shall update a graphic with 20 dynamic points/objects with all current data within 8 seconds;
3. Object Command: The maximum time between the command of a binary object by the operator and the reaction by the device shall be less than 2 seconds. Analog objects should start to adjust within 2 seconds;
4. Object Scan: All changes of state and change of analog values will be transmitted over the high-speed BACnet Ethernet network such that any data used or displayed at a controller or workstation will have been current within the previous 2 seconds;
5. Alarm Response Time: The maximum time from when an object goes into alarm to when it is annunciated at OWS shall not exceed 45 seconds;
6. Program Execution Frequency: Custom and standard applications shall be capable of running as often as once every 1 second. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control;
7. Performance: BC, AAC and ASC shall be able to execute PID control loops at a frequency of at least once per second. The controller shall scan and update the process value and output generated by this calculation at this same frequency;
8. Multiple Alarm Annunciation: OWS on the network must receive alarms within 5 seconds of each other; and
9. The DDCS shall be capable of being expanded through either the use of additional controllers or expansion cards to provide complete control of future HVAC equipment.

B. DDCS Components: Control system shall include the following:

1. OWS and software functioning as the primary operator interfaces for the DDCS;
2. BC, AAC and ASC;
3. Control panels;
4. Native BACnet communication buses to serve OWS, BC, AAC and ASC;
5. Data communication between the BC, AAC, ASC, and OWS shall be carried in a dedicated raceway;
6. BACnet communication gateways between non-DDCS systems and the DDCS (computer room unit's manufacturer's controllers and Chillers);
7. Data shall be digitally displayed with properly located decimal point and two or three alphabetic characters on the display of the OWS;
8. Provide necessary devices for proper operation of control system, i.e. transmitters, sensors, temperature controllers and indicators, motors, linkages, flow control valves, relays and gages;
9. Provide electronic equipment in accordance with the requirements of FCC Regulation, 47 CFR Part 15, Subpart B Unintentional Radiators, governing radio frequency electromagnetic interference and be so labeled;
10. Provide UL listed equipment; and
11. Raceway, wiring, terminations and mounting of equipment to present a fully functional integrated system.

2.3 BUILDING CONTROLLER (BC)

A. General: Each BC shall conform to the BACnet Building Controller (B-BC) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L.

B. System Operation: The BC shall operate the equipment as described in the sequence of operation. The system shall include the following:

1. Software: The BC complete with software shall be capable of controlling and monitoring electrical equipment; heating, ventilating and air conditioning equipment; and energy management systems. The BC shall monitor and control all input and output sensors and devices using shielded twisted pair cable. The BC shall be specifically designed to be monitored by and communicate with the OWS.
2. Controllers: Microprocessor based processors, with one or more microprocessor based input/output (I/O) modules interfacing controllers to the sensors and output devices. The system shall utilize Solid State Storage, EPROM or RAM memory. RAM and the clock for EPROM/RAM systems shall be provided with power backup of 4-hour instant recharge capacitor or 12-hours trickle recharge batteries. The battery backup shall protect the memory for a minimum of 72 hours. Controllers shall have memory error checking. Upon detection of a memory error, the controller processor shall correct the error or halt the unit to prevent erroneous operation. The BC shall be field proven and shall be listed in UL 916 PAZX.
3. Inputs and Outputs:

    a. Analog Input: Analog inputs shall be compatible with RTD temperature sensors, 0-20 mA, 0-5 V DC, 0-10 V DC or potentiometer inputs with 12 bit A/D conversion resolution minimum. Match inputs types to sensors provided.
    b. Analog Output: Analog output or pulse width modulated outputs shall be provided for control of end actuator devices. Overall analog output range of 0 to 10 volts or 4-20 mA with 8 bit D/A resolution minimum shall be provided.

c. Digital Inputs: Digital inputs shall be processed for change of status. Alarm monitor points shall be assignable to normally open or to normally closed contacts.
d. Digital Outputs: Digital outputs shall be assigned a priority with higher priorities able to override lower priorities. Controller digital, two positions signals may operate the positioning device directly or have an interposing relay to give the proper signal level.
e. Prioritization: The command prioritization mechanism in Clause 19.2 of ASNI/ASHRAE 135-2004 shall be used including the priority assignments of Clause. If the contractor needs to define a priority level that is indicated as "Available" in Clause 19.2.2, then these assignments must be submitted to and approved by the COR in advance.
f. I/O Point Distribution: All I/O points specified for a piece of equipment shall be integral to a single controller. Except where it is otherwise permitted, a single controller may be used to control more than one piece of equipment.
g. Controller Capacity: Each BC shall have the ability to monitor, control and address the required data points. The mix of addressable points shall include analog inputs, analog outputs, digital inputs and outputs required to perform the functions indicated.

4. Communication

a. Each BC shall reside on or be connected to a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing (ANSI/ASHRAE 135-2004, BACnet Annex J).
b. BACnet routing shall be performed by BCs or other BACnet device routers as necessary to connect BCs to networks of AACs and ASCs.
c. Service Port: Each controller shall be provided with a service communication port, which is BACnet Data Link/Physical layer compatible, for connection to a Portable Operator's Terminal.
d. Signal Management: BC operating systems shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and to allow for central monitoring and alarms.
e. Data Sharing: Each BC shall share data as required with each networked BC, AAC and ASC. All points on the BC shall be communicated to the OWS.

5. The property support indicated below shall be provided if the object is required to be present in order to meet the application requirements.

a. Analog Input, Analog Output and Analog Value: These objects shall have the following writeable properties: Object Name; Object Value; Description; COV Increment; Out of Service and Units. In addition, these objects shall support the properties: Device type; Reliability; Min./Max. Values; Update Interval and Resolution.
b. Binary Input, Binary Output And Binary Value: These objects shall have the following writeable properties: Object Name; Object Value; Description; Polarity; Default Value; Min On/Off and Out of Service. In addition, these objects shall support the properties: Device Type; Reliability; Active/Inactive Texts; Update Interval; Resolution; Change-of-State Time; Count Times and Time Reset.
c. Calendar: This object shall have the following writeable properties: Object Name; Object Value; Description; and Date List.
d. Device: This object shall have the following writeable properties: Object Name; Description; Location; and UTC Offset.

e. Event Enrollment: This object shall have the following writeable properties: Object Name; Object Value; Description; Out-of-Service; Event & Notify Types; Parameters; Property Ref; Enable; and Notification Class.
f. File: This object shall have the following writeable properties: Object Name; Description; File Type; and File Access.
g. Loop (PID): This object shall have the following writeable properties: Object Name; Object Value; Description; Polarity; Output and Input Refs.; Input Value & Units; Setpoint Value; PID Values; Bias; Write Priority and COV Increment. In addition, this object shall support the properties: Reliability; Update Interval; Proportional Constant & Units; Derivative Constant & Units.
h. Notification Class: This object shall have the following writeable properties: Object Name; Object Value; Description; Priority and Ack Required.
i. Program: This object shall have the following writeable properties: Object Name; Object Value and Description. In addition, this object shall support the property Reliability.
j. Schedule: This object shall have the following writeable properties: Object Name; Object Value and Description; Effective period; Schedule; Exception; Controlled Properties and Write Properties.
k. Trend Log: This object shall have the following writeable properties: Object Name; Description; Log Enable; Start/stop Times; Log Device Object Property; Log Interval; Stop When Full; Buffer Size; and Record Count.

6. BC Reliability: The mean time between failure (MTBF) of the BC shall not be less than 6,000 hours for the installed systems. System failure shall be defined as single malfunction that causes loss of data or failure to function as specified.
7. Corrective Maintenance Time: Mean Time To Repair (MTTR) is defined as the elapsed time starting with BC failure or malfunction until the BC is again available for service, including checkout and warm up time required. The MTTR of the BC shall not be greater than two hours. Maximum repair time for failures shall not be greater than six hours. Corrective maintenance times are dependent on spare parts availability at the site.
8. Data Control (D/C): The requirements below are associated with the hardware devices to be connected to the BC and the standard control software modules to be implemented. Provide additional software required to accomplish the detailed Sequence of Operations.

a. Each analog point shall have unique controller resident dual high and dual low limit alarm thresholds set in engineering units. The first set of limits shall be warning limits, which provide a normal band around the temperature set point. If the analog point exceeds these limits a warning shall be issued at the OWS indicating that the analog value is out of its normal range. An alarm shall be generated at the OWS if the analog point value exceeds the second set of limits. See “DDCS Point Function Schedule” for list of alarm limits.
b. Where digital outputs have an associated monitored input, if the monitored input does not track its associated command output within a programmable time interval, a command-failed alarm shall be reported.
c. Unless otherwise indicated, the primary analog input and the analog output of each control loop shall be resident in a single controller containing the control algorithm, and shall function independently of BACnet communication links. Secondary, reset type, analog inputs may be received from the network, but approved default values and procedures shall be substituted in the control algorithm for this secondary input if network communications fail or if the secondary input becomes erroneous or invalid.

9. BC Configuration: It shall be possible to configure the BC over the network. This configuration shall include application program assignments; group and point assignments; data point modifications (additions and deletions); alarm parameter assignments; and peripheral assignments.

    a. Changing program or application package parameters, adding data points, or deleting data points, shall not interfere with data processing or other application programs being executed.
    b. Each BC in the system shall contain its own microprocessor and memory. Each BC in the system shall be completely independent with its own hardware clock, calendar, firmware and software to maintain control on an independent basis.
    c. Each BC shall be capable of storing and executing demand forecast programs, duty cycle programs, calculation point programs, and include the following capabilities:

        1) Acquire, process, and transfer information to the OWS or other controllers on the same BACnet network.
        2) Accept, process, and execute commands from the other controllers on the same BACnet network or OWS on the network.
        3) Allow access to both data base and control functions by multiple workstations on the BACnet network at the same time. Provide plug-in connections for programmable terminals.
        4) Record, evaluate, and report the changes of state and values that occur among points associated with the BC.

    d. Each BC panel shall continuously perform self-diagnostics, communication diagnosis and diagnosis of subsidiary equipment. The BC shall provide both local and remote annunciation of detected component failures; or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each BC and shall not require the connection of an operator interface device.
    e. BC software shall provide equipment cycling protection. Control shall include a provision for limiting the number of times each piece of equipment may be cycled within any one hour period.
    f. BC shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.
    g. Provide software to execute and observe diagnostics of remote devices connected to the BACnet LAN and the ability to deactivate and restart the device.

10. Software: The BC, complete with software, shall provide a real time control language for HVAC system applications designed to accomplish easy transition from hardware control system design to local loop based control system design. The system software shall allow the user to provide control sequences directly into the controller and operators terminal memory.
11. Control Algorithms: A control application package shall be provided to permit nonstandard control algorithms to be provided as part of the initial installation or added at a later date. The control algorithms shall permit interlocks, calculations of BTUs, flows, and outputs; and provide hysteresis, scaling, offset, linearization, summation, multiplication, division, and other functions. Default modes, start up and check out tests, interlocks, demand control and other functions shall be provided utilizing these algorithms.
12. Controller Local Loops: Controllers shall be totally stand alone and independent of the OWS, for indicated control applications. Failure of the OWS shall in no way inhibit the operation or program execution of the controllers. Controllers software shall include: a

complete operating system; application packages as indicated; standard control algorithm application packages; a user control and calculation application package; and the following:

a. EPROM or RAM resident operating system (OS), operating independently of central computers. The operating system shall control BACnet communications between the operator's terminal, controllers and the input/output (I/O) modules; accept analog and digital inputs; produce analog and digital outputs; provide alarm monitoring; control application packages; and interface the necessary sensor and actuators. The controller OS shall also contain built-in diagnostic routines as indicated.
b. Allow for scaling and for calibration of sensor lead length variations to insure instrument accuracy, and provide for automatic restart of equipment based on current program time without operator intervention.
c. Provide a system advisory and alarm any time there is a loss of communication between the I/O microprocessor and the OWS. In the event of I/O microprocessor failure, provide a means for local or remote alarm. Also provide an override of selected output functions.
d. Built in safeguards to prevent the BC microprocessor from becoming captured by one control loop resident in the BC. These built-in software safeguards shall be resident in nonvolatile memory.
e. Power Fail-automatic Restart-interrupt: If power is removed and then restored, an interrupt shall be generated at one of the highest possible priority levels. This interrupt shall automatically cause a bootstrap operation to occur, which in turn shall call the automatic restart routines.
f. Data Base Manager: A menu data base manager shall be provided that manages data on an integrated, non-redundant basis. The data base manager shall allow additions and deletions to the database without detriment to existing data.
g. Timer Routine: A timer routine shall be provided that executes at the lowest foreground priority level. If a command fails to execute after a predetermined amount of time, a message shall be reported to the OWS.
h. Error Messages: Executing and operating system errors shall be reported to the OWS.
i. Recovery from Fatal Errors: The BC shall indicate an error at the OWS after an error occurs that halts operation of active programming in the controller.

13. Control Groups: User control groups shall be provided to allow selected points to assume a control state based on the reception of a pre-defined initiator. The groups shall be logically constructed without regard to their physical location in the system. Each group shall have a sufficient number of points so that each point state to be assumed shall be individually assignable. The set or reset initiators may be calendar or elapsed time event occurrences, such as alarms, or inputs from an authorized operator. A control group sequence initiator shall override other action until a reset initiator is received or a manual operator request is made.
14. Alarms: Whenever a field point status exceeds preset limits, or there are other indications of system exceptions, alarms, error or failure, there shall be at least the following indications:

a. The OWS shall sound an integral audible tone. The audible tone shall be capable of being enabled or disabled on operator command.
b. The alarm point identification, along with individual point alarm messages, shall appear at the OWS. Upon operator command, a list of alarm points programmed into the DDCS, along with their alarm messages, shall be listed on the OWS.

c. Alarm prioritization shall be configured in accordance to the applicable categories as specified in ANSI/ASHRAE 135-2004, BACnet Annex M. Notification classes shall be configured in a manner that distinguishes between the facilities involved and to meet any other operational needs requested by the FAA.

15. Memory, Processing and Functional Capability: Specifically, a BC shall contain memory, processing and functional capability to perform the following in a stand-alone mode:

    a. Scheduled start/stop; based on time of day, calendar, holiday, lead/lag schedule and temporary schedules;
    b. Adaptive start/stop;
    c. Duty cycling;
    d. Automatic temperature and humidity control;
    e. Demand control using a sliding window, predictive algorithm;
    f. Event initiated control;
    g. Calculated point including energy calculations;
    h. Scanning and alarm processing;
    i. Full direct digital control;
    j. Trend logging;
    k. Global communications;
    l. Maintenance scheduling;
    m. BACnet communications with the OWS and other controllers;
    n. Night setback control;
    o. Variable frequency drive/air flow control;
    p. Enthalpy or dry bulb switch-over (economizer); and
    q. Temperature compensated load reset.

16. BC Global Communications: Global data values required by the installation shall be updated using change-of-value notifications.
17. BC Variable Execution Timer: It shall be possible to independently set the execution speed for each point in the BC to an operator selected time from 1 to 60 seconds.
18. BC Upload and Download Capability: Each BC shall support backup and restore functionality as defined in Clause 19.1 of ANSI/ASHRAE 135-2004.
19. Test Mode Operation: Each BC shall have the ability to place input/output points in a test mode. The test mode shall allow control algorithms to be tested and developed on line without disrupting the field hardware and controlled environment. This shall be accomplished by making Out-Of-Service properties writable and outputs commandable.
20. Communications Loss - Stand-Alone Operation: The BC shall continue, without interruption, to operate peripheral equipment if communications with the network bus is interrupted. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network. Alarms shall be stored for up to 48 hours, or until memory is filled, and then when communications are restored, the alarms and abnormal operating conditions shall be transmitted to the OWS.
21. Fail Safe Operation - BC Power Loss or Component Failure: When the BC is disabled or in the event of a power failure to the BC, outputs shall fail as indicated in the sequence of operation and the “DDCS Point Function Schedule”. For such items as remote temperature adjustment, the reset signal shall maintain its last setting. Manual equipment start and stop control capabilities, such as motor starter hand-off-auto switches, shall remain fully operational. Upon the resumption of normal power, the BC shall analyze the status of controlled equipment, compare it with normal occupancy scheduling, and turn equipment on or off as necessary to resume normal operation.
22. Real Time Clock: Routines shall be provided to maintain time of day, date and interval timers.

2.4 ADVANCED APPLICATION CONTROLLER (AAC)

A. Advanced Application Controller: A limited capacity microprocessor based controller that is custom programmable. Each AAC shall conform to the BACnet Advanced Application Controller (B-AAC) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L. The controllers shall be EPROM based with sufficient I/O point capacity for controlling the units in accordance with the control drawings and the sequence of operation. The controllers shall be capable of processing the signals of the specified sensors, and shall have the capability to drive the outputs required. The AAC shall be field proven and shall be listed in UL 916 PAZX.

1. Memory: The controller shall have sufficient memory to support its own operating system and database. All set points, proportional bands, control algorithms, custom programming, and any other programmable parameters shall be stored for a minimum of 72 hours without requiring reprogramming, in the event of the loss of power.
2. Operator Interface: The controller shall have the capability of receiving configuration and program loading from the OWS or a compatible Portable Operator's Terminal.
3. Communications: Each AAC shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing (ANSI/ASHRAE 135-2004, BACnet Annex J), or it shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol. In the event of a network failure, the controller shall be capable of operating in a stand alone mode.
4. Service Port: Each controller shall provide a service communication port, which is BACnet Data Link/Physical layer compatible, for connection to a Portable Operator's Terminal.
5. Signal Management: AAC operating systems shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and to allow for central monitoring and alarms.
6. Data Sharing: Each AAC shall share data as required with each networked BC, AAC and ASC. All points on the AAC shall be communicated to the local OWS.
7. Inputs and Outputs: A minimum of 8 bit sensing resolution shall be employed for all sensors.

    a. Analog Input: Analog temperature inputs shall be compatible with RTD temperature sensors. Analog inputs shall also accept 4-20 mA or 0-10 VDC. Match inputs types to sensors provided.
    b. Analog Output: Analog output or pulse width modulated outputs shall be provided for control of end actuator devices. Overall analog output range of 0 to 10 volts or 4-20 mA with 8 bit D/A resolution minimum shall be provided.
    c. Digital Inputs: Digital inputs shall be processed for change of status. Alarm monitor points shall be assignable to normally open or to normally closed contacts.
    d. Digital Outputs: Digital outputs shall be assigned a priority with higher priorities able to override lower priorities. Controller digital, two position signals may operate the positioning device directly or have an interposing relay to give the proper signal level.
    e. Prioritization: The command prioritization mechanism in Clause 19.2 of ASNI/ASHRAE 135-2004 shall be used including the priority assignments of Clause 19.2.2. If the contractor needs to define a priority level that is indicated as "Available" in Clause 19.2.2, then these assignments must be submitted to and approved by the COR in advance.
    f. I/O Point Distribution: All I/O points specified for a piece of equipment shall be integral to a single controller. Except where it is otherwise permitted, a single controller may be used to control more than one piece of equipment.

g. Controller Capacity: Each AAC shall have the ability to monitor, control and address the required data points. The mix of points shall include analog inputs, analog outputs, digital inputs and outputs in sufficient quantities to perform the function indicated.

8. The property support indicated below shall be provided if the object is required to be present in order to meet the application requirements.

a. Analog Input, Analog Output And Analog Value: These objects shall have the following writeable properties: Object Name; Object Value; Description; COV Increment; Out of Service and Units. In addition, these objects shall support the properties: Device type; Reliability; Min./Max. Values; Update Interval and Resolution.
b. Binary Input, Binary Output And Binary Value: These objects shall have the following writeable properties: Object Name; Object Value; Description; Polarity; Default Value; Min On/Off and Out of Service. In addition, these objects shall support the properties: Device Type; Reliability; Active/Inactive Texts; Update Interval; Resolution; Change-of-State Time; Count Times and Time Reset.
c. Calendar: This object shall have the following writeable properties: Object Name; Object Value; Description; and Date List.
d. Device: This object shall have the following writeable properties: Object Name; Description; Location; and UTC Offset.
e. Event Enrollment: This object shall have the following writeable properties: Object Name; Object Value; Description; Out-of-Service; Event & Notify Types; Parameters; Property Ref; Enable; and Notification Class.
f. File: This object shall have the following writeable properties: Object Name; Description; File Type; and File Access.
g. Loop (PID): This object shall have the following writeable properties: Object Name; Object Value; Description; Polarity; Output and Input Refs.; Input Value & Units; Setpoint Value; PID Values; Bias; Write Priority and COV Increment. In addition, this object shall support the properties: Reliability; Update Interval; Proportional Constant & Units; Derivative Constant & Units.
h. Notification Class: This object shall have the following writeable properties: Object Name; Object Value; Description; Priority and Ack Required.
i. Program: This object shall have the following writeable properties: Object Name; Object Value and Description. In addition, this object shall support the property Reliability.
j. Schedule: This object shall have the following writeable properties: Object Name; Object Value and Description; Effective period; Schedule; Exception; Controlled Properties and Write Properties.

9. AAC Reliability: The mean time between failure (MTBF) of the AAC shall not be less than 6,000 hours for the installed systems. System failure shall be defined as a single malfunction that causes loss of data or failure to function as specified.
10. Corrective Maintenance Time: Mean Time To Repair (MTTR) is defined as the elapsed time starting with AAC failure or malfunction until the AAC is again available for service, including checkout and warm up time required. The MTTR of the AAC shall not be greater than two hours. Maximum repair time for failures shall not be greater than six hours. Corrective maintenance times are dependent on spare parts availability at the site.
11. Data Control (D/C): The requirements below are associated with the hardware devices to be connected to the AAC and the standard control software modules to be implemented. Provide additional software required to accomplish the detailed Sequence of Operations.

a. Each analog point shall have unique controller resident dual high and dual low limit alarm thresholds set in engineering units. The first set of limits shall be warning limits, which provide a normal band around the temperature set point. If the analog point exceeds these limits a warning shall be issued at the OWS indicating that the analog value is out of its normal range. An alarm shall be generated at the OWS if the analog point value exceeds the second set of limits. See "DDCS Point Function Schedule" for list of alarm limits.
b. Where digital outputs have an associated monitored input, if the monitored input does not track its associated command output within a programmable time interval, a command-failed alarm shall be reported.
c. Unless otherwise indicated, the primary analog input and the analog output of each control loop shall be resident in a single controller containing the control algorithm, and shall function independently of BACnet communication links. Secondary, reset type, analog inputs may be received from the network, but approved default values and procedures shall be substituted in the control algorithm for this secondary input if network communications fail or if the secondary input becomes erroneous or invalid.

12. AAC Configuration: It shall be possible to configure the AAC over the network. This configuration shall include application program assignments; group and point assignments; data point modifications (additions and deletions); alarm parameter assignments; and peripheral assignments.

a. Changing program or application package parameters, adding data points, or deleting data points, shall not interfere with data processing or other application programs being executed.
b. Each AAC in the system shall contain its own microprocessor and memory. Each AAC in the system shall be completely independent with its own hardware clock, calendar, firmware and software to maintain control on an independent basis.
c. Each AAC shall be capable of storing and executing demand forecast programs, duty cycle programs, calculation point programs, and include the following capabilities:

1) Acquire, process, and transfer information to the OWS or other controllers on the same BACnet network.
2) Accept, process, and execute commands from the other controllers on the same BACnet network or the local OWS on the network.
3) Allow access to both data base and control functions by multiple workstations on the BACnet network at the same time. Provide plug-in connections for programmable terminals.
4) Record, evaluate, and report the changes of state and values that occur among points associated with the AAC.

d. Each AAC shall continuously perform self-diagnostics, communication diagnosis and diagnosis of subsidiary equipment. The AAC shall provide both local and remote annunciation of detected component failures; or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each AAC and shall not require the connection of an operator interface device.
e. AAC software shall provide equipment cycling protection. Control shall include a provision for limiting the number of times each piece of equipment may be cycled within any one hour period.

f. AAC shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.

g. Provide software to execute and observe diagnostics of remote device connected to the BACnet LAN and the ability to deactivate and restart the device.

13. Software: The AAC, complete with software, shall provide a real time control language for HVAC system applications designed to accomplish easy transition from hardware control system design to local loop based control system design. The system software shall allow the user to provide control sequences directly into the controller and operators terminal memory.

14. Control Algorithms: A control application package shall be provided to permit nonstandard control algorithms to be provided as part of the initial installation or added at a later date. The control algorithms shall permit interlocks, calculations of BTUs, flows, and outputs; and provide hysteresis, scaling, offset, linearization, summation, multiplication, division, and other functions. Default modes, start up and check out tests, interlocks, demand control and other functions shall be provided utilizing these algorithms.

15. Controller Local Loops: Controllers shall be totally stand alone and independent of the OWS, for indicated control applications. Failure of the OWS shall in no way inhibit the operation or program execution of the controllers. Controllers software shall include: a complete operating system; application packages as indicated; standard control algorithm application packages; a user control and calculation application package; and the following:

    a. EPROM or RAM resident operating system (OS), operating independently of central computers. The operating system shall control BACnet communications between the operators terminal, controllers and the input/output (I/O) modules; accept analog and digital inputs; produce analog and digital outputs; provide alarm monitoring, control application packages; and interface the necessary sensor and actuators. The controller OS shall also contain built-in diagnostic routines as indicated.

    b. Allow for scaling and for calibration of sensor lead length variations to insure instrument accuracy, and provide for automatic restart of equipment based on current program time without operator intervention.

    c. Provide a system advisory and alarm any time there is a loss of communication between the I/O microprocessor and the OWS. In the event of I/O microprocessor failure provide a means for local or remote alarm. Also provide an override of selected output functions.

    d. Built in safeguards to prevent the AAC microprocessor from becoming captured by one control loop resident in the AAC. These built-in software safeguards shall be resident in nonvolatile memory.

    e. Power Fail-automatic Restart-interrupt: If power is removed and then restored, an interrupt shall be generated at one of the highest possible priority levels. This interrupt shall automatically cause a bootstrap operation to occur, which in turn shall call the automatic restart routines.

    f. Data Base Manager: A menu data base manager shall be provided that manages data on an integrated, non-redundant basis. The data base manager shall allow additions and deletions to the database without detriment to existing data.

    g. Timer Routine: A timer routine shall be provided that executes at the lowest foreground priority level. If a command fails to execute after a predetermined amount of time, a message shall be reported to the OWS.

h. Error Messages: Executing and operating system errors shall be reported to the OWS.
i. Recovery from Fatal Errors: The AAC shall indicate an error at the OWS after an error occurs that halts operation of active programming in the controller.

16. Control Groups: User control groups shall be provided to allow selected points to assume a control state based on the reception of a pre-defined initiator. The groups shall be logically constructed without regard to their physical location in the system. Each group shall have a sufficient number of points so that each point state to be assumed shall be individually assignable. The set or reset initiators may be calendar or elapsed time event occurrences, such as alarms, or inputs from an authorized operator. A control group sequence initiator shall override other action until a reset initiator is received or a manual operator request is made.
17. Alarms: Whenever a field point status exceeds preset limits, or there are other indications of system exceptions, alarms, error or failure, there shall be at least the following indications:

a. The OWS shall sound an integral audible tone. The audible tone shall be capable of being enabled or disabled on operator command.
b. The alarm point identification, along with individual point alarm messages, shall appear at the OWS. Upon operator command, a list of alarm points programmed into the DDCS, along with their alarm messages, shall be listed on the OWS.
c. Alarm prioritization shall be configured in accordance to the applicable categories as specified in ANSI/ASHRAE 135-2004, BACnet Annex M. Notification classes shall be configured in a manner that distinguishes between the facilities involved and to meet any other operational needs requested by the FAA.

18. Memory, Processing and Functional capability: Specifically, an AAC shall contain memory, processing and functional capability to perform the following in a stand-alone mode:

a. Scheduled start/stop; based on time of day, calendar, holiday, lead/lag schedule and temporary schedules;
b. Adaptive start/stop;
c. Duty cycling;
d. Automatic temperature and humidity control;
e. Demand control using a sliding window, predictive algorithm;
f. Event initiated control;
g. Calculated point including energy calculations;
h. Scanning and alarm processing;
i. Full direct digital control;
j. Global communications;
k. BACnet communications with the OWS and other controllers;
l. Night setback control;
m. Variable frequency drive/air flow control;
n. Enthalpy or dry bulb switch-over (economizer); and
o. Temperature compensated load reset.

19. AAC Global Communications: Global data values required by the installation shall be updated using change-of-value notifications.
20. AAC Variable Execution Timer: It shall be possible to independently set the execution speed for each point in the AAC to an operator selected time from 1 to 60 seconds.

21. AAC Upload and Download Capability: Each AAC shall support backup and restore functionality as defined in Clause 19.1 of ANSI/ASHRAE 135-2004.
22. Test Mode Operation: Each AAC shall have the ability to place input/output points in a test mode. The test mode shall allow control algorithms to be tested and developed on line without disrupting the field hardware and controlled environment. This shall be accomplished by making Out-Of-Service properties writable and outputs commandable.
23. Communications Loss - Stand-Alone Operation: The AAC shall continue, without interruption, to operate peripheral equipment if communications with the network bus is interrupted. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network. Alarms shall be stored for up to 48 hours, or until memory is filled, and then when communications are restored, the alarms and abnormal operating conditions shall be transmitted to the OWS.
24. Fail Safe Operation - AAC Power Loss or Component Failure: When the AAC is disabled or in the event of a power failure to the AAC, outputs shall fail as indicated in the sequence of operation and the "DDCS Point Function Schedule". For such items as remote temperature adjustment, the reset signal shall maintain its last setting. Manual equipment start and stop control capabilities, such as motor starter hand-off-auto switches, shall remain fully operational. Upon the resumption of normal power, the AAC shall analyze the status of controlled equipment, compare it with normal occupancy scheduling, and turn equipment on or off as necessary to resume normal operation.
25. Real Time Clock: Routines shall be provided to maintain time of day, date and interval timers.

2.5 APPLICATION SPECIFIC CONTROLLER (ASC)

A. Application Specific Controller: A limited capacity microprocessor based controller that is pre-configured for a specific application, with limited adjustability. Each ASC shall conform to BACnet Application Specific Controller (B-ASC) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L. The controllers shall be EPROM based or non-volatile flash memory with sufficient I/O point capacity for controlling the units in accordance with the control drawings and the sequence of operation. The controllers shall be capable of processing the signals of the specified sensors, and shall have the capability to drive the outputs required. The ASC shall be field proven and shall be listed in UL 916 PAZX.

1. Memory: The controller shall have sufficient memory to support its own operating system and database. All set points, proportional bands, control algorithms, and any other programmable parameters shall be stored in on-board memory.
2. Operator Interface: The controller shall have the capability of receiving configuration and program loading from the OWS or a compatible Portable Operator's Terminal.
3. Communications: Each ASC shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol. In the event of a network failure, the controller shall be capable of operating in a stand alone mode.
4. Service Port: Each controller shall provide a service communication port, which is BACnet Data Link/Physical layer compatible, for connection to a Portable Operator's Terminal..
5. Signal Management: ASC operating systems shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and to allow for central monitoring and alarms.
6. Data Sharing: Each ASC shall share data as required with each networked BC, AAC and ASC. All points on the ASC shall be communicated to the local OWS.
7. Inputs and Outputs: A minimum of 8 bit sensing resolution shall be employed for all sensors.

a. Analog Input: Analog temperature inputs shall be compatible with RTD temperature sensors. Analog inputs shall also accept 4-20 mA or 0-10 V DC. Match inputs types to sensors provided.
b. Analog Output: Analog output values shall be provided for control of end actuator devices.
c. Digital Inputs: Digital inputs shall be processed for change of status. Alarm monitor points shall be assignable to normally open or to normally closed contacts.
d. Digital Outputs: Digital outputs shall be assigned a priority with higher priorities able to override lower priorities. Controller digital, two position signals may operate the positioning device directly or have an interposing relay to give the proper signal level.
e. Prioritization: The command prioritization mechanism in Clause 19.2 of ASNI/ASHRAE 135-2004 shall be used including the priority assignments of Clause 19.2.2. If the contractor needs to define a priority level that is indicated as "Available" in Clause 19.2.2, then these assignments must be submitted to and approved by the COR in advance.
f. Fail Safe Operation: Outputs shall be designed to interface with the equipment being monitored to fail as indicated in the sequence of operation or the “DDCS Point Function Schedule”. For such items as remote temperature adjustment, the reset signal shall maintain its last setting. Manual equipment start and stop control capabilities shall be fully operational through the motor starter hand-off-auto switches.
g. Controller Capacity: Each ASC shall have the ability to monitor, control and address the required data points. The mix of points shall include analog inputs, analog outputs, digital inputs and outputs in sufficient quantities to perform the function indicated.

B. ASC Software

1. The ASC shall operate totally stand-alone and independent of the OWS and other controllers, for all specified control applications. Software shall include a complete operating system, communications handler, point processing, standard control algorithms and specific control sequences. Software shall include built-in diagnostics.
2. ASC upload and download capability: Each ASC shall support backup and restore functionality as defined in Clause 19.1 of ANSI/ASHRAE 135-2004.
3. All modifications to set-points, parameters, etc., shall be made electronically via an OWS.
4. Each ASC shall be equipped with standard pre-installed control programs specific to the application. Custom settings shall be able to be utilized as part of the pre-configured application program to meet the control strategies called for in the sequence of operation.

2.6 OPERATOR WORK STATION (OWS)

A. The OWS shall be provided for command entry, information management, network alarm management and database management functions. All real-time control functions and control logic of each piece of equipment controlled shall be resident in the BC, AAC and ASC to facilitate greater fault tolerance and reliability.

1. The OWS shall consist of all necessary hardware to support the BAS hardware/software required and perform all functions and capabilities specified. The system shall consist of

a personal computer, monitor, mouse, printer and any other hardware required to meet the requirements specified.

B. Hardware: As a minimum, provide the hardware described below. Where the BAS manufacturer's recommended OWS hardware requirements exceeds these minimum requirements, provide hardware in accordance with the manufacturer's recommendations.

1. Acceptable Personal Computer Manufacturers: Personal computer manufacturers shall be companies that are in the normal business of providing computers to vendors on a day-to day basis for use in industrial applications. The computer shall operate using a Microsoft® Windows 7 or higher operating system environment capable of operating as a workstation in a Windows network environment and meet the requirements of this specification. The manufacturer must provide as a normal service, an on-site warranty, 24-hour rapid response hot-line, and replacement parts. Subject to compliance with these requirements, manufacturers offering products that may be incorporated in the Work include but are not limited to, the following:

   a. IBM
   b. Dell
   c. Hewlett-Packard

2. Provide a personal computer which meets the requirements as specified by the Schneider Electric (SE) ARTCC / CERAP Program Office, but in no case fails to meet the following minimum requirements:

   a. Intel Dual/Quad Core 2.4 GHz/Core i5 3.33 GHz or higher.
   b. 4 gigabytes of 1333 MHz DDR3 SDRAM, expandable to 16 gigabytes.
   c. 48x/32x variable speed recordable/rewriteable CD-RW with software.
   d. Redundant Array of Independent Disks (RAID) with minimum capacity of 250 Gigabyte per disk250 Gigabyte SATA hard drive.
   e. Super Video Graphics Array (SVGA) display driver with minimum 512 megabytes of video memory and MPEG capability.
   f. 22 inch color LCD monitor with minimum SVGA resolution of 1600 by 1200 pixels, and 16.7 million colors.
   g. Sound card with powered speakers.
   h. Full upper and lower case ASCII keyboard, numeric keypad.
   i. 2 button mouse with scroll wheel.
   j. 6 USB ports.
   k. 1 serial port.
   l. 10/100/1000 Mbps communications port for communication with the BAS.

3. The personal computer shall function as a satellite operator workstation complete with mouse, keyboard and color monitor, to be physically located in coordination with the COR and ESU.
4. The operator workstation shall provide total keyboard-less operation as the primary operator interface.
5. A plain paper laser printer with 10 pages per minute minimum print speed, minimum 6 megabytes of RAM, 600 x 600 dpi resolution, instant on fuser, energy star compliant, and 50 sheet paper tray, and parallel port or USB connection to the computer.
6. Additional hardware shall be provided as necessary to provide the functions required by this specification.

2.7 OPERATOR WORK STATION (OWS) USER INTERFACE

A. General: The existing Schneider Electric StruxureWare® workstation installed as part of the previous Fuel Storage System project will be the primary operator interface for the new and existing systems. The new OWS shall be loaded with new StruxureWare® front-end software and other utilities as necessary. New OWS loaded with front-end user interface described below will primarily be used for network and system configurations, programming modification and control logic download for new BACnet system until the control system replacement for the entire facility is complete. All new and existing Schneider Electric StruxureWare® OWS control screens shall be available to an operator at any Schneider Electric StruxureWare® OWS, either existing or provided as part of this project.

B. The contractor, in coordination with the Schneider Electric ARTCC / CERAP Program Office, shall provide hardware, programming and OWS control screen development to allow operator access to existing Metasys DDC system data and control from the Schneider Electric StruxureWare® OWS terminals.

C. Communications: The OWS shall communicate using BACnet/IP and use Ethernet to connect to the IP network, while using the same Ethernet LAN for non-IP communications to other BACnet devices on the LAN. Interoperability on wide area networks (WANs) must be supported. The OWS shall reside on a high-speed network with the building controllers. The OWS shall be able to access all system information.

D. The latest tested and reliable version of the DDCS manufacturer's system software available at the time shall be installed in the OWS and the DDCS controllers prior to system testing and personnel training.

E. OWS control screen modules are available from the Schneider Electric (SE) ARTCC / CERAP Program Office and may be modified by the contractor, in coordination with the Schneider Electric (SE) ARTCC / CERAP Program Office, to effect the desired operation as described herein.

F. OWS interface software shall minimize operator training through the use of English language prompting, English language point identification and industry standard PC application software. The software shall provide, as a minimum, the following functionality:

1. Graphical viewing and control of control system;
2. Scheduling and override of control operations;
3. Collection and analysis of historical data;
4. Definition and construction of dynamic color graphic displays; and
5. Editing, programming, storage and downloading of controller databases.

G. The OWS interface shall allow each authorized operator to execute the following functions as a minimum:

1. Log In and Log Out: System shall require user name and password to log in to operator interface.
2. Point-and-click Navigation: Operator interface shall be graphically based and shall allow operators to access graphics for equipment and geographic areas using point-and-click navigation.
3. View and Adjust Equipment Properties: Operators shall be able to view controlled equipment status and to adjust operating parameters such as set points, PID gains, on and off controls, and sensor calibration.

4. View and Adjust Operating Schedules: Operators shall be able to view scheduled operating hours of each schedulable piece of equipment on a weekly or monthly calendar-based graphical schedule display, to select and adjust each schedule and time period, and to simultaneously schedule related equipment. System shall clearly show exception schedules and holidays on the schedule display.
5. Time Clock: Operators shall be able to set the date and time in any device on the network that supports time-of-day functionality. This capability shall be provided for individual devices, groups of devices, or all devices simultaneously. The workstation shall be able to synchronize time. The workstation shall be able to perform as a BACnet network "time master."
6. View and Respond to Alarms: Operators shall be able to view a list of currently active system alarms, to acknowledge each alarm, and to clear (delete) unneeded alarms.
7. View and Configure Trends: Operators shall be able to view a trend graph of each trended point and to edit graph configuration to display a specific time period or data range. Operator shall be able to create custom trend graphs to display on the same page data from multiple trended points.
8. View and Configure Reports: Operators shall be able to run pre-configured reports, to view report results, and to customize report configuration to show data of interest.
9. Manage Control System Hardware: Operators shall be able to view controller status, to restart (reboot) each controller, and to download new control software to each controller.
10. Manage Operator Access: Typically, only a few operators are authorized to manage operator access. Authorized operators shall be able to view a list of operators with system access and of functions they can perform while logged in. Operators shall be able to add operators, to delete operators, and to edit operator function authorization. Operator shall be able to authorize each operator function separately.
11. Manage Demand Limiting Control Strategies: Operator shall be able to configure and adjust demand limiting control strategies for the building to reduce peak demand and consumption. Demand limiting control strategies shall adjust a building’s operations when a predetermined demand threshold is met to keep demand below the threshold during critical peak load periods of the day.

H. Graphical Color Displays

1. Operator’s workstation shall display all data associated with project as indicated in “DDCS Point Function Schedule” and control diagrams. Operator’s workstation shall display all data using two and/or three-dimensional graphic representations of all mechanical equipment. System shall be capable of displaying graphic file, text, and dynamic object data together on each display. Information shall be labeled with descriptors and shall be shown with the appropriate engineering units. All information on any display shall be dynamically updated without any action by the user. OWS shall allow user to change all field-resident functions associated with the project, such as set points, schedules, holiday/event schedules, etc. from any screen no matter if that screen shows all text or a complete graphic display. At a minimum, OWS shall display all data related to the following:

    a. Temperature and flow control diagram for each mechanical equipment, including outside air units and computer room air handling units;
    b. Temperature and flow control diagram for chilled/condenser water system including system schematic diagram;
    c. Floor plans indicating the locations of space temperature and humidity sensors and all controllers;
    d. Equipment summary page of each type of equipment indicating status, temperature and set-point;

e. Building Controller diagrams;
f. Advanced Application Controller diagrams;
g. I/O summary and configuration display of each BC, AAC and ASC; and
h. Floor plans indicating the locations of water leak detection panels.

2. The interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme using a mouse. Each display shall be protected from modifying unless operator has appropriate security level. A security level shall be assigned to each display and critical system object. The menu label shall not appear on the graphic if the operator does not have the appropriate security level.
3. Dynamic airflow values, temperature values, humidity values and status indication shall be shown in their actual respective locations and shall automatically update to represent current conditions without operator intervention. For the terminal units, the space temperature sensor display and point description shall indicate both terminal unit number and room number.
4. All binary and analog data objects can be displayed as light/switch indicator, sequence of multiple graphics to simulate motion, individual graphic item or animation using graphical symbols. Graphics shall be saved in an industry-standard format such as BMP, JPEG, or GIF. Provide all software, tools and library of pre-engineered graphical screens and symbols to allow the user to add, modify or delete system graphic displays.
5. A mouse shall be used to move the pointer arrow to the desired item for selection of new display or to allow the operator to make changes to object data.

I. System Access and Security

1. Provide security function that prevents unauthorized use unless operator is logged on. Access shall be limited to operator's assigned functions when user is logged on. Each operator's terminal shall provide security for 10 users as a minimum. Each user shall have an individual User ID/Name and Password. System user shall be allowed individual assignment of only those control functions and menu items to which that user requires access. Each user shall also have a set security level, which defines access to displays and individual objects the user may control. System shall include minimum of 5 separate and distinct security levels for assignment to users.
2. System shall include an auto logout feature that shall automatically logout user when there has been no keyboard or mouse activity for a set period of time. Time period shall be adjustable by system administrator.

J. Schedule

1. Operators shall be able to view scheduled operating hours of each schedulable piece of equipment on a weekly or monthly calendar-based graphical schedule display, to select and adjust each schedule and time period, and to simultaneously schedule related equipment. Also, operators shall be able to schedule holidays and special events directly from the calendar.
2. Scheduling shall include optimum start based on all parameters specified in the sequence of operation. Each and every individual zone or group of equipment shall be able to have optimum start time independently. Optimum start feature shall calculate the startup time needed to match zone temperature to set point.

K. Alarm

1. Operator's workstation shall provide audible, visual, and printed means of alarm indication. Printout of alarms shall be sent to the assigned terminal and port. System

input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object. Configure and enable alarm points as noted in the "DDCS Point Function Schedule." Alarms shall be BACnet alarm objects and shall use BACnet alarm services.

2. Alarm messages shall use an English language descriptor without acronyms or mnemonics to describe alarm source, location, and nature. Alarm messages shall be in user-definable text and shall be entered either at the OWS. The alarm dialog box shall always become the top dialog box regardless of the application(s), currently running.
3. OWS shall be able to display messages, print, start programs, send e-mail, text message, and audibly annunciate. Operators shall be able to view system alarms and changes of state chronologically, to acknowledge and delete alarms, and to archive closed alarms to the workstation. OWS shall provide log of alarm messages. Alarm log shall be archived to the hard disk of the OWS.

L. Trend Log

1. Operator shall be able to configure trend sample or change of value (COV) interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs. Controller shall sample and store trend data and shall be able to archive data to the hard disk. Coordinate items to be trended and trend configurations with the FAA facility maintenance personnel. Trends shall be BACnet trend objects.
2. OWS shall periodically gather historically recorded data stored in the building controllers and archive the information. Archived files shall be appended with new sample data, allowing samples to be accumulated. Systems that write over archived data shall not be allowed, unless limited file size is specified. Operator shall be able to configure trend sample or change of value (COV) interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs. Coordinate items to be trended and trend configurations with the FAA facility maintenance personnel.
3. Software shall be capable of graphing the trend logged object data. Software shall be capable of creating two-axis (x,y) graphs that display up to ten object types at the same time in different colors. Graphs shall show object values relative to time
4. Operator shall be able to change trend log setup information. This includes the information to be logged as well as the interval at which it is to be logged. All input, output, and value object types in the system may be logged.

M. Operator Activity Log

1. Operator Activity Log shall be included with system that tracks all operator changes and activities. System shall track what is changed in the system, who performed this change, date and time of system activity and value of the change before and after operator activity. Operator shall be able to display all activity, sort the changes by user, time and also by operation.
2. Log shall be gathered and archived to hard drive on operator workstation as needed. Operator shall be able to export data for display and sorting in a spreadsheet.

N. Demand Limiting

1. Operator shall be able to configure and adjust demand limiting control strategies for the building to reduce peak demand and consumption. Demand limiting control strategies

shall adjust a building's operations when a predetermined demand threshold is met to keep demand below the threshold during critical peak load periods of the day.

O. Software and Tools

1. OWS shall be provided with all necessary software and tools for system configuration and programming. All application controllers shall be programmed using graphical tools that allow the user to connect function blocks on screen that provide sequencing of all control logic. Function blocks shall be represented by graphical displays that are easily identified and distinct from other types of blocks.
2. Programming tools shall include a real time operation mode. Function blocks shall display real time data and be activated to show status of data inputs and outputs when in real time operation.
3. Software and tools shall also include a database of applications that include pre-engineered standard logic files for controllers and associated graphics. Operator shall be able to select unit type, input/output configuration and other items that define unit to be controlled as necessary.
4. System shall be able to automatically detect any devices connected on the BACnet network by scanning of the entire network. This function shall display device instance, network identification and description of connected devices. Also, it shall be possible to record and display software and logical programming file loaded into each controller. A copy of each file shall be stored on the computers hard drive. If needed, this file shall be downloaded to the appropriate controller by selection using the mouse.
5. System shall include backup/restore function that will back up entire system to selected medium and then restore system from that media.
6. Graphics Generation: Graphically based tools and documentation shall allow Operator to edit system graphics, to create graphics, and to integrate graphics into the system. Operator shall be able to add analog and binary values, dynamic text, static text, and animation files to a background graphic using a mouse.
7. Graphics Library: Complete library of standard HVAC equipment graphics shall include equipment such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. Library shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. Library graphic file format shall be compatible with graphics generation tools.
8. Custom Application Programming: Operator shall be able to create, edit, debug, and download custom programs. The system shall be fully operable while custom programs are edited, compiled, and downloaded.

2.8 NETWORK AND COMMUNICATION

A. Control products, communication media, connectors, repeaters, hubs, switches and routers provided under this Section shall comprise a BACnet network. Provide the devices needed to integrate the existing MetaSys controllers into the new Schneider Electric StruxureWare® system. The Contractor shall provide and install communication cable, connectors, repeaters, bridges, routers, switches and hubs necessary for the DDCS network. The contractor shall provide additional network hardware such as Ethernet routers and switches for the extension of DDCS network or connection.

B. The time clocks in controllers shall be automatically synchronized daily. Time synchronization shall be implemented via BACnet time synchronization services. The DDCS shall automatically adjust for daylight savings time.

C. Network operator interface and value passing shall be transparent to network architecture.

1. An operator interface connected to a controller shall allow the operator to interface with each network controller as if directly connected. Controller information such as data, status, and control algorithms shall be viewable and editable from each network controller.
2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the network. Program and test all cross-controller links required to execute control strategies specified. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.

D. A break in the communication path of the network shall be announced as an alarm and shall automatically initiate a network reconfiguration such that the resulting sections of the bus continue to function as separate networks. No loss of control shall result from such a break in the bus.

2.9 CONTROL PANELS

A. Local Control Panels: Unitized cabinet with suitable brackets for wall or floor mounting, located as indicated on drawings or adjacent to each system under automatic control if not indicated on drawings. Provide common keying for all panels.

1. Construction: NEMA 1 as defined in ICS-6 "Enclosures for Industrial Control Systems", totally enclosed, with hinged doors and keyed lock, with manufacturer's standard shop-painted finish and color. Provide NEMA 3R and NEMA 4X type panels where required by the application.
2. Panel-Mounted Equipment: Temperature and humidity controllers, relays, switches and automatic switches; except safety devices. Mount devices with adjustments accessible through front of panel.
3. Door-Mounted Equipment: Flush-mount (on hinged door) manual switches, keyed switches, alarm horns, pushbuttons, changeover switches, digital displays and indicator lights.
4. Tags: Devices shall be permanently labeled with laminated plastic nameplates, black with white lettering, with minimum 1/4 inch lettering. Tag shall include device ID's as shown on as-built documentation and DDCS software identification. Internal and external wires shall also be labeled.
5. Panel Components: Enclosures shall include following:

    a. BC, AAC, ASC, hubs, switches, repeaters or routers.
    b. Provide pre-wired control cabinets containing:
        1) 120V power outlet;
        2) Terminal strips; and
        3) Electrical relays - latching or magnetically held.

    c. Provide electronic equipment in accordance with the requirements of FCC Regulation, 47 CFR Part 15, Subpart B Unintentional Radiators, governing radio frequency electromagnetic interference and be so labeled.
    d. Provide UL listed equipment.
    e. Raceway, wiring, terminations and mounting of equipment to present a fully functional integrated system.

2.10 CONTROL TRANSFORMERS

A. General: Provide high capacity step-down transformers where required to power control system components. The transformers shall have a secondary output rating that is at least 150 percent of the total load of the connected devices. Each transformer shall be enclosed in a metal box with conduit knockouts. The transformers shall be UL Listed. The secondary output of the transformer shall be protected by an appropriately sized fuse.

2.11 INPUT AND OUTPUT SENSORS AND DEVICES

A. General: Input and output sensors and devices shall be closely matched to the requirements of the BC, AAC, and ASC for accurate, responsive, noise free signal input and output. Control input sensitivity shall be matched to the control loop gain requirements for precise and responsive control. In no case shall computer inputs be derived from pneumatic sensors nor shall thermocouples be used.

1. Temperature Sensors: Temperature sensors shall be compatible with new BACnet StruxureWare® DDC controllers provided by Schneider Electric.

    a. Space Temperature Sensors: Provide with blank institutional type locking covers. Accuracy shall be plus or minus 0.5°F over range of 50 to 100°F.
    b. Duct Temperature Sensors: Rigid stem or averaging type as specified in the sequence of operation or as shown on the control drawings. Accuracy shall be plus or minus 0.5°F over range of 30 to 130°F. Thermistor type averaging sensors will not be accepted for averaging elements
    c. Water Temperature Sensors: Provide with a separable, copper, or stainless steel well. Accuracy shall be plus or minus 0.5°F over range of 30 to 200°F.
    d. Outside Air Wall Mounted Sensors: Provide with a sun shield and mount where effects of sun and mass of the building are minimized. Coordinate location with COR. Accuracy shall be plus or minus 0.5°F over a range of minus 30 to 130°F.

2. Space and Duct Relative Humidity Sensors: Relative humidity sensors shall be bulk polymer capacitive type with 0 to 100 percent relative humidity range. Operating range of the sensor shall be 32 to 140°F. Temperature effect shall be less than 0.12 percent per degree F. Accuracy shall be plus or minus 2 percent in the 20 to 95 percent range. Supply voltage shall be 12 to 30 VDC. The sensor response time constant shall be 120 seconds or less. Sensor shall not be affected by condensation and shall recover from being saturated without re-calibration.
3. Differential pressure transmitter (Air): The differential pressure transmitter shall be calibrated for the appropriate operating range based on set point. The output signal shall be transmitted in an analog 4-20mA format with an accuracy of plus or minus 1 percent of the calibrated span. The transmitter shall have a local span and zero. Transmitter shall be capable of withstanding pressures of up to 8 times the calibrated range without damage or re-calibration.
4. Differential Pressure Transmitter (Liquid): The differential pressure transmitter shall be capable of measuring differential pressures from 0 to 250 psig and shall be calibrated for 0-100 psig. The output signal shall be transmitted in an analog 4-20 mA format with an accuracy of plus or minus 0.5 percent of the calibrated span. The transmitter shall have a local span and zero adjustment and 3-valve manifold to allow for field calibration. Transmitter shall be capable of withstanding pressures of up to 250 psig without damage or re-calibration.

5. Freeze Protection Thermostat: Provide with manual reset and an adjustable set point between 32 and 55°F. Thermostat shall include sensor that responds to lowest temperature sensed in any 1 foot segment of the element. At least one foot of sensing element shall be provided per square foot of coil. Install sensor as per the manufacturer's recommendations. Freezestat shall be provided with a minimum of two contacts, one rated for a minimum of 120V, 16 Amps, and one for a minimum of 120V, 6 Amps.

B. Equipment Operation Sensors:

1. Current Relays: Current relays shall be sized for a current range appropriate to the fan or pump motor being monitored. The trip point shall be adjustable through a pot and set to 75 percent of rated motor current. The current relay shall be capable of withstanding a maximum continuous current of 150 Amps. Operating temperature shall be -58°F to 149°F. The current relay shall meet UL 94V-0 for flammability. A LED indicator shall be included which distinguishes between the following three conditions: tripped relay switch, current present but relay switch not tripped and no current present. The monitored frequency shall be 6 Hz minimum, allowing for accurate monitoring of variable frequency drives. The relay switch shall be rated for 1 to 135 VAC/DC at 0.3 Amps and shall not be polarity sensitive.
2. Differential Pressure Switch (Liquid): Differential pressure switch piped across pump with adjustable operating range of not less than 125 percent and not more than 175 percent of the total dynamic head of the pump served. Switch shall include an adjustable dead-band with a minimum dead-band of 1 psig. Switch shall be rated for minimum 2 amps at 120 VAC. Repeatability shall be maximum of plus or minus 1 percent of full scale. Enclosure shall be NEMA 1 with adjustments and operation visible through transparent cover.
3. Differential Pressure Switch (Air): Differential pressure switch piped across filter or fan inlet and outlet with adjustable set point and a range of 0 to 5 inches wg, with maximum pressure rating of at least 10 inches wg.

2.12 DAMPER ACTUATORS

A. Damper Actuators: Provide electric damper actuators for all dampers. See Division 23, “Duct Accessories” for information on control dampers.

1. Damper Actuators: Provide electric type, direct shaft mount damper actuators with bracket arrangement for location outside of the air stream. Actuators shall provide at least 125 percent of the required torque to effectively operate the damper. Actuator drive time for 90 degrees rotation shall be 120 seconds maximum. Actuators shall be rated for a cycle life of 60,000 full stroke cycles minimum. Actuators shall be normally open, normally closed, or fail in position as required to obtain the operation as described in the Sequence of Operation or as shown on the DDCS Point Function Schedule. Normally open and normally closed dampers shall return, using a spring mechanism, to their normal position in the event of a power failure or loss of signal to the actuator. Provide transformers, and accessories as required. Actuators requiring linkages, crank arms, connecting rods, or ball joints are not acceptable. Damper actuator shall be securely attached to the damper shaft with a set screw or some other fastener to minimize slippage. When a U-Bolt is used to attach the actuator to the damper shaft, the shaft shall be modified with a file or a grinder to provide a flat side or a notch where the U-bolt is fastened to the shaft to minimize slippage.
2. Damper Position Switch: When required by the sequence of operation or the DDCS Point Function Schedule, provide damper position switches. Switches shall provide dry contact

signals to the controller when the damper is fully open or fully closed, as required by the sequence of operation. Switch may be a part of electric actuators.

2.13 CONTROL VALVES

A. General: Factory fabricated, of type, body material, and pressure class indicated. Where type or body material is not indicated, make selection as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature rating of piping system.

B. Characterized Control Ball Valves:

1. Up to and including 3 Inches: Nickel-plated forged brass body, valve trim shall utilize stainless steel ball and stem, fiberglass reinforced Teflon PTFE seats with O-rings, 2 EPDM O-rings packing.
2. Hydronic Systems:

a. Flow Characterizing Disc: A flow characterizing disc, made of Tefzel Teflon shall be installed in the inlet of 2-way characterized control ball valves. 3-way valves shall utilize flow characterizing discs at both input ports. Standard ball valves without this feature are not acceptable.
b. Pressure Rating: Service of 400 psi at 212°F.
c. Close Off Pressure: 200 psi.
d. Rangeability: 500:1.
e. Sizing: 5-psi maximum pressure drop at design flow rate.
f. Flow Characteristics: 2-way valves shall have equal port percentage characteristics; 3-way valves shall have linear characteristics. Operators shall close valves against pump shutoff head.

C. Globe Pattern:

1. Over 3 Inches: Iron body, bronze trim, 316 stainless steel rising stem, bronze plug-type disc, flanged ends, renewable bronze seat and disc, TFE V-ring packing
2. Hydronic Systems:

a. Pressure Rating: Service of 125 psi WSP at 250°F, ANSI Class 125.
b. Internal Construction: Replaceable plugs and seats of stainless steel or bronze.

1) Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom of guided plugs.

c. Rangeability: 50:1.
d. Sizing: 5-psi maximum pressure drop at design flow rate.
e. Flow Characteristics: 2-way valves shall have equal percentage characteristics; 3-way valves shall have linear characteristics. Operators shall close valves against pump shutoff head.

D. Butterfly Valves: Refer to Division 23, “General-duty Valves for HVAC Piping”, for the requirements of butterfly valves.

E. Valve Actuator: Provide electric valve actuators, which are two position or modulating as required by the Sequence of Operation. Actuators shall be of ample capacity to handle the

required load under all conditions and as a minimum shall close valves against pump shutoff head pressure of 55 psi. Unless otherwise indicated, valves shall be arranged to return to the normal (fail-safe) position in the event of a power failure to the actuator. Actuator shall be provided with wheel or handle for manual override, which shall allow manual positioning of control valve without disconnecting the power.

F. Valve Position Transmitter: When required by the sequence of operation or the DDCS Point Function Schedule, supply a valve position transmitter, which provides proportional valve position signal through a 0-10 VDC or 4-20 mA feedback signal to the DDC controller. The position transmitter may be part of the electric actuator.

2.14 HAND-OFF-AUTO AND OVERRIDE SWITCHES

A. General: Provide oil tight two or three position knob type switches as required by the application. Switches shall include screw terminals and contacts rated for the application, but not less than 10 amps at 120 VAC. Switches shall be rated both mechanically and electrically for minimum 500,000 operations. Include legend plate, which matches the application.

2.15 RELAYS

A. Relays: Provide relays with LED relay coil status indicator. Rated coil voltage shall match the application. Contacts shall be minimum DPDT rated for 10 amps resistive at 120 VAC. Panel mounted relays shall be plug-in blade type, with surface or snap track mounted relay bases and screw terminals. Field mounted relays shall be installed in an enclosure and provided with screw terminals. Provide relay with Hand-Off-Auto switch where controlled equipment does not already include a Hand-Off-Auto switch. Provide latching type relays for unit start/stop's to fail in last commanded state.

B. Time delay relay: Provide delay-on-make relay, with 0-60 second adjustable time delay, and separable relay base with screw terminals. Time adjustment shall be through a knob mounted on the relay. DPDT relay contacts shall be rated for a minimum of 5 amperes at 120 VAC. Time shall be adjusted as required to minimize spikes in facility power demand after a power failure.

2.16 FILTER GAGES

A. General: Provide differential pressure switch/gage to sense the pressure drop across each air handling unit filter bank and separate filter banks as scheduled. Furnish gages with 0 to 4 inch w.c. range, 0.1 inch minor divisions, plus or minus 2 percent accuracy, and 5 inch diameter case. Switch shall include dry contacts rated for 0.5 amps at 125 VAC resistive, switch set point indicator on the gage, knob adjustment on the front of the unit. Surface mount gages on unit or ductwork near filter bank with high and low pressure connections installed according to manufacturer's recommendations.

2.17 FLOW METERS

A. Electromagnetic Flow Meter for Water Service (Chiller Branch Piping): Provide electromagnetic type flow meters as shown on the mechanical sheets and described hereinafter. The flow meter shall have the DC powered electromagnetic coils and electrodes, and measure

the induced voltage across the electrodes as a conductive fluid flows through the magnetic fields. The voltage is proportional to the average flow velocity of the fluid and then amplified and processed digitally by the converter to produce the signal for flow rate and totalization. Provide flow meters and transducers located in the pipe as shown on the drawings. Locate meter to provide the most efficient reading point.

1. Flow Range: 0.1 ~ 39.4 feet/seconds
2. Pipe size range: 1" through 24" nominal
3. Flow Direction: Unidirectional or Bidirectional
4. Provide remote transmitter with mounted hardware and the necessary cable
5. Alphanumeric LCD displays total flow, flow rate, flow direction and alarm conditions
6. Output signal: 4-20 mA or 0-10V analog output for flow rate
7. Accuracy: 0.4% of calibrated span for liquids
8. Fluid conductivity: 5 µS/cm minimum
9. Maximum fluid temperature: 140 deg F
10. Ambient temperature range: -4 to 140 deg F
11. Maximum operating pressure: 400PSI
12. Stainless steel electrode and tube with PTFE liner
13. Housing: NEMA 4X
14. Body: Wafer to match piping style or ANSI flanged specification.
15. Power Supply Options: 90 to 265 VAC, 45 to 60 Hz, and 35 mA maximum
16. Known Acceptable Source: Onicon model F-3000 Series

B. Electromagnetic Flow Meter for Water Service (Chilled Water and Condenser Water Main Piping): Provide electromagnetic type flow meters as shown on the mechanical sheets and described hereinafter. The flow meter shall have the DC powered electromagnetic coils and electrodes, and measure the induced voltage across the electrodes as a conductive fluid flows through the magnetic fields. The voltage is proportional to the average flow velocity of the fluid and then amplified and processed digitally by the converter to produce the signal for flow rate and totalization. Provide flow meters and transducers located in the pipe as shown on the drawings. Locate meter to provide the most efficient reading point. The flow measuring sensors shall be of the hot tap insertion type. The flow meter shall be provided with all necessary accessories including, but not limited to, mounting adapter, sitting, hot tap mount/tools with ball-type isolation valve, and flow transmitter.

1. Flow Range: 0.1 ~ 20 feet/seconds
2. Pipe size range: 3" through 72" nominal
3. Flow Direction: Unidirectional or Bidirectional
4. Provide remote transmitter with mounted hardware and the necessary cable
5. Alphanumeric LCD displays total flow, flow rate, flow direction and alarm conditions
6. Output signal: 4-20 mA or 0-10V analog output for flow rate
7. Accuracy: 1% of calibrated span for liquids
8. Fluid conductivity: 20 µS/cm minimum
9. Maximum fluid temperature: 140 deg F
10. Ambient temperature range: -4 to 140 deg F
11. Maximum operating pressure: 400PSI
12. All wetted metal parts shall be constructed of 316 stainless steel
13. Pressure Drop: 0.1 psi @ 12 feet/seconds
14. Power Supply Options: 20 to 28 VAC, 60 Hz
15. Provide hot tap with ball valve assembly to allow for meter removal.
16. Known Acceptable Source: Onicon model F-3500 Series

2.18 WATER LEAK DETECTION SYSTEM

A. General: Provide a leak detection system as indicated in the mechanical plans to detect leaks under the HVAC piping and in front of each AHU discharge under raised floor. The leak detection system shall be capable of detecting the presence of water (40 to 174°F) along the length of the new cable. Upon detection of water, the system shall sound an alarm and pin point the location of the leak in a display on the leak detection system panel. An alarm input will also activate an alarm signal at the OWS.

1. Known Acceptable Source: TraceTek TTDM leak detection and location module with TraceTek 1000 sensing cable manufactured by Raychem Corporation.
2. Provide water leak detection sensing cable as indicated in the mechanical plans to detect leaks under the HVAC piping and in front of each AHU discharge under raised floor.
3. Connect the sensing cable to the sensing cable system detection panel with system jumper cable using quick-connect-type connectors installed on the ends of each cable length.

B. Alarms and Locator Module: The alarm and locator module shall be able to detect the presence of water along the cable and indicate the location of the first contact with water with a precision of at least one percent of the cable length regardless of the position of the water ingress along the cable. The location of the first water contact shall be retained on the display of the alarm and locator module until the module is updated. The signal processor module shall be powered by 110 VAC. The module shall have labeled colored pilot lights indicating POWER, SERVICE, LEAK, and FAULT. Each light shall be a different color. The module shall include test, audible and visual alarm acknowledge (or alarm silence), and update functions as a minimum. Only the acknowledge or alarm silence function shall be accessible from the exterior of the enclosure. Other functions shall require access by key.

C. Module Signal Processor: The alarm and locator module shall sound a local alarm, actuate an output relay, and have a 4 line x 20 character backlit LCD read out that displays the distance in feet from the start of the sensing cable to the location of the first water ingress along the cable. The alarm and locator module shall have three sets of DPDT contacts rated for 110 VAC for the alarm contact shall be used to send a signal to the OWS. The sensitivity of the module shall be adjustable, enabling the system to detect leaks of different sizes. The module shall have a precision of 0.1 percent maximum of the cable length independent of the position of the water ingress along the cable. Provide a recess mounted steel cabinet conforming to NEMA OS-1, Type 1, with continuously hinged doors and engraved nameplates.

D. Leak Sensing Cable: As a minimum, the sensing cable shall consist of two sensor wires, a continuity monitor wire, and an insulated signal return wire. The sensor wires shall be jacketed by a conductive polymer to protect the conductors from corrosion. The sensor wires, continuity wire, and signal wire shall be covered by an abrasion resistant protective braid. The cable shall be provided in modular lengths of 3, 10, 25 or 50 ft with factory installed male/female quick-connect-type connectors on each end. The cable shall be flexible and carry not more than 24 VDC under normal operating conditions. Known Acceptable Source: TraceTek 1000.

E. Jumper Cable: The jumper cable shall consist of four wires in an overall insulated jacket to provide conductivity between the four wires in the segments of the water sensing cable. The cable shall be provided in modular lengths of 3, 10, 25 or 50 feet with factory installed male/female quick-connect-type connectors on each end that are compatible with the connectors on the water sensing cable.

F. System Map: Provide a new locator map to show layout of the leak detection cable. The map shall show the exact layout of entire new cable system with numerical indications in feet of each 25-foot interval along the cable (i.e., 0 ft, 25 ft, 50 ft, and 75 ft) and at center of each bend. The map shall also show locations and identifications of the control unit, the system map, and the pipe drip pan below the monitored pipes. The map shall be drawn at not less than 1/8 inch per foot scale, and it shall be clearly legible and readable. The map shall be installed behind a clear Plexiglas sheet for protection.

2.19 WATER LEVEL TRANSMITTER

A. Provide ultrasonic type water level transmitters with appropriate sensing range to measure the fluid level as shown on the drawings. The output signal shall be transmitted in an analog 4-20mA, 0-10VDC or 0-5 VDC format with an accuracy of plus or minus 0.15% of span in air. Transmitter shall be provided with NEMA 4X rated enclosure. Operating range of the sensor shall be minus 40°F to 130°F. Install transmitters in conformance with manufacturer's installation recommendations including optimization of selection of transducer placement.

2.20 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. Uninterruptible Power Supply: Provide UPS backup for each BC, AAC, communication switch, router, repeater and OWS installed under this section. A battery backup UPS system shall have a nominal input/output voltage of 120 VAC sine wave and be rated as required by application. The battery shall be maintenance-free, sealed, leak proof and lead-acid type. Each UPS shall be sized such that the controllers and network devices remain active during the power failure. Provide UPS with necessary network hardware and/or set of contacts for remote monitoring of UPS Status and UPS Alarm from the control system.

2.21 CATEGORY 5E CABLE

A. General: Products listed in this section represent the minimum required features and level of quality to meet system operational requirements. Where DDCS manufacturer’s recommendations exceed the specified minimum requirement, provide the cable recommended by the manufacturer**.**

B. Category 5e cables shall conform to or exceed EIA/TIA 568-B.2. Other standards supported shall include IEEE 802.3, 10BASE-T; and 100BASE-T. In addition, cables shall be capable of supporting evolving high-end applications. The cable shall be Underwriter's Laboratories (UL) listed type CMP.

C. Nonplenum Category 5e Unshielded Twisted Pair cables shall be composed of 24 AWG solid copper conductors, dual insulated with high density polyethylene (HDPE). The insulated conductors shall be twisted into pairs and jacketed with Polyvinyl Chloride (PVC) and shall meet or exceed the specifications listed below:

1. Maximum DC Resistance: 9.38A/100 m.
2. Mutual Capacitance: @1.0 Khz – 4.59 nF/100 m.
3. Mutual Capacitance Unbalance: 131.2 pF/100 m.
4. Attenuation (db/305 m): @1.0 Mhz – 6.3 db; @4.0 Mhz – 13.0 db; @10.0 Mhz – 20.0 db; @16.0 Mhz – 25.0 db; @25.0 Mhz – 32.0 db; @100.0 Mhz – 67.0 db.
5. Characteristic Impedance: @1.0 Mhz – 100.0 ± 15 ohm; @25.0 Mhz – 100.0 ± 15 ohm.

6. Worst Pair Near-End Crosstalk (db/305 m): @1.0 Mhz – 68.0 db; @4.0 Mhz – 59.0 db; @10.0 Mhz – 53.0 db; @16.0 Mhz – 50.0 db; @25.0 MHz – 47.0 db; @100.0 MHz – 38.0 db.

D. Plenum Category 5e Unshielded Twisted Pair cables shall be composed of 24 AWG bare solid-copper conductors, insulated with TEFLON. The insulated conductors shall be twisted into pairs and sheathed with a low smoke PVC jacket and shall meet or exceed the specifications listed below:

1. Maximum DC Resistance: 9.38A/100 m.
2. Mutual Capacitance: @ 1.0 Khz – 4.59 nF/100 m.
3. Mutual Capacitance Unbalance (pair to ground): 131.2 pF/100 m.
4. Attenuation (dB/305 m): @1.0 Mhz – 6.3 db; @4.0 Mhz – 13.0 db; @10.0 Mhz – 20.0 db; @16.0 Mhz – 25.0 db; @25.0 Mhz – 32.0 db; @100.0 Mhz – 67.0 db.
5. Characteristic Impedance: @1.0 Mhz – 100.0 ± 15 ohm; @25.0 Mhz – 100.0 ± 15 ohm.
6. Worst Pair Near-End Crosstalk (db/305 m): @1.0 Mhz – 68.0 db; @4.0 Mhz – 59.0 db; @10.0 Mhz – 53.0 db; @16.0 Mhz – 50.0 db; @25.0 MHz – 47.0 db; @100.0 MHz – 38.0 db.

E. Category 5e cables shall be run using a star topology format. The length of each individual run of horizontal copper cable shall not exceed 328 feet (100 meters).

2.22 FIBER OPTIC CABLE

A. General: Products listed in this section represent the minimum required features and level of quality to meet system operational requirements. Where DDCS manufacturer's recommendations exceed the specified minimum requirement, provide the cable recommended by the manufacturer**.**

B. Performance:

1. Multi-mode fiber optic cable:

a. Multimode fiber optic cable shall have a cladding diameter of 125 +/-2 microns and a core diameter of 62.5 +/-3 microns. It must be FDDI and ATM compliant and conform to all relevant ANSI and EIA/TIA standards.
b. The maximum attenuation shall be 3.5 dB/km @ 850nm and 1.0 dB/km @ 1300nm when measured in accordance with EIA-455-61. Attenuation measurements are to be made using an OTDR for cable runs that contain a splice, and Power Meter for unspliced cable run.

2. Single-mode fiber optic cable:

a. Single-mode fiber optic cable shall have a cladding diameter of 125 +/-2 microns and a core diameter of 9.3 +/-0.5 microns. It must be FDDI and ATM compliant and conform to all relevant ANSI and EIA/TIA standards.
b. The maximum attenuation shall be 0.6 dB/km @ 1300nm and 0.5 dB/km @ 1550nm when measured in accordance with EIA-455-61. Attenuation measurements are to be made using an OTDR for cable runs that contain a splice, and Power Meter for unspliced cable run.

C. Connectors: Fiber optic connectors shall be of type SC, with ceramic ferrules, beige for multi-mode, blue for single-mode. Maximum insertion loss is 0.5 dB.

D. Identification: All fiber must be run through inner duct or conduit. The pathway must be clearly labeled as "FIBER OPTIC CABLE" and must be labeled with information on the fiber's termination point and the fiber's owner. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials.

E. Quality Control:

1. Factory test cables on reels according to TIA/EIA-568-B.1.

2. Factory test multi-mode optical fiber cables according to TIA/EIA-526-14-A and TIA/EIA-568-B.3.

3. Prepare test and inspection reports. Cable will be considered defective if it does not pass tests and inspections.

2.23 CABLE AND WIRE

A. For Class 1 circuits, and power wiring provide 14 AWG minimum, Type THHN/THWN, solid wire in separate raceway.

B. For Class 2 and 3 circuits, provide 18 AWG minimum, power limited 300V, 140°F, type CM cable, which is so labeled. When recommend by the equipment manufacturer, or when required to comply with 47 CFR Part 15, Subpart B, “Unintentional Radiators,” provide shielded cables.

C. Cable and wire shall be non-halogenated low smoke producing cable tested in accordance with NFPA 262, “Standard Method of Test for Fire and Smoke Characteristics of Wires and Cables.” When burned, the cable shall produce a maximum peak optical smoke density of 0.5 and a maximum average optical smoke density of 0.15.

2.24 ROUTERS AND SWITCHES

A. Routers: Coordinate with the SE ARTCC Program Office to provide a StruxureWare® native BACnet compliant Ethernet router with BACnet MS/TP and BACnet /IP capabilities. The router shall have 10Base-T/100Base-TX Ethernet port with RJ-45 jack and EIA-485 MS/TP port with baud rate of 9.6 to 76.8 kbps, and shall serve as BACnet Broadcast Management Device (BBMD) when connected to IP network. Provide the router in accordance with the requirements of FCC Regulation, 47 CFR Part 15, Subpart B and the router shall be listed in UL 916 PAZX.

B. Switches: Provide Ethernet switch for the network connection between OWS, BC and/or BACnet router where necessary. The switch shall have minimum of five 10/100/1000Base-T Ethernet ports with RJ-45 jack and have the LEDs for power and link status. Provide the switch in accordance with the requirements of FCC Regulation, 47 CFR Part 15, Subpart B.

2.25 TAGS

A. Tags: Devices shall be permanently labeled with phenolic resin nameplates, black with white lettering, with minimum 1/4 inch lettering. Tag shall include device ID's, as shown on as-built documentation and software identification, affixed to the unit identification. Internal and external wires shall also be labeled.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Install equipment as indicated to comply with manufacturer's written instructions.

B. Connect and configure equipment and software to achieve the sequence of operation specified.

C. Verify location of temperature sensors, humidity sensors, and other exposed control sensors with plans and room details before installation. Locate room sensors 60 inches above the finished floor.

D. Install damper motors on outside of duct.

1. When a U-Bolt is used to attach the actuator to the damper shaft, modify the shaft to provide a flat side or a notch with a file or a grinder, where the U-bolt is fastened to the shaft to minimize slippage.

E. Install labels and nameplates to identify control components according to Division 23, “Identification for HVAC Piping and Equipment.” Devices shall be permanently labeled with phenolic resin nameplates, black with white lettering, with minimum 1/4-inch lettering. Tag shall include device ID's as shown on as built documentation and DDCS software identification. Internal and external wires shall also be labeled using computer printed wire tags. These tags shall include description and termination locations in the panel. Submit a complete list of nameplates prior to ordering.

F. Install hydronic instrument wells, valves, and other accessories according to Division 23, “Hydronic Piping.”

G. Install software in control units and OWS. Implement all features of programs to specified requirements and appropriate to sequence of operation. Provide English listing of analog/digital points and alarm messages.

H. Provide a ¼ inch diameter hole in the duct adjacent to each duct temperature sensor to allow the insertion of a test probe for sensor calibration. Provide a removable plug to seal the hole.

I. Color coding of Category 5e cable shall conform to requirements of EIA/TIA Standards.

J. Components of the network cabling system shall be labeled in accordance with EIA/TIA-606.

3.2 ELECTRICAL INSTALLATION

A. Install raceways, boxes, and cabinets in accordance with Division 26 requirements.

B. Install building wire and cable in accordance with Division 26 requirements.

1. Install wire and cable in raceways. Conduit shall be at a minimum 3/4 inch in size.
2. Install communication LAN wiring and fiber between BC, AAC, ASC and OWS in dedicated raceway separate from all other types of wire and cable.
3. For each sensor, input or output device, provide a single cable from the sensor or device directly to the BC, AAC or ASC. Each cable shall include the quantity of conductors required for the specific sensor or device. Sharing of conductors for multiple sensors shall not be permitted. Splices in the cable between the sensor or device and the BC, AAC or ASC shall not be allowed. Cables associated with analog signals shall be shielded. Drain wires from shielded cables (not including communication LAN cables) shall be grounded to the BC, AAC or ASC enclosure as close as possible to the point of entry
4. Install wire connectors and soldering lugs for use with copper conductors.
5. Fasten flexible conductors, bridging cabinets and doors, neatly along hinge side; protect against abrasion. Tie and support conductors neatly.
6. Number-code or color-code conductors, except local individual room controls, for future identification and servicing of control system.
7. Panels, junction boxes and raceway/conduit associated with the DDCS shall be clearly identified as part of the DDCS.

C. Provide Hand-Off-Auto selector switches for motor starters and disconnect switches to override automatic interlock controls when switch is in Hand position, except for safety interlocks such as freeze protection, smoke detectors or fire alarm interlocks. Do not provide Hand-Off-Auto selector switches for equipment operated through variable frequency drives.

3.3 CONNECTIONS

A. Ground equipment in accordance with Division 26 requirements.

1. Connect electrical components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten electrical connectors and terminals according to manufacturer’s published torque-tightening values. If manufacturer’s torque values are not indicated, use those specified in UL 486A.

3.4 COORDINATION

A. Test and Balance

1. Provide Test and Balance Contractor a single set of necessary tools to interface to control system for testing and balancing.
2. Train Test and Balance Contractor to use control system interface tools.
3. Test and Balance Contractor shall return tools undamaged and in working condition at completion of testing and balancing.

3.5 COMMISSIONING

A. Manufacturer's Field Services: Provide the services of a Schneider Electric factory-authorized service representative to start control systems and provide the commissioning coordination/support required under Division 1, Sections ”General Commissioning Requirements” and “HVAC Commissioning Requirements”.

1. Verify that equipment installation complies with contract documents, NEC, and manufacturer's written installation requirements. Correct deficiencies before proceeding.
2. Install BC, AAC, ASC and OWS with the latest software revision available. Confirm proper operation before proceeding.
3. Calibrate devices, make final settings, and thoroughly test control system and safeties under actual operating conditions for satisfactory performance before notifying the COR that the DDCS is operational.
4. Replace damaged or malfunctioning controls and equipment.
5. Start, test, and adjust control systems in accordance with the detailed requirements of the "Field Quality Control" section of this specification. This section details the following tasks, which shall be performed by the contractor:

    a. Test Plan
    b. Display Demonstration
    c. Functional Demonstration
    d. Operator Programming Demonstration
    e. Validation
    f. Testing
    g. Installation Inspection Report

6. Adjust, calibrate, and fine tune circuits and equipment to achieve Sequence of Operation specified and to provide safe, efficient operation. Provide "Installation Inspection Report" to the COR as described below under "Field Quality Control"..

3.6 FIELD QUALITY CONTROL

A. Test Plan: Submit test plan at least 60 calendar days prior to conducting the acceptance tests. Develop a detailed testing plan that consists of step by step procedures for entering nominal values into the system to simulate environmental conditions to be expected. Each test shall fully demonstrate the system operation capability as described below. Testing shall include local OWS functionality.

1. Display Demonstration: Perform a complete demonstration and readout of the capabilities of monitoring and control system in both textual and graphical format. This demonstration shall include an all points log to validate operation of 100 percent of the data points. Successful demonstration, including installation and training, constitutes a partial acceptance of the delivered system for on line operation. The demonstration shall include the basic operation of 100 percent of the connected points and shall show, in accordance with the I/O summary:

    a. Analog display;
    b. Digital display;
    c. Start/Stop display;
    d. Command of selected start/stop points; and
    e. Selected Set Point Adjustment (SPA) action, both automatically and manually initiated.

2. Functional Demonstration: The following functions shall be demonstrated:

    a. Analog alarm and return to normal;
    b. Digital alarm and return to normal;
    c. Start/Stop alarm and return to normal;

d. Off line memory access, including modification of at least two addressable memory locations;
e. Software driven functions, including energy management application programs, event initiated programs, alarm limits and analog alarm lockout;
f. That OWS are capable of full system control;
g. That single points and groups of points can be added or deleted in the program through keyboard entry;
h. Sequential start up after simulated power interruption;
i. Fail safe operation;
j. Alarms and other functions;
k. Simulated failure of all main equipment and auto transfer to standby;
l. Simulated power failure and automatic restarting of main equipment;
m. Simulated failure of BACnet transmission bus; and
n. BC, AAC and ASC failure (enunciate at OWS), with controlled devices positioned as required in the fail mode section of the DDCS Point Function Schedule

3. Operator Programming Demonstration: The following programming capabilities shall be demonstrated:

a. Assigning of high and low analog alarm limits;
b. Modifying analog alarm value;
c. Displaying group condition showing group detected, point within group off normal, ground fault and AC power off;
d. Modifying time based program by setting and resetting time assignment;
e. Dumping and reloading data;
f. Adding a point (the point type shall be selected by the COR at time of acceptance);
g. Deleting a point;
h. Adding a new group of points; and
i. Uploading and downloading of BC, AAC and ASC configuration programs.

4. Validation: Completely check out, calibrate and test connected hardware and software to insure that the system performs in accordance with the specified requirements and approved sequences of operation. Validation shall be witnessed by COR.

a. Running each specified report;
b. Displaying and demonstrating each data entry to show site specific customizing capability and demonstrating parameter changes;
c. Step through penetration tree, displaying graphics, demonstrating dynamic update and direct access to graphics;
d. Executing digital and analog commands in graphic mode;
e. Demonstrating DDC loop precision and stability through trend logs of inputs and outputs (6 loops minimum) by continuous operation of 7 days testing;
f. Demonstrating DDCS performance through trend logs and command trace;
g. Demonstrating scan, update, and alarm responsiveness;
h. Demonstrating spreadsheet and curve plot software and its integration with the database;
i. Demonstrating on line user guide and help function and mail facility;
j. Demonstrating digital system configuration graphics with interactive up-line and down-line load, and demonstrating specified diagnostics;
k. Demonstrating multitasking by showing dynamic curve plot and graphic construction operating simultaneously through split screen;
l. Demonstrating class programming with point options of beep duration, beep rate, alarm archiving and color banding;

m. Demonstrate BC, AAC and ASC stand alone execution, remote control interface, upload and download data from remote controller, and Windows XP compatibility;

n. Time and Event Application Control: Demonstrate that the system is capable of start/stop of controlled devices based on time and date setting, occupancy schedules, holiday schedules, activity defined schedules, lead/lag time and schedules changes, and rotational schedules; and

o. Network Strategies: A trend on a panel shall be set up for a point from a different panel. This point shall also be trended in its own panel for the same intervals. Comparison of the two trends shall indicate if communication problems occurred during the 7 days testing period. Provide a historical communication error summary for the 7-day period as an alternative.

B. Testing: Perform complete tests, as indicated. Schedule test date with COR and confirm date in writing at least ten working days prior to test. The written test date confirmation shall identify changed conditions that may affect the test results. Provide equipment and personnel required to perform the test. Perform tests of the DDCS, in accordance with the approved test plan, in presence of the COR.

C. Installation Inspection Report: Upon completion of tests, a list shall be provided by the COR, showing each outstanding item. The Contractor shall provide a schedule detailing items to be corrected and date for completion. As each item is approved, an appropriate notation shall be entered at the time of correction on the inspection report, with counter signature of the COR and date. A copy of this report shall be provided to the COR. If the system fails acceptance tests, the Contractor shall operate his system off line during corrective procedures.

3.7 TRAINING

A. General: Skilled and efficient use of the system requires operators trained to a level of proficiency that allows the Government to be independent from the DDCS supplier in the day to day operation of the facility and assures the Government that the capability of the DDCS can be used to operate the facility safely and efficiently. Government support personnel shall be trained on the system software prior to the completion of the system installation. In coordination with the SE ARTCC Program Office, submit a factory course description with an outline and conduct the sessions with factory instructors and training material after commissioning is complete and before acceptance of the system. Equipment installers are not acceptable instructors. The training shall be provided for 8 electrical/electronic technicians. The Contractor shall coordinate with the COR to determine the level of training required by each ESU technician and the specific criteria to be covered during the training. Coordinate the training schedule with the COR at least 60 days prior to the completion of system installation and submit the training outline at least 30 days prior to the scheduled training for review and approval. Provide the following training:

B. Interim Orientation Training: Provide 8 hours of interim orientation training on site per each shift, for two (2) shifts of maintenance staff, for a total of eight (8) students, on the system being installed. This training shall be coordinated with the COR at least 30 days prior to the installation of the first DDCS control panel for the chiller water system. Training shall include:

a. General introduction to BACnet based DDCS;
b. Overview of StruxureWare® Hardware and Software;
c. Interim operation and transitioning between I/Net and StruxureWare® systems;
d. Review of new control sequence for chilled water and condenser water system;
e. Day-to-day operation, trouble shooting and manual override;

C. Operator Training: Emphasis shall be on maintenance training, which shall provide in-depth knowledge on how to conduct complete troubleshooting, maintenance and repair of the installed equipment. Training shall include both diagnostics software and hardware maintenance. Provide review of menu driven operator's training of data display, alarm and status descriptors, data requesting, execution of commands, insertion and deletion of a point and development of software maintenance. Preventive maintenance training shall also be provided to determine software, firmware, or hardware failures.

1. Provide three (3) days of operator training on site per each shift, for two (2) shifts of maintenance staff, for a total of eight (8) students. Training shall encompass:

    a. Installation, wiring, calibration and troubleshooting of sensors, BC, AAC, ASC and control devices;
    b. Repair and replacement of sensors, BC, AAC, ASC and control devices;
    c. Preventative maintenance;
    d. Sequence of operation review;
    e. Sign on - Sign off;
    f. Selection of all displays and reports;
    g. Commanding of points, keyboard and mouse mode;
    h. Modifying English text;
    i. Use of all dialogue boxes and menus;
    j. Modifying warning limits, alarm limits and start and stop times;
    k. System initialization;
    l. Download and initialization of remote panels;
    m. Purge and dump of historical data;
    n. Use of OWS; and
    o. Password modification.

2. Supervisor Training: Supervisors shall participate in the operator training described above. In addition, provide an additional eight (8) hours of supervisor training encompassing:

    a. Password assignment and modification;
    b. Operator assignment and modification;
    c. Operator authority assignment and modification;
    d. Point disable and enable;
    e. Terminal and data segregation and modification;
    f. Use of OWS; and
    g. Use of spreadsheet package with system data.

3. Programming Training: Provide one (1) week of programming training for a total of three (3) students. Programmer training shall be for three (3) environmental technicians and shall be scheduled by the COR with 40 days advance notice anytime during the warranty period. Training shall include:

    a. Overview of BACnet based DDCS;
    b. Software review of Sequence of Operation and flowcharts;
    c. Modification of control programs;
    d. Add-Delete-Modify data points;
    e. Use of diagnostics;
    f. System maintenance procedures;
    g. Review of initialization;
    h. Upload and download and off line archiving of all system software; and

i. Graphic creation.

4. On-site Application Training: Provide two (2) days of refresher training on site per each shift, for two (2) shifts of maintenance staff, for a total of eight (8) students. This training shall be provided within one year of system operation following the final acceptance of the control system. Coordinate the training schedule with the COR at least 45 days prior to the scheduled training. Training shall encompass:

   a. Calibration and troubleshooting of sensors, BC, AAC, ASC and control devices;
   b. Repair and replacement of sensors, BC, AAC, ASC and control devices;
   c. Preventative maintenance;
   d. Selection of all displays and reports;
   e. Modifying warning limits, alarm limits and start and stop times;
   f. Purge and dump of historical data;
   g. Operator authority assignment and modification;
   h. System maintenance procedures; and
   i. Graphic modification

5. Training aids: Provide all training aids, equipment and training manuals. Provide one copy of the training manual for each student. Submit materials for Government approval.
6. Video Recording: The FAA reserves the right to videotape the training sessions for later use.
7. Student education level: The training for the various courses shall be structured for electrical/electronic technicians with experience in operating computers, but little experience in programming. The students education level shall be high school plus approximately two years technical training in math, sciences, and electrical and mechanical equipment.

3.8 ACCEPTANCE

A. As Built Documentation: Submit complete set of as built data which shall identify the equipment supplied and the interconnecting wiring along with identification of components by part number or by ordering number. Record actual locations of control components, including control units, thermostats, and sensors. Revise Shop Drawings to reflect actual installation and operating sequences. Data shall also include final set points, alarm limits, time schedules, and other DDCS software information specific to this installation.

1. DDCS Database: Maintain CD or DVD copies of data files and application software for reload and use in the event of a system crash or memory failure. Deliver two (2) hard copies to the COR during training session, and archive one soft copy in an external hard disk to be provided by the controls contractor for storage in the facility.
2. Design Drawings: Deliver two hard copies of CAD generated system design drawings in DXF/DWG format to the COR during training session, and archive one soft copy in an external hard disk to be provided by the controls contractor for storage in the facility.
3. Provide electronic copies of As-built shop drawings, DDC logic diagrams and Operation and Maintenance Manual. The drawings, logic diagrams and O&M manual shall be generated in PDF or JPEG file format and be located in the OWS, so the user can access the diagrams and manuals without using a special software or tool. Panel layout diagram shall consist of a scale drawing showing all control devices installed in the panel. Wiring diagram shall consist of a complete schematic drawing showing the termination between the field/control devices and controller.

B. Software, Firmware and Hardware Documentation Rights: The system described shall be used to control environmental parameters at the ARTCC. As such, it is essential that the Government have full and complete rights to system software, and to system firmware and hardware documentation supplied for this project. The Government shall have the right to reproduce (for internal use), copy, alter, use (within the scope of this project) data and software submitted. In return for this right the Government agrees to maintain this data in a reasonably secure manner and agrees not to divulge the data to competitors or use the data for alternate purposes. The DDCS manufacturer shall be required to license the Government to use the OWS and DDCS software.

C. Guarantee: The Guarantee shall include a service and parts guarantee for one year from the date of acceptance of the installation, without charge to the Government. After completion of the original installation, provide service incidental to the proper performance of the control system under the guarantee for the period of one year. Calibrate and adjust the control system, including controllers, sensors, relays, control valves, motors, and other equipment provided under this contract. Place them in complete operating condition subject to the approval of the COR.

D. Acceptance: The acceptance date of the system shall be that date the COR and the Contractor jointly agree that the system meets the requirements of this specification. This date shall be the effective date of the start of the first year maintenance contract and shall constitute formal acceptance by the FAA at the facility.

3.9 MAINTENANCE SERVICE

A. First Year Maintenance Service: Provide first year maintenance. In addition to and in coordination with the SE ARTCC Program Office, a single source at the contractors facility shall be identified for first year maintenance type items. Failures under first year maintenance shall be corrected by the contractor at his expense. Such occurrences shall not void acceptance. Appropriate logs, schedules, and reports shall be maintained to reflect those items and their redress. First year maintenance service shall extend for a period of one year after system acceptance and shall include the following provisions:

1. Establish and maintain a telephone line that may be used by field facilities to obtain factory support of the installed system. The telephone number shall be made available to the Government facility at the time of installation. The telephone shall be staffed by an on-call factory trained equipment specialist and programmer. The telephone shall be answered during normal plant hours. During nights, weekends, and holidays, an answering machine shall be provided to receive Government trouble calls. Trouble calls shall be returned by the factory within 14 hours of receipt of the call on night, weekend, and holiday calls, and within two hours if the call is received during normal plant hours.
2. Ship LRUs and requested parts upon request by the Government facility requiring first year maintenance parts and assistance, within three hours during normal plant hours and within 15 hours during nights, holidays, and weekends. Shipping costs to the Government facility shall be borne by the contractor. Shipping shall be UPS or similar fast door-to-door service. Factory shipments shall be addressed to the Environmental Support Unit.
3. Repair all returned parts at the contractor’s expense. The only exception is for neglect or abuse such as damage by liquids or breakage or power anomalies.
4. Contractor first year maintenance support applies to software as well as equipment.
5. Government maintenance technicians shall perform required preventative maintenance tasks in accordance with periodic maintenance tasks and procedures specified in the

Contractors periodic maintenance requirements handbook, developed in conjunction with the SE ARTCC Program Office.

6. Provide to the COR a local existing commercial source (within the local metropolitan commuting area) where parts, LRUs and circuit boards, and trained technical support can be obtained. The Government at its discretion has the right to procure parts and service on a local basis to restore the system to an operating configuration on an emergency basis and such action shall not void the guarantees. Costs for local support shall be borne by the Government.

3.10 SOFTWARE SUPPORT SERVICE

A. First Year Software Support Service: Up to 120 hours of software support shall be provided by a technical representative of Schneider Electric during the first year following the final acceptance of the control system. The software support shall include software changes to fine tune the system and to support changes to the Sequence of Operation for the controls installed under this contract. The software support shall be scheduled by the DDCS supervisor on an as needed basis.

END OF SECTION 23 09 00

SECTION 23 09 23.12 - CONTROL DAMPERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes the following types of control dampers and actuators for DDC systems:

1. General control-damper actuator requirements.
2. Electric and electronic actuators for CD: EF 310 Duct Actuators

1.3 DEFINITIONS

A. DDC: Direct-digital control.

B. RMS: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product, including the following:

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation instructions, including factors affecting performance.

B. Shop Drawings:

1. Include plans, elevations, sections, and **mounting** details.
2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Include diagrams for air and process signal tubing.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plan drawings and corresponding product installation details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Product installation location shown in relationship to room, duct, and equipment.
2. Size and location of wall access panels for control dampers and actuators installed behind walls.
3. Size and location of ceiling access panels for control dampers and actuators installed above inaccessible ceilings.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For control actuators to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASME Compliance: Fabricate and label products to comply with ASME Boiler and Pressure Vessel Code where required by authorities having jurisdiction.

C. Delegated Design: Engage a qualified professional **engineer**, as defined in Section 014000 "Quality Requirements," to size products where indicated as delegated design.

D. Ground Fault: Products shall not fail due to ground fault condition when suitably grounded.

E. Backup Power Source: Systems and equipment served by a backup power source shall have associated control damper actuators served from a backup power source.

F. Environmental Conditions:

1. Provide electric control-damper actuators, with protective enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Electric control-damper actuators not available with integral enclosures, complying with requirements indicated, shall be housed in protective secondary enclosures.

a. Hazardous Locations: Explosion-proof rating for condition.

G. Selection Criteria:

1. Fail positions unless otherwise indicated:

a. High Exhaust: Open

b. Low Exhaust: Closed

2.2 GENERAL CONTROL-DAMPER ACTUATORS REQUIREMENTS

A. Actuators shall operate related damper(s) with sufficient reserve power to provide smooth modulating action or two-position action and proper speed of response at velocity and pressure conditions to which the damper is subjected.

B. Actuators shall produce sufficient power and torque to close off against the maximum system pressures encountered. Actuators shall be sized to close off against the fan shutoff pressure as a minimum requirement.

C. The total damper area operated by an actuator shall not exceed 80 percent of manufacturer's maximum area rating.

D. Provide one actuator for each damper assembly where possible. Multiple actuators required to drive a single damper assembly shall operate in unison.

E. Avoid the use of excessively oversized actuators which could overdrive and cause linkage failure when the damper blade has reached either its full open or closed position.

F. Use jackshafts and shaft couplings in lieu of blade-to-blade linkages when driving axially aligned damper sections.

G. Provide mounting hardware and linkages for connecting actuator to damper.

H. Select actuators to fail in desired position in the event of a power failure.

2.3 ELECTRIC AND ELECTRONIC ACTUATORS

A. Type: Motor operated, with or without gears, electric and electronic.

B. Voltage:

1. Voltage selection is delegated to professional designing control system
2. Actuator shall deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.
3. Actuator shall function properly within a range of 85 to 120 percent of nameplate voltage.

C. Construction:

1. Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.
2. 100 up to 400 W: Gears ground steel, oil immersed, shaft-hardened steel running in bronze, copper alloy, or ball bearings. Operator and gear trains shall be totally enclosed in dustproof cast-iron, cast-steel, or cast-aluminum housing.
3. Greater Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.

D. Field Adjustment:

1. Spring return actuators shall be easily switchable from fail open to fail closed in the field without replacement.
2. Provide gear-type actuators with an external manual adjustment mechanism to allow manual positioning of the damper when the actuator is not powered.

E. Modulating Actuators:

1. Capable of stopping at all points across full range, and starting in either direction from any point in range.
2. Control Input Signal:

   a. Three Point, Tristate, or Floating Point: Clockwise and counter-clockwise inputs. One input drives actuator to open position, and other input drives actuator to close position. No signal of either input remains in last position.
   b. Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for zero- to 10- or 2- to 10- V dc and 4- to 20-mA signals.
   c. Pulse Width Modulation (PWM): Actuator drives to a specified position according to a pulse duration (length) of signal from a dry-contact closure, triac sink or source controller.
   d. Programmable Multi-Function:

      1) Control input, position feedback, and running time shall be factory or field programmable.
      2) Diagnostic feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.
      3) Service data, including at a minimum, number of hours powered and number of hours in motion.

F. Fail-Safe:

1. Where indicated, provide actuator to fail to an end position.
2. Internal spring return mechanism to drive controlled device to an end position (open or close) on loss of power.
3. Batteries, capacitors, and other non-mechanical forms of fail-safe operation are acceptable only where uniquely indicated.

G. Integral Overload Protection:

1. Provide against overload throughout the entire operating range in both directions.
2. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.

H. Damper Attachment:

1. Unless otherwise required for damper interface, provide actuator designed to be directly coupled to damper shaft without need for connecting linkages.
2. Attach actuator to damper drive shaft in a way that ensures maximum transfer of power and torque without slippage.

3. Bolt and set screw method of attachment is acceptable only if provided with at least two points of attachment.

I. Temperature and Humidity:

1. Temperature: Suitable for operating temperature range encountered by application with minimum operating temperature range of minus 20 to plus 120 deg F (minus 29 to plus 49 deg C)
2. Humidity: Suitable for humidity range encountered by application; minimum operating range shall be from 25 to 75 percent relative humidity, non-condensing.

J. Enclosure:

1. Suitable for ambient conditions encountered by application.
2. NEMA 250, Type 2 for indoor and protected applications.
3. NEMA 250, Type 4 or Type 4X for outdoor and unprotected applications.
4. Provide actuator enclosure with a heater and controller where required by application.

K. Stroke Time:

1. Operate damper from fully closed to fully open within **15** seconds.
2. Operate damper from fully open to fully closed within **15** seconds.
3. Move damper to failed position within **15** seconds.
4. Select operating speed to be compatible with equipment and system operation.
5. Actuators operating in smoke control systems comply with governing code and NFPA requirements.

L. Sound:

1. Spring Return: 62 dBA.
2. Non-Spring Return: 45 dBA.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for dampers and instruments installed in duct systems to verify actual locations of connections before installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Furnish and install products required to satisfy most stringent requirements indicated.

B. Properly support dampers and actuators, tubing, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a minimal force.

C. Provide ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

D. Seal penetrations made in fire-rated and acoustically rated assemblies.

E. Fastening Hardware:

1. Stillson wrenches, pliers, or other tools that will cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for assembling and tightening nuts.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

F. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

3.3 ELECTRIC POWER

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install circuit breakers. Comply with requirements from FAA-C-1217g, and within manufacturers recommendations.

C. Furnish and install power wiring. Comply with requirements in Section 260519 "Wires and Cables”.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install engraved phenolic nameplate with damper identification on damper.

3.5 CHECKOUT PROCEDURES

A. Control-Damper Checkout:

1. Check installed products before continuity tests, leak tests, and calibration.
2. Verify that damper actuator and linkage attachment are secure.

3. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
4. Verify that damper blade travel is unobstructed.

3.6 ADJUSTMENT, CALIBRATION, AND TESTING:

A. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.

B. Stroke control dampers with pilot positioners. Adjust damper and positioner following manufacturer's recommended procedure, so damper is 100 percent closed, 50 percent closed, and 100 percent open at proper air pressure.

C. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.

D. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

END OF SECTION 230923.12

SECTION 23 21 13 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:

1. Hot-water heating piping.
2. Chilled-water piping.
3. Condenser-water (including Piping to/from Engine Generators)
4. Radiator Jacket-Water piping
5. Makeup-water piping.
6. Condensate-drain piping.
7. Blowdown-drain piping.
8. Air-vent piping.
9. Safety-valve-inlet and -outlet piping.

B. Related Sections include the following:

1. Section 23 21 23 "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.

1.2 DEFINITIONS

A. PTFE: Polytetrafluoroethylene.

1.3 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:

1. Hot-Water Heating Piping: 100 psig at 200 deg F.
2. Chilled-Water Piping: 100 psig at 200 deg F.
3. Condenser-Water Piping: 100 psig at 150 deg F.
4. Radiator Jacket Water Piping: 100 psig at 240 deg F.
5. Makeup-Water Piping: 80 psig at 150 deg F.
6. Condensate-Drain Piping: 200 deg F.
7. Blowdown-Drain Piping: 200 deg F.
8. Air-Vent Piping: 200 deg F.
9. Safety-valve-inlet and –outlet piping: 100 psig at 200 deg F.

1.4 SUBMITTALS

A. Product Data: For each type of the following:

1. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
2. Pipes.
3. Hydronic specialties.
4. Strainers.
5. Air Control Devices.

B. Shop Drawings: Detail, at 1/4 scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

C. Welding certificates.

D. Qualification Data: For Installer.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. DWV Copper Tubing: ASTM B 306, Type DWV.

C. Wrought-Copper Fittings: ASME B16.22.

1. Known Acceptable Source: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Anvil International, Inc.
    b. S. P. Fittings; a division of Star Pipe Products.

D. Wrought-Copper Unions: ASME B16.22.

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Class 125 as indicated in Part 3 "Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150 as indicated in Part 3 "Piping Applications" Article.

D. Malleable-Iron Unions: ASME B16.39; Class 150 as indicated in Part 3 "Piping Applications" Article.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Class 125; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

H. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.3 STAINLESS STEEL TYPE 304L

A. Seamless pipe material conforming to ASTM A312.

2.4 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

E. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

F. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions:

1. Known Acceptable Source: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Capitol Manufacturing Company.
b. Central Plastics Company.
c. Hart Industries International, Inc.
d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
e. Zurn Plumbing Products Group; AquaSpec Commercial Products Division.

2. Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.

D. Dielectric Flanges:

1. Known Acceptable Source: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Capitol Manufacturing Company.
b. Central Plastics Company.
c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Factory-fabricated companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

E. Dielectric-Flange Kits:

1. Known Acceptable Source: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Central Plastics Company.
   d. Pipeline Seal and Insulator, Inc.

2. Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
3. Separate companion flanges and steel bolts and nuts shall have 150-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings:

1. Known Acceptable Source: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Calpico, Inc.
   b. Lochinvar Corporation.

2. Galvanized-steel coupling with inert and noncorrosive thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

G. Dielectric Nipples:

1. Known Acceptable Source: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Perfection Corporation; a subsidiary of American Meter Company.
   b. Precision Plumbing Products, Inc.
   c. Sioux Chief Manufacturing Company, Inc.

2. Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.6 VALVES

A. Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 22 and 23.

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Section 23 09 00 "Instrumentation and Controls for HVAC."

C. Brass, Venturi, Balancing Valves:

1. Known Acceptable Source:

    a. Bell & Gossett Domestic Pump; a division of ITT Industries.
    b. Flow Design Inc.
    c. Gerand Engineering Co.
    d. Griswold Controls.

2. Body: Brass ball valve with calibrated venturi.
3. Ball: Stainless steel.
4. Stem: Field repairable stem with dual Teflon seals and EPDM o-ring
5. End Connections: Threaded or socket.
6. Pressure Gage Connections: Integral seals for portable differential pressure meter.
7. Handle Style: Lever, with memory stop to retain set position and graduated markings.
8. CWP Rating: Minimum 125 psig.
9. Maximum Operating Temperature: 250 deg F.
10. Stem Extension: Extended stem to allow for insulation.

D. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

1. Known Acceptable Source: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Armstrong Pumps, Inc.
    b. Bell & Gossett Domestic Pump; a division of ITT Industries.
    c. Flow Design Inc.
    d. Gerand Engineering Co.
    e. Griswold Controls.
    f. Taco.
    g. Tour & Andersson; available through Victaulic Company of America.

2. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Stem Seals: EPDM O-rings.
5. Disc: Glass and carbon-filled PTFE.
6. Seat: PTFE.
7. End Connections: Flanged or grooved.
8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
9. Handle Style: Lever, with memory stop to retain set position.
10. CWP Rating: Minimum 125 psig.
11. Maximum Operating Temperature: 250 deg F.

2.7 AIR CONTROL DEVICES

A. Known Acceptable Source:

1. Amtrol, Inc.
2. Armstrong Pumps, Inc.
3. Bell & Gossett Domestic Pump; a division of ITT Industries.

4. Taco.

B. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/4.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 225 deg F.

C. Automatic Air Vents:

1. Body: Bronze or cast iron.
2. Internal Parts: Nonferrous.
3. Operator: Noncorrosive metal float.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/4.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 240 deg F.

D. Expansion Tanks:

1. Known Acceptable Source:

   a. AMTROL, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett; a Xylem brand.
   d. Flow Fab, Inc.
   e. Taco, Inc.

2. Tank: Diaphragm – Type; welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature, with taps in bottom of tank for tank fitting and taps in end of tank for gage glass. Tanks shall be factory tested after taps are fabricated and shall be labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Air-Control Tank Fitting: Cast-iron body, copper-plated tube, brass vent tube plug, and stainless-steel ball check, 100-gal. unit only; sized for compression-tank diameter. Provide tank fittings for 125-psig working pressure and 250 deg F maximum operating temperature.
4. Tank Drain Fitting: Brass body, nonferrous internal parts; 125-psig working pressure and 240 deg F maximum operating temperature; constructed to admit air to compression tank, drain water, and close off system.
5. Gage Glass: Full height with dual manual shutoff valves, 3/4-inch-diameter gage glass, and slotted-metal glass guard.

2.8 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. Body for Strainers at Coils: Bronze body with bolted cover and bottom drain connection.
3. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
4. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
5. CWP Rating: 125 psig.

B. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, stainless steel, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, NPS 2-1/2 and smaller, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.
2. Schedule 80 steel pipe; Class 125, cast-iron or Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

B. Hot-water heating piping, aboveground, NPS 3 and larger, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and brazed joints.
2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

C. Chilled-water piping, aboveground, NPS 2-1/2 and smaller, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.
2. Schedule 80 steel pipe; Class 125, cast-iron or 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

D. Chilled-water piping, aboveground, NPS 3 and larger, shall be any of the following:

1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

E. Condenser-water piping, aboveground, NPS 2 and smaller, shall be the following:

1. Schedule 80 steel pipe; Class 125, cast-iron 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

F. Condenser-water piping, aboveground, NPS 2-1/2 and larger, shall be the following:

1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
2. For Cooling Tower Risers: RTRP and RTRF with flanged joints or 304L Schedule 10 Stainless Steel.

G. Radiator Jacket-water piping, aboveground, NPS 2-1/2 and larger, shall be the following:

1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

H. Radiator Jacket-water piping, aboveground, NPS 2-1/2 and smaller, shall be the following:

1. Schedule 80 steel pipe; Class 125, cast-iron 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

I. Makeup-water piping installed aboveground shall be either of the following:

1. Type L or M, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.

J. Condensate-Drain Piping: Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

K. Blowdown-Drain Piping: Schedule 80 Steel. Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

L. Air-Vent Piping:

1. Inlet: Schedule 80 Steel.
2. Outlet: Type L, copper tubing with soldered compression or flared joints.

3.2 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.

B. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.

C. Install check valves at each pump discharge and elsewhere as required to control flow direction.

D. Install safety valves as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

E. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.3 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

P. Install valves according to Divisions 22 and 23.

Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

S. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

T. Identify piping as specified in Section 23 05 53 "Identification for HVAC Piping and Equipment."

3.4 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 7 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
6. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
7. NPS 4: Maximum span, 12 feet; minimum rod size, 1/2 inch.
8. NPS 6: Maximum span, 12 feet; minimum rod size, 1/2 inch.
9. NPS 8: Maximum span, 12 feet; minimum rod size, 5/8 inch.
10. NPS 10: Maximum span, 12 feet; minimum rod size, 3/4 inch.
11. NPS 12: Maximum span, 12 feet; minimum rod size, 7/8 inch.

D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
6. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.

E. Fiberglass Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.

F. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Divisions 22 and 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.6 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Manual vents at heat-transfer coils and elsewhere as required for air venting.

C. Install expansion tanks in a high point of the closed system. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.

1. Install tank fittings that are shipped loose.

2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of glycol solution. Do not overload building components and structural members.

3.7 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Section 23 05 19 "Meters and Gages for HVAC Piping."

3.8 CHEMICAL TREATMENT

A. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.

B. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.

C. Fill Radiator Jacket water system with engine coolant.

3.9 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.

4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test.
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION 23 21 13

SECTION 232113.13 - UNDERGROUND HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Ductile-iron pipe and fittings.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Conduit piping.
2. Cased piping.
3. Loose-fill insulation.

B. Shop Drawings: For underground hydronic piping. Signed and sealed by a professional engineer.

1. Calculate requirements for expansion compensation for underground piping.
2. Show expansion compensators, offsets, and loops with appropriate materials to allow piping movement in the required locations. Show anchors and guides that restrain piping movement with calculated loads, and show concrete thrust block dimensions.
3. Show pipe sizes, locations, and elevations. Show piping in trench, conduit, and cased pipe with details showing clearances between piping, and show insulation thickness.

1.4 INFORMATIONAL SUBMITTALS

A. Coordinate "Qualification Data" Paragraph below with qualification requirements in Section 014000 "Quality Requirements" and as supplemented in "Quality Assurance" Article.

B. Qualification Data: For qualified Installer.

C. Welding certificates.

D. Material Test Reports: For cased piping.

E. Source quality-control reports.

F. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Fiberglass Pipe and Fitting Installers: Installers of RTRF and RTRP shall be certified by manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.

B. Welding Qualifications: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with provisions in ASME B31.9, "Building Services Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing hydronic piping systems with the following minimum working-pressure ratings:

1. Condenser-Water Piping: 150 psig

2.2 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot end.

1. Standard-Pattern, Mechanical-Joint Fittings: AWWA C110/A21.10, ductile or gray iron.
2. Compact-Pattern, Mechanical-Joint Fittings: AWWA C153/A21.53, ductile iron.

a. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

PART 3 - EXECUTION

3.1 EARTHWORK

A. See Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATION

A. Condenser-Water Piping:

1. NPS 2 and smaller shall be any of the following:
   a. Schedule 40 steel pipe; fittings; cast-iron flanges and flange fittings; and threaded joints.

2. NPS 2-1/2 and larger shall be any of the following:
   a. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
   b. Mechanical-joint, ductile-iron pipe; standard pattern mechanical-joint fittings; and mechanical joints.

3. Cased piping with polyurethane carrier-pipe insulation.

   a. Piping Insulation Thickness: 2 inches

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Remove standing water in the bottom of trench.

C. Do not backfill piping trench until field quality-control testing has been completed and results approved.

D. Install piping at uniform grade of 0.2 percent. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points and elsewhere as required for system drainage. Install manual air vents at high points.

E. In conduits, install drain valves at low points and manual air vents at high points.

F. Install components with pressure rating equal to or greater than system operating pressure.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. See Section 230517 "Sleeves and Sleeve Seals for HVAC Piping" for sleeves and mechanical sleeve seals through exterior building walls.

J. Secure anchors with concrete thrust blocks. Concrete is specified in Section 033000 "Cast-in-Place Concrete."

K. See Section 134700 "Cathodic Protection" for cathodic devices and connections to piping and conduit systems.

3.4 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

D. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.5 IDENTIFICATION

A. Install continuous plastic underground warning tapes during back filling of trenches for underground hydronic piping. Locate tapes 6 to 8 inches below finished grade, directly over piping. See Section 312000 "Earth Moving" for warning-tape materials and devices and their installation.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

1. Prepare hydronic piping for testing according to ASME B31.9 and as follows:

    a. Leave joints, including welds, uninsulated and exposed for examination during test.
    b. Fill system with water. Where there is risk of freezing, air or a safe, compatible liquid may be used.
    c. Use vents installed at high points to release trapped air while filling system.

2. Test hydronic piping as follows:

    a. Subject hydronic piping to hydrostatic test pressure that is not less than 1.5 times the design pressure.

b. After hydrostatic test pressure has been applied for 10 minutes, examine joints for leakage. Remake leaking joints using new materials and repeat hydrostatic test until no leaks exist.

3. Test conduit as follows:

a. Seal vents and drains and subject conduit to 15 psig for four hours with no loss of pressure. Repair leaks and retest as required.

E. Prepare test and inspection reports.

END OF SECTION 232113.13

SECTION 23 21 23 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Self-priming, non-clog pumps.

2. Separately coupled, base-mounted, double-suction centrifugal pumps.

3. Vertical, Cantilever Sump Pumps.

1.2 DEFINITIONS

A. Buna-N: Nitrile rubber.

B. EPT: Ethylene propylene terpolymer.

1.3 SUBMITTALS

A. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

B. Shop Drawings: Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of hydronic pumps and are based on the specific system indicated.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Mechanical Seals: One set of mechanical seal(s) for each pump.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Known Acceptable Source: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 SELF PRIMING, NONCLOG PUMPS

A. Known Acceptable Source:

1. Hydromatic; Div. of Pentair, MP series

B. Description: Factory-assembled and –tested, flexible coupled driven horizontal self-priming non-clog centrifugal sewage and trash pump. Rate pump for 125-psig minimum working pressure and a continuous water temperature of 225 deg F.

C. Pump Construction:

1. Casing: The pump volute case, suction elbow, priming port housing, suction and discharge connections, bearing frame assembly and priming cover shall be high quality gray cast iron, ASTM A-48, Class 30 or better. In addition the three internal wearing parts of impeller, wear plate and lip plate shall be made of high quality ductile iron. All external mating parts shall be machined and Buna-N Rubber O-ring sealed on a beveled edge. Gaskets shall not be acceptable. Casing shall have integral, internal thermostat to interlock starter to prevent pump from overheating.
2. Inlet Suction Elbow: Inlet suction elbow and wear plate shall be removable as a unit so that all parts of the pump case, including the priming port, shall be accessible for cleaning and inspection without removing the suction or discharge piping. The replaceable wear plate shall be bolted to the inlet elbow.
3. Priming Port Housing: A suction type flapper check valve shall be installed in the priming port housing. It shall consist of a flapper valve bracket, stainless steel shaft and bearings, and a Buna-N check valve gasket attached to the flapper bracket with a bolt, washer, weight and nut. The priming cover handle and priming cover arm are to be cast iron. The flapper must be accessible through the top priming port so that it can be removed or installed with the pump volute full of liquid without loss of liquid. The flap valve assembly shall be capable of being removed or replaced without draining the pump case, removing the suction elbow or disturbing the piping connections.
4. Impeller: Impeller shall be of the two-vane, semi-open, non-clog design and have pump out vanes on the backside to prevent grit and other materials from collecting in the seal area. Impeller shall be either threaded on to the shaft or pressed on to a tapered shaft and keyed. A 300 series stainless steel screw and washer shall lock impeller against reverse rotation on the shaft. Impeller clearance shall be externally adjustable without the use of shims or requiring the disassembly of the pump unit. Adjustment shall be accomplished by means of jacking or adjustment bolts located at the end of the bearing housing rotating assembly.
5. Mechanical Seals: The pump shall have two mechanical seals, mounted in tandem, with a separate oil chamber between the seals. John Crane Type 21, seals shall be used with the rotating seal faces being carbon and the stationary seal faces to be ceramic. The inner seal shall be replaceable without disassembly of the seal chamber and without the use of special tools. The inner seal shall be accessible by removing the suction inlet elbow and impeller. Pump-out vanes shall be present on the backside of the impeller to keep contaminants out of the seal area. Seals shall be locally available and a spare set provided initially with unit. There shall be an oil chamber between the outer seal and the inner seal with a drain plug opening for inspection of oil contamination or inner seal failure. The unit shall be designed so that the seal system totally separates the pumping system from the bearing system, assuring that in the event of a seal failure that contaminants will not enter into the bearing housing and damage the bearings. There shall be a space between the seal chamber and the bearing housing which is completely open, allowing visual inspection of the outer seal by maintenance personnel. The unit shall be equipped with a stainless steel shaft sleeve under the inner seal to prolong the shaft life by eliminating the possibility of scoring the shaft, should the inner seal fail. Replacement of the seals shall be accomplished without disturbing the suction or discharge piping.
6. Lip Plate: Impeller shall be used in combination with a replaceable volute lip plate. Where impeller is of full diameter, a flat back plate shall be provided. Where impeller

trim is required, a volute lip plate shall be used in combination so as not to lose priming efficiency. Pump shall be capable of operating with various matched impeller trim / lip plate combinations without disturbing the volute case. The flat back plate or volute lip plate shall be replaceable for renewed efficiency.

7. Wear Plate: The replaceable wear plate is held to the suction elbow by two Allen head screws. The clearance set between the wear plate and impeller shall be maintained at 15 thousandths (.015). Replacement of the wear plate, impeller and inner seal shall be accomplished through the removable suction elbow.
8. Pump Bearings: Permanently lubricated roller type ball bearings. Bearings shall be grease or oil lubricated, locally available, and sized for a minimum B10 life of 20,000 hours for normal operations.

D. Motor: NEMA Premium Efficiency, IEEE-841 Harsh Environment, TEFC, single speed, with permanently lubricated ball bearings, unless otherwise indicated; and rigidly mounted to pump casing. Comply with requirements in Section 23 05 13 "Common Motor requirements for HVAC Equipment." Thermostat within pump casing shall be interlocked to motor starter to prevent overheating. BMS shall monitor point.

2.3 SEPARATELY COUPLED, BASE-MOUNTED, DOUBLE-SUCTION CENTRIFUGAL PUMPS

A. Known Acceptable Source:

1. American-Marsh Pumps.
2. Armstrong Pumps Inc.
3. Aurora Pump; Division of Pentair Pump Group.
4. Buffalo Pumps, Inc.
5. Crane Pumps & Systems.
6. Flowserve Corporation.
7. ITT Corporation; Bell & Gossett.
8. Mepco, LLC.
9. PACO Pumps.
10. Patterson Pump Co.; a subsidiary of the Gorman-Rupp Co.
11. Peerless Pump Company.
12. TACO Incorporated.

B. Description: Factory-assembled and -tested, centrifugal, impeller-between-bearings, separately coupled, double-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.

C. Pump Construction:

1. Casing: Horizontally split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and ASME B16.1, Class 125 flanges. Casing supports shall allow removal and replacement of impeller without disconnecting piping.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, and keyed to shaft. For pumps not frequency-drive controlled, trim impeller to match specified performance.
3. Pump Shaft: Stainless steel.

4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket.
5. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings.

D. Shaft Coupling: Molded-rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor. EPDM coupling sleeve for variable-speed applications.

E. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

F. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

G. Motor: Secured to mounting frame, with adjustable alignment.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

    a. Enclosure: NEMA MG-1 Inverter Duty, TEFC with Ingress Protection rating greater or equal to IP-54.

    b. Motors shall be sized for non-overloading over entire pump curve.

    c. Special condition: Altitude at 4226 feet.

3. Motors on variable speed pumps shall be compatible with variable frequency drives provided in Division 26 29 23, “Variable-Frequency Motor Controllers.”
4. Motors shall have shaft mounted static grounding ring: Aegis SGR or approved equal.

2.4 VERTICAL, CANTILEVER SUMP PUMPS

A. Submersible, Fixed-Position, Single-Seal Sump Pumps:
1. Know Acceptable Source:

    a. Basis of Design: Carver GVC Series
    b. Alyan Pump Company.
    c. Armstrong Pumps, Inc.
    d. Chicago Pump Company; Grundfos Pumps Corporation.
    e. Federal Pump Corp.
    f. Flo Fab inc.
    g. PACO Pumps; Grundfos Pumps Corporation, USA.
    h. Peerless Pump Company.
    i. Pentair Pump Group.
    j. Swaby Manufacturing Company.

k. Tramco Pump Company.
l. Vertiflo Pump Company.
m. Weil Pump Company, Inc.
n. Weinman; a Crane Pumps & Systems brand.
o. Yeomans Chicago Corporation.

B. Description: Factory-assembled and -tested sump-pump unit.

C. Pump Type: Wet-pit-volute, single-stage, separately-coupled, overhung-impeller, centrifugal sump pump as defined in HI 1.1-1.2 and HI 1.3.

D. Pump Casing: Cast iron, with strainer inlet and flanged connection discharge piping.

A. Impeller: Statically and dynamically balanced, ASTM A 532/A 532M, abrasion-resistant cast iron, ASTM B 584, cast bronze, or 316 Stainless Steel, designed for clear wastewater handling, and keyed and secured to shaft.

B. Pump and Motor Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.

C. Pump Discharge Piping: Factory or field fabricated, galvanized, ASTM A 53/A 53M, Schedule 40, steel pipe with ASME B16.1, Class 125, cast-iron flanges and flanged fittings or ASME B16.4, Class 125, gray iron threaded fittings.

D. Support Plate: Cast iron or coated steel and strong enough to support pumps, motors, and controls. Refer to Part 2 "Sump-Pump Basins and Basin Covers" Article for requirements.

E. Shaft Seal: Stuffing box, with graphite-impregnated braided-yarn rings and bronze packing gland.

F. Motor: Single-speed; grease-lubricated ball bearings and mounting on vertical, cast-iron pedestal.

1. Oil Monitoring and Controls:

a. Enclosure: NEMA 250, Type 4X, wall-mounted.
b. Special condition: Altitude at 5300 feet.
c. Switch Type: Mechanical-float type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float switch matching control and electric bell; 120-V ac, with transformer and contacts for remote audible alarm.
e. Oil Detection: Visual and audible alarms and override of pump start upon detection of oil on surface of water.

PART 4 - EXECUTION

4.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations for suitable conditions where pumps are to be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

4.2 CONCRETE BASES

A. Install concrete bases of dimensions indicated for pumps and controllers. Refer to Section 23 05 00, "Common Work Results for HVAC."

4.3 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories. Set sump pump(s) at proper elevation off bottom of sump floor. Make direct connections to sanitary drainage piping. Install sump pump and connect to drainage piping. Install cover so top surface is flush with finished slab.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

D. Vibration isolation devices are specified in Section 23 05 48 "Vibration controls for HVAC Piping and Equipment." Fabricate brackets or supports as required. Hanger and support materials are specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."

E. Set base-mounted pumps on concrete foundation. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.

1. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.
2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.

4.4 ALIGNMENT

A. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.

B. Comply with pump and coupling manufacturers' written instructions.

C. Adjust pump and motor shafts for angular and offset alignment by methods specified in HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation."

D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

4.5 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

E. Install check valve and isolation valve on discharge side of pumps.

F. Install electrical connections for power, controls, and devices.

G. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

H. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

4.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Perform the following startup checks for each pump before starting:

    a. Verify bearing lubrication.
    b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
    c. Verify that pump is rotating in the correct direction.

5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
6. Start motor.
7. Open discharge valve slowly.

4.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train FAA's maintenance personnel to adjust, operate, and maintain hydronic pumps. Refer to Section 01 79 00 "Demonstration and Training."

END OF SECTION 23 21 23

SECTION 232500 - HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes the following HVAC water-treatment systems:

1. Manual and automatic chemical-feed equipment and controls.
2. Chemical treatment test equipment.
3. Chemicals.
4. HVAC makeup-water softeners.
5. Water filtration equipment.

1.3 DEFINITIONS

A. EEPROM: Electrically erasable, programmable read-only memory.

B. RO: Reverse osmosis.

C. TSS: Total suspended solids are solid materials, including organic and inorganic, that are suspended in the water. These solids may include silt, plankton, and industrial wastes.

1.4 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for the following products:

1. Bypass feeders.
2. Water meters.
3. Inhibitor injection timers.
4. pH controllers.
5. TSS controllers.
6. Biocide feeder timers.
7. Chemical solution tanks.
8. Injection pumps.
9. Chemical test equipment.
10. Chemical material safety data sheets.
11. Water softeners.
12. Centrifugal separators.

B. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to HVAC systems.

C. 1. Include plans, elevations, sections, and attachment details.

1. Include diagrams for power and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For water softeners and water filtration units and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

B. Water Analysis Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider.

C. Field quality-control reports.

D. Other Informational Submittals:

1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in "Performance Requirements" Article.
2. Water Analysis: Illustrate water quality available at Project site.
3. Passivation Confirmation Report: Verify passivation of galvanized-steel surfaces, and confirm this observation in a letter to Architect.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sensors, injection pumps, water softeners, water filtration units, and controllers to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:

a. Ampion Corp.
b. Anderson Chemical Company.
c. Aqua-Chem, Inc..
d. Barclay Water Management, Inc.
e. Cascade Water Services, Inc.

2.2 PERFORMANCE REQUIREMENTS

A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or to the environment.

B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

C. Closed hydronic systems, including chilled water, shall have the following water qualities:

1. pH: Maintain a value within 9.0 to 10.5.
2. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
3. Boron: Maintain a value within 100 to 200 ppm.
4. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
5. Soluble Copper: Maintain a maximum value of 0.20 ppm.
6. TSS: Maintain a maximum value of 10 ppm.
7. Ammonia: Maintain a maximum value of 20 ppm.
8. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
9. Microbiological Limits:

a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/mL.
b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/mL.
c. Nitrate Reducers: Maintain a maximum value of 100 organisms/mL.
d. Sulfate Reducers: Maintain a maximum value of zero organisms/mL.
e. Iron Bacteria: Maintain a maximum value of zero organisms/mL.

D. Open hydronic systems, including condenser water, shall have the following water qualities:

1. pH: Maintain a value within 6.5 to 9.2.
2. "P" Alkalinity: Maintain a maximum value of 100 ppm.
3. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
4. Soluble Copper: Maintain a maximum value of 0.20 ppm.
5. TSS: Maintain a maximum value of 25 ppm.
6. Ammonia: Maintain a maximum value of 20 ppm.

7. Free "OH" Alkalinity: Maintain a maximum value of zero ppm.
8. Microbiological Limits:

    a. Total Aerobic Plate Count: Maintain a maximum value of 10,000 organisms/mL.
    b. Total Anaerobic Plate Count: Maintain a maximum value of 1000 rganisms/mL.
    c. Nitrate Reducers: Maintain a maximum value of 100 organisms/mL.
    d. Sulfate Reducers: Maintain a maximum value of zero organisms/mL.
    e. Iron Bacteria: Maintain a maximum value of zero organisms/mL.

9. Polymer Testable: Maintain a minimum value within 10 to 40.

2.3 MANUAL CHEMICAL-FEED EQUIPMENT

A. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch (89-mm) fill opening in the top, and NPS 3/4 (DN 20) bottom inlet and top side outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.

1. Capacity: 2 gal.
2. Minimum Working Pressure: 125 psig.

2.4 AUTOMATIC CHEMICAL-FEED EQUIPMENT

A. Water Meter:

1. AWWA C700, oscillating-piston, magnetic-drive, totalization meter.
2. Body: Bronze.
3. Minimum Working-Pressure Rating: 150 psig.
4. Maximum Pressure Loss at Design Flow: 3 psig.
5. Registration: Gallons (Liters) or cubic feet.
6. End Connections: Threaded.
7. Controls: Flow-control switch with normally open contacts; rated for maximum 10 A, 250-V ac, and that will close at adjustable increments of total flow.

B. Inhibitor Injection Timers:

1. Microprocessor-based controller with digital display in NEMA 250, Type 12 enclosure with gasketed and lockable door. Interface for start/stop and status indication at central workstation as described in Section 230923 "Direct Digital Control (DDC) System for HVAC."
2. Programmable timers with infinite adjustment over full range, and mounted in cabinet with hand-off-auto switches and status lights.
3. Test switch.
4. Hand-off-auto switch for chemical pump.
5. Illuminated legend to indicate feed when pump is activated.
6. Programmable lockout timer with indicator light. Lockout timer to deactivate the pump and activate alarm circuits.
7. Digital display makeup totalizer to measure amount of makeup and bleed-off water from two water meter inputs.

C. pH Controller:

1. Microprocessor-based controller, 1 percent accuracy in a range from zero to 14 units. Incorporate solid-state integrated circuits and digital display in NEMA 250, Type 12 enclosure with gasketed and lockable door. Interface for start/stop and status indication at central workstation as described in Section 230923 "Direct Digital Control (DDC) System for HVAC."
2. Digital display and touch pad for input.
3. Sensor probe adaptable to sample stream manifold.
4. High, low, and normal pH indication.
5. High or low-pH-alarm-light trip points, field adjustable; with silence switch.
6. Hand-off-auto switch for acid pump.
7. Internal adjustable hysteresis or deadband.

D. TSS Controller:

1. Microprocessor-based controller, 1 percent accuracy in a range from zero to 5000 micromhos. Incorporate solid-state integrated circuits and digital display in NEMA 250, Type 12 enclosure with gasketed and lockable door. Interface for start/stop and status indication at central workstation as described in Section 230923 "Direct Digital Control (DDC) System for HVAC."
2. Digital display and touch pad for input.
3. Sensor probe adaptable to sample stream manifold.
4. High, low, and normal conductance indication.
5. High- or low-conductance-alarm-light trip points, field adjustable; with silence switch.
6. Hand-off-auto switch for solenoid bleed-off valve.
7. Bleed-off valve activated indication.
8. Internal adjustable hysteresis or deadband.
9. Bleed Valves:

    a. Cooling Systems: Forged-brass body, globe pattern, general-purpose solenoid with continuous-duty coil, or motorized valve.
    b. Steam Boilers: Motorized ball valve, steel body, and TFE seats and seals.

E. Biocide Feeder Timer:

1. Microprocessor-based controller with digital display in NEMA 250, Type 12 enclosure with gasketed and lockable door. Interface for start/stop and status indication at central workstation as described in Section 230923 "Direct Digital Control (DDC) System for HVAC."
2. 24-hour timer with 14-day skip feature to permit activation any hour of day.
3. Precision, solid-state, bleed-off lockout timer and clock-controlled biocide pump timer. Prebleed and bleed lockout timers.
4. Solid-state alternator to enable use of two formulations.
5. 24-hour display of time of day.
6. 14-day display of day of week.
7. Battery backup so clock is not disturbed by power outages.
8. Hand-off-auto switches for biocide pumps.
9. Biocide A and Biocide B pump running indication.

F. Chemical Solution Tanks:

1. Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with minimum 110 percent containment vessel.
2. Molded cover with recess for mounting pump.
3. Capacity: 30 gal.

G. Chemical Solution Injection Pumps:

1. Self-priming, positive displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.
2. Adjustable flow rate.
3. Metal and thermoplastic construction.
4. Built-in relief valve.
5. Fully enclosed, continuous-duty, single-phase motor. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints except ASTM A 269, Type 304, stainless steel for steam boiler injection assemblies.

I. Injection Assembly:

1. Quill: Minimum NPS 1/2 with insertion length sufficient to discharge into at least 25 percent of pipe diameter.
2. Ball Valve: Three-piece stainless steel, as described in "Stainless-Steel Pipes and Fittings" Article; selected to fit quill.
3. Packing Gland: Mechanical seal on quill of sufficient length to allow quill removal during system operation.
4. Assembly Pressure/Temperature Rating: Minimum 600 psig at 200 deg F.

2.5 STAINLESS-STEEL PIPES AND FITTINGS

A. Stainless-Steel Tubing: Comply with ASTM A 269, Type 316.

B. Stainless-Steel Fittings: Comply with ASTM A 815/A 815M, Type 316, Grade WP-S.

C. Two-Piece, Full-Port, Stainless-Steel Ball Valves: ASTM A 351/A 351M, Type 316 stainless-steel body; ASTM A 276, Type 316 stainless-steel stem and vented ball, carbon-filled TFE seats, threaded body design with adjustable stem packing, threaded ends, and 250-psig Steam Working Pressure and 600-psig Cold Working Pressure ratings.

D. Three-Piece, Full-Port, Stainless-Steel Ball Valves: ASTM A 351/A 351M, Type 316 stainless-steel body; ASTM A 276, Type 316 stainless-steel stem and vented ball, threaded body design with adjustable stem packing, threaded ends, and 150-psig Steam Working Pressure and 600-psig Cold Working Pressure rating.

2.6 CHEMICAL TREATMENT TEST EQUIPMENT

A. Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounting cabinet for testing pH, TSS, inhibitor, chloride, alkalinity, and hardness; sulfite and testable polymer tests for high-pressure boilers; and oxidizing biocide test for open cooling systems.

B. Sample Cooler:

1. Tube: Sample.

a. Size: NPS 1/4 tubing.
b. Material: ASTM A 666, Type 316 stainless steel.
c. Pressure Rating: Minimum 2000 psig.
d. Temperature Rating: Minimum 850 deg F.

2. Shell: Cooling water.

a. Material: ASTM A 666, Type 304 stainless steel.
b. Pressure Rating: Minimum 250 psig.
c. Temperature Rating: Minimum 450 deg F.

3. Capacities and Characteristics:

a. Tube: Sample.

1) Flow Rate: 0.25 gpm.
2) Entering Temperature: 400 deg F.
3) Leaving Temperature: 88 deg F.
4) Pressure Loss: 6.5 psig.

b. Shell: Cooling water.

1) Flow Rate: 3 gpm.
2) Entering Temperature: 70 deg F.
3) Pressure Loss: 1.0 psig.

C. Corrosion Test-Coupon Assembly: Constructed of corrosive-resistant material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.

1. Two-station rack for closed-loop systems.
2. Four-station rack for open-loop systems.

2.7 CHEMICALS

A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment and that can attain water quality specified in "Performance Requirements" Article.

B. Water Softener Chemicals:

1. Mineral: High-capacity, sulfonated-polystyrene ion-exchange resin that is stable over entire pH range with good resistance to bead fracture from attrition or shock. Resin exchange capacity minimum 30,000 grains/cu. ft. of calcium carbonate of resin when regenerated with 15 lb of salt.
2. Salt for Brine Tanks: High-purity sodium chloride, free of dirt and foreign material. Rock and granulated forms are unacceptable.

2.8 HVAC MAKEUP-WATER SOFTENER

A. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:

   a. CSI Water System.
   b. Ecodyne Industrial.
   c. Culligan International Company.
   d. Diamond Water Systems, Inc.
   e. Rain Soft.

B. Description: Twin mineral tanks and one brine tank, factory mounted on skid.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Fabricate supports and attachments to tanks with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure as recommended in writing by manufacturer.

E. Mineral Tanks:

   1. Fabricate and label steel filter tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   2. Fabricate and label Fiber Reinforced Plastic filter tanks to comply with ASME Boiler and Pressure Vessel Code: Section X, if indicated.
   3. Pressure Rating: 100 psig minimum.
   4. Wetted Components: Suitable for water temperatures from 40 to at least 100 deg F.
   5. Freeboard: 50 percent, minimum, for backwash expansion above the normal resin bed level.
   6. Support Legs or Skirt: Constructed of structural steel, welded, or bonded to tank before testing and labeling.
   7. Finish: Hot-dip galvanized on exterior and interior of tank after fabrication.
   8. Upper Distribution System: Single-point type, fabricated from galvanized-steel pipe and fittings.
   9. Lower Distribution System: Hub and radial-arm or header-lateral type; fabricated from PVC pipe and fittings with individual, fine-slotted, nonclogging polyethylene strainers; arranged for even-flow distribution through resin bed.

F. Controls: Automatic; factory mounted on mineral tanks and factory wired.

   1. Adjustable duration of regeneration steps.
   2. Push-button start and complete manual operation override.

3. Pointer on pilot-control valve shall indicate cycle of operation.
4. Means of manual operation of pilot-control valve if power fails.
5. Main Operating Valves: Industrial, automatic, multiport, diaphragm type with the following features:

    a. Slow opening and closing, nonslam operation.
    b. Diaphragm guiding on full perimeter from fully open to fully closed.
    c. Isolated dissimilar metals within valve.
    d. Self-adjusting, internal, automatic brine injector that draws brine and rinses at constant rate independent of pressure.
    e. Float-operated brine valve to automatically measure the correct amount of brine to the softener and refill with fresh water.
    f. Sampling cocks for soft water.

6. Flow Control: Automatic control of backwash and flush rates over variations in operating pressures that do not require field adjustments. Equip mineral tanks with automatic-reset-head water meter that electrically activates cycle controller to initiate regeneration at preset total in gallons and that automatically resets after regeneration to preset total in gallons for next service run. Include alternator to regenerate one mineral tank with the other in service.

G. Brine Tank: Combination measuring and wet-salt storing system.

1. Tank and Cover Material: Fiberglass a minimum of 3/16 inch thick; or molded polyethylene a minimum of 3/8 inch thick.
2. Brine Valve: Float operated and plastic fitted for automatic control of brine withdrawn and freshwater refill.
3. Size: Large enough for at least four regenerations at full salting.

H. Factory-Installed Accessories:

1. Piping, valves, tubing, and drains.
2. Sampling cocks.
3. Main-operating-valve position indicators.
4. Water meters.

I. Water Test Kit: Include in wall-mounting enclosure for water softener.

2.9 FILTRATION EQUIPMENT

A. Centrifugal Separators:

1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:

    a. Cullingham International Comoany.
    b. Ecodyne Industrial.
    c. Grizwold Controls.
    d. Lakos; Cluade Laval Corporation.

e. Pep Filters, Inc.
f. Rosedale Products, Inc.

2. Description: Simplex separator housing with baffles and chambers for removing particles from water by centrifugal action and gravity.
3. Housing: With manufacturer's proprietary system of baffles and chambers.

a. Construction: Fabricate and label steel separator housing to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
b. Inlet: Designed with tangential entry to produce centrifugal flow of feedwater.
c. Vortex Chamber: Designed for downward vortex flow and gravity separation of particles.
d. Collection Chamber: Designed to hold separated particles.
e. Outlet: Near top of unit.
f. Purge: At bottom of collection chamber.
g. Pipe Connections NPS 2 and Smaller: Threaded according to ASME B1.20.1.
h. Pipe Connections NPS 2-1/2 and Larger: Steel, Class 150 flanges according to ASME B16.5 or grooved according to AWWA C606. Provide stainless-steel flanges if tank is stainless steel.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

A. Install chemical application equipment on concrete bases level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.

B. Install seismic restraints for equipment and floor-mounting accessories and anchor to building structure. See Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

C. Install water-testing equipment on wall near water-chemical-application equipment.

D. Install interconnecting control wiring for chemical treatment controls and sensors.

E. Mount sensors and injectors in piping circuits.

F. Bypass Feeders: Install in closed hydronic systems, including chilled water, and equipped with the following:

1. Install bypass feeder in a bypass circuit around circulating pumps unless otherwise indicated on Drawings.
2. Install water meter in makeup-water supply.

3. Install test-coupon assembly in bypass circuit around circulating pumps unless otherwise indicated on Drawings.
4. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below feeder inlet.
5. Install a swing check on inlet after the isolation valve.

G. Install automatic chemical-feed equipment for steam boiler and steam condensate systems and include the following:

1. Install makeup-water softener.
2. Install water meter in makeup-water supply.
3. Install inhibitor injection pumps and solution tanks with injection timer sensing contacts in water meter.

    a. Pumps shall operate for timed interval when contacts close at water meter in makeup-water supply connection.

4. Install test equipment and furnish test-kit to Owner.
5. Install RO unit for makeup water.
6. Install TSS controller with sensor and bleed valves.

    a. Bleed valves shall cycle to maintain maximum TSS concentration.

7. Install inhibitor injection timer with injection pumps and solution tanks.

    a. Pumps shall operate for timed interval on contact closure at water meter in makeup-water supply connection. Injection pump shall discharge into main steam supply header.

H. Install automatic chemical-feed equipment for condenser water and include the following:

1. Install makeup-water softener.
2. Install water meter in makeup-water supply.
3. Install inhibitor injection pumps and solution tanks with injection timer sensing contacts in water meter.

    a. Pumps shall operate for timed interval on contact closure at water meter in makeup-water supply connection. Injection pump shall discharge into boiler feedwater tank or feedwater supply connection at boiler.

4. Install test equipment and provide test-kit to Owner. Install test-coupon assembly in bypass circuit around circulating pumps unless otherwise indicated on Drawings.
5. Install TSS controller with sensor and bleed valves.

    a. Bleed valves shall cycle to maintain maximum TSS concentration.

6. Install pH sensor and controller with injection pumps and solution tanks.

    a. Injector pumps shall operate to maintain required pH.

7. Install biocide feeder alternating timer with two sets of injection pumps and solution tanks.

    a. Injection pumps shall operate to feed biocide on an alternating basis.

3.3 WATER SOFTENER INSTALLATION

A. Install water softener equipment on concrete bases level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor mineral and brine tanks and floor-mounting accessories to substrate.

B. Install seismic restraints for tanks and floor-mounting accessories and anchor to building structure. See Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

C. Install brine lines and fittings furnished by equipment manufacturer but not factory installed.

D. Prepare mineral-tank distribution system and underbed for minerals and place specified mineral into mineral tanks.

E. Install water-testing sets on wall adjacent to water softeners.

3.4 RO UNIT INSTALLATION

A. Install RO unit and storage tank on concrete bases level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor RO unit and storage tank with pumps to substrate.

B. Install seismic restraints for tanks and floor-mounting accessories and anchor to building structure. See Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

C. Install interconnecting piping and controls furnished by equipment manufacturer but not factory installed.

D. Install water-testing sets on wall adjacent to RO unit.

3.5 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance.

C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Section 232113 "Hydronic Piping."

D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Section 230523

E. Confirm applicable electrical requirements in electrical Sections for connecting electrical equipment.

F. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC system's startup procedures.
4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
8. Repair leaks and defects with new materials and retest piping until no leaks exist.

C. Equipment will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. At four-week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis advising Owner of changes necessary to adhere to "Performance Requirements" Article.

F. Comply with ASTM D 3370 and with the following standards:

1. Silica: ASTM D 859.
2. Steam System: ASTM D 1066.
3. Acidity and Alkalinity: ASTM D 1067.
4. Iron: ASTM D 1068.
5. Water Hardness: ASTM D 1126.

3.7 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion, scale formation, and biological growth for cooling, chilled-water piping and condenser-water piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion and shall include the following:

1. Initial water analysis and HVAC water-treatment recommendations.
2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
3. Periodic field service and consultation.
4. Customer report charts and log sheets.
5. Laboratory technical analysis.
6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.

END OF SECTION 232500

SECTION 23 30 00 – AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manual volume dampers.
2. Control dampers.
3. Fire dampers.
4. Turning vanes.
5. Duct-mounted access doors.
6. Flexible connectors.
7. Flexible ducts.
8. Duct accessory hardware.

B. Related Sections:

1. Section 28 31 00 "Fire Detection and Alarm" for duct-mounted fire and smoke detectors.

1.2 SUBMITTALS

A. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

a. Special fittings.
b. Manual volume damper installations.
c. Control damper installations.
d. Fire-damper, smoke-damper, combination fire- and smoke-damper, installations, including sleeves; and duct-mounted access doors and remote damper operators.
e. Wiring Diagrams: For power, signal, and control wiring.

B. Coordination Drawings: Refer to Section 23 05 00 “Common Work Results for HVAC.”

C. Source quality-control reports.

D. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.3 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with AMCA 500-D testing for damper rating.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60.
2. Exposed-Surface Finish: Mill phosphatized.

C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.

D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Air Balance Inc.; a division of Mestek, Inc.
b. McGill AirFlow LLC.
c. Nailor Industries Inc.
d. Ruskin Company.

2. Standard leakage rating.
3. Suitable for horizontal or vertical applications.
4. Frames:

a. Hat-shaped, galvanized-steel channels, 0.064-inch minimum thickness.
b. Mitered and welded corners.
c. Flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:

a. Multiple or single blade.
b. Parallel- or opposed-blade design.
c. Stiffen damper blades for stability.
d. Galvanized-steel, 0.064 inch thick.

6. Blade Axles: Galvanized steel .
7. Bearings:

a. Oil-impregnated bronze or molded synthetic.
b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Tie Bars and Brackets: Galvanized steel.

B. Jackshaft:

1. Size: 1-inch diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

C. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.3 CONTROL DAMPERS

A. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Ruskin Company.
2. Johnson Controls.

B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

C. Frames:

1. Hat or U shaped.
2. Galvanized-steel channels, 0.064 inch thick.
3. Mitered and welded corners.

D. Blades:

1. Multiple blade with maximum blade width of 8 inches.
2. Opposed-blade design.

3. Galvanized steel.
4. 0.064 inch thick.
5. Blade Edging: Closed-cell neoprene edging, inflatable seal blade edging, or replaceable rubber seals.

E. Blade Axles: 1/2-inch- diameter; galvanized steel ; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.

1. Operating Temperature Range: From minus 40 to plus 200 deg F.

F. Bearings:

1. Oil-impregnated bronze or molded synthetic.
2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
3. Thrust bearings at each end of every blade.

2.4 FIRE DAMPERS

A. Known Acceptable Source:

1. Air Balance Inc.; a division of Mestek, Inc.
2. Arrow United Industries; a division of Mestek, Inc.
3. Cesco Products; a division of Mestek, Inc.
4. Greenheck Fan Corporation.
5. Nailor Industries Inc.
6. NCA Manufacturing, Inc.
7. Pottorff.
8. Prefco; Perfect Air Control, Inc.
9. Ruskin Company.
10. Vent Products Company, Inc.
11. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Type: Static and dynamic; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.

D. Fire Rating: 3 hours. *Coordinate with wall rating.*

E. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: 0.39 inch thick, as indicated, and of length to suit application.
2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

J. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

K. Heat-Responsive Device: Electric, resettable or replaceable link and switch package, factory installed, 165 deg F and 212 deg F rated.

2.5 FLANGE CONNECTORS

A. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Ductmate Industries, Inc.
2. Nexus PDQ; Division of Shilco Holdings Inc.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Description: Add-on orroll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gage and Shape: Match connecting ductwork.

2.6 TURNING VANES

A. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. METALAIRE, Inc.
4. SEMCO Incorporated.
5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."

D. Vane Construction: Singlewall.

2.7 DUCT-MOUNTED ACCESS DOORS

A. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Nailor Industries Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."

1. Door:

a. Double wall, rectangular.
b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
c. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
d. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:

a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches.
d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

2.8 FLEXIBLE CONNECTORS

A. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Ventfabrics, Inc.
4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to 2 strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd..

2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

F. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.

1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.9 FLEXIBLE DUCTS

A. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Flexmaster U.S.A., Inc.
2. McGill AirFlow LLC.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor-barrier film.

1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 175 deg F.
4. Insulation R-Value: Comply with ASHRAE/IESNA 90.1-2004.

C. Flexible Duct Connectors:

1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

2.10 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel ducts.

C. Install control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.
2. Upstream from duct filters.
3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
6. At each change in direction and at maximum 50-foot spacing.
7. Upstream from turning vanes.
8. Control devices requiring inspection.
9. Elsewhere as indicated.

H. Install access doors with swing against duct static pressure.

I. Install fire and smoke dampers according to UL listing.

J. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches.
2. Two-Hand Access: 12 by 6 inches.

3. Head and Hand Access: 18 by 10 inches.
4. Head and Shoulders Access: 21 by 14 inches.
5. Body Access: 25 by 14 inches.
6. Body plus Ladder Access: 25 by 17 inches.

K. Label access doors according to Section 23 05 53 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

L. Install flexible connectors to connect ducts to equipment.

M. Connect diffusers to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.

N. Connect flexible ducts to metal ducts with draw bands.

O. Install duct test holes where required for testing and balancing purposes.

P. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Inspect turning vanes for proper and secure installation.
4. Operate fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 23 30 00

SECTION 23 31 13 - METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Sheet metal materials.
4. Sealants and gaskets.
5. Hangers and supports.

B. Related Sections:

1. Section 23 30 00 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.
2. Section 23 05 93 "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing requirements for metal ducts.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

1.3 SUBMITTALS

A. Product Data: For each type of the following products:
1. Sealants and gaskets.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.

9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment, and vibration isolation.

C. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.

D. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:

a. Lighting fixtures.
b. Air outlets and inlets.
c. Speakers.
d. Sprinklers.
e. Access panels.
f. Perimeter moldings.

E. Welding certificates.

F. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Lindab Inc.
    b. McGill AirFlow LLC.
    c. SEMCO Incorporated.
    d. Sheet Metal Connectors, Inc.
    e. Spiral Manufacturing Co., Inc.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals,

and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Stainless Sheet Steel: Type 304 for outdoor ducts and gooseneck.

D. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

E. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 3 inches .
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

F. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.5 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

G. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."

B. Building Attachments: Concrete inserts or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Do not use powder-actuated concrete fasteners.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 23 30 00 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 9 painting Sections.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by COR, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

    a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

C. Duct system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.8 DUCT CLEANING

A. Clean duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 23 30 00 "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.

6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.9 START UP

A. Air Balance: Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing."

3.10 DUCT SCHEDULE

A. Supply Ducts:

1. Ducts Connected to Constant-Volume Air-Handling Units :

   a. Pressure Class: Positive 2-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. Galvanized for interior, stainless steel for exterior.

2. Ducts Connected to Equipment Not Listed Above:

   a. Pressure Class: Positive 2-inch wg.
   b. Minimum SMACNA Seal Class: A.

B. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. Ducts Connected to Air-Handling Units :

   a. Pressure Class: Positive or negative 2-inch wg.
   b. Minimum SMACNA Seal Class: A.

2. Ducts Connected to Equipment Not Listed Above:

   a. Pressure Class: Positive or negative 2-inch wg .
   b. Minimum SMACNA Seal Class: A.

C. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.

D. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."

   a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
   b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.

c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."

a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
4) Radius-to Diameter Ratio: 1.5.

b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.

E. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."

a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: 45-degree entry.

END OF SECTION 23 31 13

SECTION 233416 - CENTRIFUGAL HVAC FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes: For each product.

1. Airfoil centrifugal fans.
2. Backward-inclined centrifugal fans.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Include rated capacities, furnished specialties, and accessories for each fan.
2. Certified fan performance curves with system operating conditions indicated.
3. Certified fan sound-power ratings.
4. Motor ratings and electrical characteristics, plus motor and electrical accessories.
5. Material thickness and finishes, including color charts.
6. Dampers, including housings, linkages, and operators.

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show fan room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For centrifugal fans to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Belts: One set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. AMCA Compliance:

1. Comply with AMCA performance requirements and bear the AMCA-Certified Ratings Seal.
2. Operating Limits: Classify according to AMCA 99.

B. Unusual Service Conditions:

1. Altitude: 4226 feet above sea level.

2.2 AIRFOIL CENTRIFUGAL FANS

A. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:

1. Acme Engineering & Manufacturing Company.
2. Chicago Blower Corporation.
3. Cincinnati-Fan.
4. Aerovent.
5. Loren Cook Company.
6. Howden Bufalo, Inc.

B. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
3. Factory-installed and -wired disconnect switch.

C. Housings:

1. Formed panels to make curved-scroll housings with shaped cutoff.
2. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
3. Horizontally split, bolted-flange housing.
4. Spun inlet cone with flange.
5. Outlet flange.

D. Airfoil Wheels:

1. Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange.
2. Heavy backplate.
3. Hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.
4. Cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.

E. Shafts:

1. Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

F. Prelubricated and Sealed Shaft Bearings:

1. Self-aligning, pillow-block-type bearings.
2. Ball-Bearing Rating Life: ABMA 9, Ll0 at 120,000 hours.
3. Roller-Bearing Rating Life: ABMA 11, Ll0 at 120,000 hours.

G. Grease-Lubricated Shaft Bearings:

1. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
2. Ball-Bearing Rating Life: ABMA 9, Ll0 at 120,000 hours.
3. Roller-Bearing Rating Life: ABMA 11, Ll0 at 120,000 hours.

H. Grease-Lubricated Shaft Bearings:

1. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
2. Ball-Bearing Rating Life: ABMA 9, Ll0 at 120,000 hours.
3. Roller-Bearing Rating Life: ABMA 11, Ll0 at 120,000 hours.

I. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size: 1.5.
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.

4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Mount: Adjustable for belt tensioning.

J. Accessories:

1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2. Scroll Drain Connection: NPS 1 (DN 25) steel pipe coupling welded to low point of fan scroll.
3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
4. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.
5. Discharge Dampers: Assembly with opposed blades constructed of two plates formed around and to shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
6. Inlet Screens: Grid screen of same material as housing.
7. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
8. Spark-Resistant Construction: AMCA 99.
9. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
10. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.

2.3 BACKWARD-INCLINED CENTRIFUGAL FANS

A. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:

1. Acme Engineering & Manufacturing Company.
2. Chicago Blower Corporation.
3. Cincinnati-Fan.
4. Aerovent.
5. Loren Cook Company.
6. Howden Buffalo, Inc.

B. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
3. Factory-installed and -wired disconnect switch.

C. Housings:

1. Formed panels to make curved-scroll housings with shaped cutoff.
2. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
3. Horizontally split, bolted-flange housing.
4. Spun inlet cone with flange.
5. Outlet flange.

D. Backward-Inclined Wheels:

1. Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange, backplate, backward-inclined blades, and fastened to shaft with set screws.
2. Welded or riveted to flange and backplate; cast-iron or cast-steel hub riveted to backplate.

E. Shafts:

1. Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

F. Prelubricated and Sealed Shaft Bearings:

1. Self-aligning, pillow-block-type ball bearings.
2. Ball-Bearing Rating Life: ABMA 9, Ll0 at 120,000 hours.
3. Roller-Bearing Rating Life: ABMA 11, Ll0 at 120,000 hours.

G. Grease-Lubricated Shaft Bearings:

1. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
2. Ball-Bearing Rating Life: ABMA 9, Ll0 at 120,000 hours.
3. Roller-Bearing Rating Life: ABMA 11, Ll0 at 120,000 hours.

H. Grease-Lubricated Shaft Bearings:

1. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
2. Ball-Bearing Rating Life: ABMA 9, Ll0 at 50,000 120,000 hours.
3. Roller-Bearing Rating Life: ABMA 11, Ll0 at 120,000 hours.

I. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size: 1.5.
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.

4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Mount: Adjustable for belt tensioning.

J. Accessories:

1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
4. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.
5. Discharge Dampers: Assembly with [parallel] [opposed] blades constructed of two plates formed around and to shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
6. Inlet Screens: Grid screen of same material as housing.
7. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
8. Spark-Resistant Construction: AMCA 99.
9. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
10. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.

2.4 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

2.5 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210/ASHRAE 51, "Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install centrifugal fans level and plumb.

B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

D. Equipment Mounting:

1. Install centrifugal fans on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

E. Install units with clearances for service and maintenance.

F. Label fans according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

B. Install ducts adjacent to fans to allow service and maintenance.

C. Install piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain with pipe sizes matching the drain connection.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections:

1. Verify that shipping, blocking, and bracing are removed.

2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. See Section 230593 "Testing, Adjusting, and Balancing For HVAC" for testing, adjusting, and balancing procedures.
10. Remove and replace malfunctioning units and retest as specified above.

D. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

END OF SECTION 233416

SECTION 233423 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Propeller fans.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on Longmont, CO 5300 ft. Elevation.

B. Operating Limits: Classify according to AMCA 99.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:

1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material thickness and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.
6. Roof curbs.
7. Fan speed controllers.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

C. Delegated-Design Submittal: For unit hangars and supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Roof framing and support members relative to duct penetrations.
2. Ceiling suspension assembly members.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Belts: Two sets for each belt-driven unit.

1.8 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

1.9 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 PROPELLER FANS

A. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring with baked-enamel finish coat applied after assembly.

B. Steel Fan Wheels: Formed-steel blades riveted to heavy-gage steel spider bolted to cast-iron hub.

C. Fan Wheel: Replaceable, cast or extruded-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.

D. Fan Drive: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.

E. Fan Drive:

1. Resiliently mounted to housing.
2. Statically and dynamically balanced.
3. Selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
4. Extend grease fitting to accessible location outside of unit.
5. Service Factor Based on Fan Motor Size: 1.4.
6. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
7. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.

    a. Ball-Bearing Rating Life: ABMA 9, L_{10} of 100,000 hours.

8. Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
9. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
10. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
11. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.

F. Accessories:

1. Gravity Shutters: Aluminum blades in aluminum frame; interlocked blades with nylon bearings.
2. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
3. Wall Sleeve: Galvanized steel to match fan and accessory size.
4. Weathershield Hood: Galvanized steel to match fan and accessory size.

5. Weathershield Front Guard: Galvanized steel with expanded metal screen.
6. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
7. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

G. Capacities and Characteristics:

1. See Drawings for capacities

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

B. Enclosure Type: Totally enclosed, fan cooled.

2.3 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Equipment Mounting:

1. Install power ventilators on cast-in-place concrete equipment base(s).
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

C. Secure roof-mounted fans to roof curbs with cadmium-plated hardware. See Section 077200 "Roof Accessories" for installation of roof curbs.

D. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

E. Support suspended units from structure using threaded steel rods and elastomeric hangers having a static deflection of 1 inch. Vibration-control devices are specified in Section 230548 "Vibration and Seismic Controls for HVAC."

F. Install units with clearances for service and maintenance.

G. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.

8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.

END OF SECTION 233423

SECTION 235700 - HEAT EXCHANGERS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes **plate** heat exchangers.

1.3 DEFINITIONS

A. TEMA: Tubular Exchanger Manufacturers Association.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Design Calculations: Calculate requirements for selecting seismic restraints and for designing bases.
2. Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.

C. Delegated-Design Submittal: Details and design calculations for seismic restraints for heat exchangers.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Equipment room, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members to which heat exchangers will be attached.

B. Seismic Qualification Data: Certificates, for heat exchanger, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Heat Exchanger: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of heat exchanger anchorage devices on which certification is based and their installation requirements.

C. Source quality-control reports.

D. Field quality-control reports.

E. Sample Warranty: For manufacturer's warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For heat exchangers to include in emergency, operation, and maintenance manuals.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of domestic-water heat exchangers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Structural failures including heat exchanger, storage tank, and supports.
   b. Faulty operation of controls.
   c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Periods: From date of Substantial Completion.

   a. Plate, Domestic-Water Heat Exchangers:

      1) Plate-and-Frame Type: **One** year

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic restraints for heat exchangers.

B. Seismic Performance: Heat exchangers shall withstand the effects of earthquake motions determined according to **ASCE/SEI 7**

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified **and the unit will be fully operational after the seismic event**."
2. Component Importance Factor is 1.5

2.2 GASKETED-PLATE HEAT EXCHANGERS

A. Configuration: Freestanding assembly consisting of frame support, top and bottom carrying and guide bars, fixed and movable end plates, tie rods, individually removable plates, and one-piece gaskets.

B. Construction: Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1.

C. Frame:

1. Capacity to accommodate **15** percent additional plates.
2. Painted carbon steel with provisions for anchoring to support.

D. Top and Bottom Carrying and Guide Bars: Painted carbon steel, aluminum, or stainless steel.

1. Fabricate attachment of heat-exchanger carrying and guide bars with reinforcement strong enough to resist heat-exchanger movement during seismic event when heat-exchanger carrying and guide bars are anchored to building structure.

E. End-Plate Material: Painted carbon steel.

F. Tie Rods and Nuts: Steel or stainless steel.

G. Piping Connections: Factory fabricated of materials compatible with heat-exchanger shell. Attach tappings to shell before testing and labeling.

1. NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
2. NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.

H. Capacities and Characteristics:

1. Capacities are in the drawings.

2.3 ACCESSORIES

A. Hangers and Supports:

1. Custom, steel **suports** for mounting on **floor**.

2. **Factory** or **Field**-fabricated steel **supports** to ensure both horizontal and vertical support of heat exchanger. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Shroud: **Aluminum** sheet.

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect heat exchangers according to ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1. Affix ASME label.

B. Hydrostatically test heat exchangers to minimum of one and one-half times pressure rating before shipment.

C. Heat exchangers will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas for compliance with requirements for installation tolerances and for structural rigidity, strength, anchors, and other conditions affecting performance of heat exchangers.

B. Examine roughing-in for heat-exchanger piping to verify actual locations of piping connections before equipment installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 GASKETED-PLATE HEAT-EXCHANGER INSTALLATION

A. Install gasketed-plate heat exchanger on custom-designed wall supports anchored to structure as indicated on Drawings.

B. Install metal shroud over installed gasketed-plate heat exchanger according to manufacturer's written instructions.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in other Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements for steam and condensate piping specified in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Heating Piping Specialties."

C. Maintain manufacturer's recommended clearances for tube removal, service, and maintenance.

D. Install piping adjacent to heat exchangers to allow space for service and maintenance of heat exchangers. Arrange piping for easy removal of heat exchangers.

E. Install shutoff valves at heat-exchanger inlet and outlet connections.

F. Install relief valves on heat-exchanger heated-fluid connection and install pipe relief valves, full size of valve connection, to floor drain.

G. Install vacuum breaker at heat-exchanger steam inlet connection.

H. Install hose end valve to drain shell.

I. Install thermometer on heat-exchanger **inlet and** outlet piping, and install thermometer on heating-fluid **inlet and** outlet piping. Comply with requirements for thermometers specified in Section 230519 "Meters and Gages for HVAC Piping."

J. Install pressure gages on heat-exchanger and heating-fluid piping. Comply with requirements for pressure gages specified in Section 230519 "Meters and Gages for HVAC Piping."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections **with the assistance of a factory-authorized service representative**:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Heat exchanger will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 CLEANING

A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

3.6 DEMONSTRATION

A. **Train** Owner's maintenance personnel to adjust, operate, and maintain heat exchangers.

END OF SECTION 235700

SECTION 23 64 16 - CENTRIFUGAL WATER CHILLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Packaged, water-cooled, variable speed electric-motor-driven centrifugal chillers.

B. Related Sections:

1. Section 01 79 00 "Demonstration and Training”.

2. Section 28 30 00 "Refrigerant Detection and Alarm" for refrigerant monitors, alarms and ventilation equipment interlocks.

1.2 DEFINITIONS

A. BAS: Building automation system.

B. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.

C. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in terms of Btu/h to the total power input given in terms of watts at any given set of rating conditions.

D. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by ARI 550/590 and referenced to ARI standard rating conditions.

E. kW/Ton: The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons at any given set of rating conditions.

F. NPLV: Nonstandard part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by ARI 550/590 and intended for operating conditions other than the ARI standard rating conditions.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Centrifugal chillers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

B. Condenser-Fluid Temperature Performance:

1. Startup Condenser-Fluid Temperature: Chiller shall be capable of starting with an entering condenser-fluid temperature of 55 deg F and providing stable operation until the system temperature is elevated to the minimum operating entering condenser-fluid temperature.
2. Minimum Operating Condenser-Fluid Temperature: Chiller shall be capable of continuous operation over the entire capacity range indicated with an entering condenser-fluid temperature of 55 deg F.
3. Make factory modifications to standard chiller design if necessary to comply with performance indicated.

C. Site Altitude: Chiller shall be suitable for altitude at which installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.

D. Performance Tolerance:

1. Allowable Capacity Tolerance: Per ARI 550/590.
2. Allowable IPLV/NPLV Performance Tolerance: Per ARI 550/590.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.

1. Performance at ARI standard conditions and at conditions indicated.
2. Performance at ARI standard unloading conditions.
3. Minimum evaporator flow rate.
4. Refrigerant capacity of chiller.
5. Fluid capacity of evaporator and condenser.
6. Characteristics of safety relief valves.
7. Minimum entering condenser-fluid temperature.
8. Performance at varying capacities with constant design condenser-fluid temperature. Repeat performance at varying capacities for different condenser-fluid temperatures from design to minimum in 5 deg F increments.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, load distribution, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

C. Certificates: For certification required in "Quality Assurance" Article.

D. Seismic Qualification Certificates: For chillers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Startup service reports.

F. Operation and Maintenance Data: For each chiller to include in emergency, operation, and maintenance manuals.

G. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE

A. ARI Certification: Certify chiller according to ARI 550 certification program.

B. ARI Rating: Rate chiller performance according to requirements in ARI 550/590.

C. ASHRAE Compliance:

1. ASHRAE 15 for safety code for mechanical refrigeration.
2. ASHRAE 147 for refrigerant leaks, recovery, and handling and storage requirements.

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004.

E. ASME Compliance: Fabricate and label chillers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1**,** as applicable to chiller design. For chillers charged with R-134a refrigerant, include an ASME U-stamp and nameplate certifying compliance.

F. Comply with NFPA 70.

G. Comply with requirements of UL and UL Canada, and include label by a qualified testing agency showing compliance.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Installation will require chiller to be rigged in multiple components and assembled within the facility. Unit shall be shipped from factory in sealed components. It is expected that the extent of disassembly required is that the compressor and motor will need to be separate from the tube bundles.

B. Ship each chiller with a full charge of refrigerant. Charge each chiller with nitrogen if refrigerant is shipped in containers separate from chiller.

C. Ship each oil-lubricated chiller with a full charge of oil.

1. Ship oil factory installed in chiller.

1.7 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.

B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of chillers that fails in materials or workmanship within specified warranty period.

1. Extended warranties include, but are not limited to, the following:

a. Complete chiller including refrigerant and oil charge.
b. Complete compressor and drive assembly including refrigerant and oil charge.
c. Refrigerant and oil charge.
d. Parts and labor.
e. Loss of refrigerant charge for any reason.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following: *May be sole sourced, if so then “but not limited to” will be deleted.

1. Trane

2.2 MANUFACTURED UNIT

A. Description: Factory-assembled and -tested chiller complete with compressor, compressor motor, compressor motor controller, lubrication system evaporator, condenser, controls, interconnecting unit piping and wiring, and indicated accessories.

1. Disassemble chiller into major assemblies as required by the installation after factory testing and before packaging for shipment.
2. Chillers shall be disassembled by the manufacturer to the degree in which will allow the chiller to fit through the doors into the chiller room from the areaway near the loading dock. This shall be coordinated by the contractor.
3. For chillers with dual compressors, provide each compressor with a dedicated motor and motor controller, and provide for continued operation when either compressor-drive assembly fails or is being serviced.

B. Fabricate chiller mounting base with reinforcement strong enough to resist chiller movement during a seismic event when chiller is anchored to field support structure.

2.3 COMPRESSOR-DRIVE ASSEMBLY

A. Description: Multistage, variable-displacement, centrifugal-type compressor driven by an electric motor.

B. Compressor:

1. Casing: Cast iron, precision ground.
2. Impeller: High-strength cast aluminum or cast-aluminum alloy on carbon- or alloy-steel shaft.

C. Drive: Direct- or gear-drive, open or hermetic design using an electric motor as the driver.

1. Gear Drives: For chillers with gear drives, provide single- or double-helical gear design continuously coated with oil while chiller is operating. Gears shall comply with American Gear Manufacturer Association standards.
2. Drive Coupling: For chillers with open drives, provide flexible disc with all-metal construction and no wearing parts to ensure long life without the need for lubrication.
3. Seals: Seal drive assembly to prevent refrigerant leakage.

D. Compressor Motor:

1. Continuous-duty, squirrel-cage, induction-type, two-pole motor with energy efficiency required to suit chiller energy efficiency indicated.
2. Factory mounted, aligned, and balanced as part of compressor assembly before shipping.
3. Motor shall be of sufficient capacity to drive compressor throughout entire operating range without overload and with sufficient capacity to start and accelerate compressor without damage.
4. For chillers with open drives, provide motor with totally enclosed enclosure.
5. Provide motor with thermistor or RTD in each of three-phase motor windings to monitor temperature and report information to chiller control panel.
6. Provide motor with thermistor or RTD to monitor bearing temperature and report information to chiller control panel.
7. Provide open-drive motor with internal electric heater, internally powered from chiller power supply.

E. Vibration Balance: Balance chiller compressor and drive assembly to provide a precision balance that is free of noticeable vibration over the entire operating range.

1. Overspeed Test: 25 percent above design operating speed.

F. Service: Easily accessible for inspection and service.

1. Compressor's internal components shall be accessible without having to remove compressor-drive assembly from chiller.
2. Provide lifting lugs or eyebolts attached to casing.

G. Economizers: For multistage chillers, provide interstage economizers.

H. Capacity Control: Modulating, variable-inlet, guide-vane assembly combined with hot-gas bypass, if necessary, to achieve performance indicated.

1. Maintain stable operation that is free of surge, cavitation, and vibration throughout range of operation. Configure to achieve most energy-efficient operation possible.
2. Operating Range: From 100 to 10 percent of design capacity.
3. Condenser-Fluid Unloading Requirements over Operating Range: Drop-in entering condenser-fluid temperature of 2.5 deg F for each 10 percent in capacity reduction.

I. Oil Lubrication System: Consisting of pump, filtration, heater**,** cooler, factory-wired power connection, and controls.

1. Provide lubrication to bearings, gears, and other rotating surfaces at all operating, startup, coastdown, and standby conditions including power failure.
2. Thermostatically controlled oil heater properly sized to remove refrigerant from oil.
3. Oil filter shall be the easily replaceable cartridge type, minimum 0.5-micron efficiency, with means of positive isolation while servicing.
4. Refrigerant- or water-cooled oil cooler.
5. Factory-installed and pressure-tested piping with isolation valves and accessories.
6. Oil compatible with refrigerant and chiller components.
7. Positive visual indication of oil level.

2.4 REFRIGERATION

A. Refrigerant:

1. Type R-123; ASHRAE 34, Class A1 or Class B1.
2. Compatibility: Chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.

B. Refrigerant Flow Control: Manufacturer's standard refrigerant flow-control device satisfying performance requirements indicated.

C. Pressure Relief Device:

1. Comply with requirements in ASHRAE 15 and in applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. For Chillers Using R-123: ASME-rated, spring-loaded, pressure relief valve; single- or multiple-reseating type. Pressure relief valve(s) shall be provided for each heat exchanger. Condenser shall have dual valves with one being redundant and configured to allow either valve to be replaced without loss of refrigerant.

D. Refrigeration Transfer: Provide service valves and other factory-installed accessories required to facilitate transfer of refrigerant from chiller to a remote refrigerant storage and recycling system. Comply with requirements in ASHRAE 15 and ASHRAE 147.

E. Refrigerant Isolation for Chillers Using R-123: Factory install positive shutoff, manual isolation valves in the compressor discharge line to the condenser and the refrigerant liquid line leaving

the condenser to allow for isolation and storage of full refrigerant charge in the chiller condenser shell. In addition, provide isolation valve on suction side of compressor from evaporator to allow for isolation and storage of full refrigerant charge in the chiller evaporator shell**.**

F. Positive-Pressure System:

1. During nonoperational periods, positive-pressure system shall automatically maintain a positive pressure for atmosphere in the refrigerant pressure vessel of not less than 0.5 psig (adjustable) up to a pressure that remains within the vessel design pressure limits.
2. System shall be factory wired and include controller, electric heat, pressure transmitter, or switch.

2.5 EVAPORATOR

A. Description: Shell-and-tube design with water in tubes and refrigerant surrounding tubes within shell. Shell is separate from condenser.

B. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.

C. Designed to prevent liquid refrigerant carryover from entering compressor.

D. Provide evaporator with sight glass or other form of positive visual verification of liquid-refrigerant level.

E. Tubes:

1. Individually replaceable from either end and without damage to tube sheets and other tubes.
2. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
3. Material: Copper.
4. Nominal OD: 3/4 inch.
5. Minimum Wall Thickness: 0.025 inch.
6. External Finish: Manufacturer's standard.
7. Internal Finish: Enhanced or smooth.

F. End Tube Sheets: Continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.

G. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.

H. Water Box:

1. Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
2. Marine type for water box with piping connections. Standard type for water box without piping connections.
3. Hinged or davited water-box covers.

4. Nozzle Pipe Connections: Welded, ASME B16.5 or flat-face flange.
5. Thermistor or RTD temperature sensor factory installed in each nozzle.
6. Fit each water box with 1-inch drain connection at low point and vent connection at high point, each with threaded plug.

2.6 CONDENSER

A. Description: Shell-and-tube design with water in tubes and refrigerant surrounding tubes within shell. Shell is separate from evaporator.

B. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.

C. Designed to prevent direct impingement of high-velocity hot gas from compressor discharge on tubes.

D. Provide condenser with sight glass or other form of positive visual verification of refrigerant charge and condition.

E. Tubes:

1. Individually replaceable from either end and without damage to tube sheets and other tubes.
2. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
3. Material: Copper.
4. Nominal OD: 3/4 inch.
5. Minimum Wall Thickness: 0.025 inch.
6. External Finish: Manufacturer's standard.
7. Internal Finish: Enhanced or smooth.

F. End Tube Sheets: Continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.

G. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.

H. Water Box:

1. Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
2. Marine type for water box with piping connections. Standard type for water box without piping connections.
3. Hinged or davited water-box covers.
4. Nozzle Pipe Connections: Welded, ASME B16.5, flat-face flange or grooved with mechanical-joint coupling and flange adapter.
5. Thermistor or RTD temperature sensor factory installed in each nozzle.
6. Fit each water box with drain connection at low point and vent connection at high point, each with threaded plug.

2.7 INSULATION

A. Closed-cell, flexible elastomeric thermal insulation complying with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Thickness: 3/4 inch

B. Adhesive: As recommended by insulation manufacturer.

C. Factory-applied insulation over all cold surfaces of chiller capable of forming condensation. Components shall include, but not be limited to, evaporator shell and end tube sheets, evaporator water boxes including nozzles, refrigerant suction pipe from evaporator to compressor, cold surfaces of compressor, refrigerant-cooled motor, and auxiliary piping.

1. Apply adhesive to 100 percent of insulation contact surface.
2. Before insulating steel surfaces, prepare surfaces for paint, and prime and paint as indicated for other painted components. Do not insulate unpainted steel surfaces.
3. Seal seams and joints to provide a vapor barrier.
4. After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.

2.8 ELECTRICAL

A. Factory installed and wired, and functionally tested at factory before shipment.

B. Single-point, field-power connection to fused disconnect switch. Minimum withstand rating shall be as required by electrical power distribution system, but not less than 65,000 A.

1. Branch power circuit to each motor, electric heater, dedicated electrical load, and controls with disconnect switch or circuit breaker.

a. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
b. NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit-trip set point.

2. NEMA ICS 2-rated motor controller for auxiliary motors, hand-off-auto switch, and overcurrent protection for each motor.
3. Control-circuit transformer with primary and secondary side fuses.

C. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.

D. Factory-installed wiring outside of enclosures shall be in metal raceway except make terminal connections with not more than a 24-inch length of liquidtight conduit.

E. Factory install and wire capacitor bank for the purpose of power factor correction to 0.95 at all operating conditions.

1. If capacitors are mounted in a dedicated enclosure, use same NEMA enclosure type as motor controller. Provide enclosure with service entrance knockouts and bushings for conduit.
2. Capacitors shall be non-PCB dielectric fluid, metallized electrode design, low loss with low-temperature rise. The kVAr ratings shall be indicated and shall not exceed the maximum limitations set by NFPA 70. Provide individual cells as required.
3. Provide each cell with current-limiting replaceable fuses and carbon-film discharge resistors to reduce residual voltage to less than 50 V within one minute after de-energizing.
4. Provide a ground terminal and a terminal block or individual connectors for phase connection.

2.9 VARIABLE FREQUENCY CONTROLLER

A. Motor controller shall be factory mounted and wired on the chiller to provide a single-point, field-power termination to the chiller and its auxiliaries.

B. Description: NEMA ICS 2; listed and labeled as a complete unit and arranged to provide variable speed by adjusting output voltage and frequency.

C. Enclosure: Unit mounted, NEMA 250, Type 12, with hinged full-front access door with lock and key.

D. Integral Disconnecting Means: Door-interlocked, NEMA AB 1, instantaneous-trip circuit breaker with lockable handle. Minimum withstand rating shall be as required by electrical power distribution system, but not less than 65,000 A.

E. Technology: Pulse width modulated (PWM) output with insulated gate bipolar transistors (IGBT); suitable for variable torque loads.

F. Controller shall consist of a rectifier converter section, a digital/analog driver regulator section, and an inverter output section.

1. Rectifier section shall be a full-wave diode bridge that changes fixed-voltage, fixed-frequency, ac line power to a fixed dc voltage. Silicon controller rectifiers, current source inverters, and paralleling of devices are unacceptable. Rectifier shall be insensitive to phase rotation of the ac line.
2. Regulator shall provide full digital control of frequency and voltage.
3. Inverter section shall change fixed dc voltage to variable-frequency, variable ac voltage, for application to a squirrel-cage motor. Inverter shall produce a sine-coded, pulse width modulated (PWM) output wave form and shall conduct no radio-frequency interference back to the input power supply.

G. Output Rating: Three phase; with voltage proportional to frequency throughout voltage range.

H. Operating Requirements:

1. Input AC Voltage Tolerance: 460-V ac, plus 10 percent or 506 V maximum.
2. Input frequency tolerance of 60 Hz, plus or minus 2 Hz.
3. Capable of driving full load, without underating, under the following conditions:

a. Ambient Temperature: 0 to 50 deg C.
b. Relative Humidity: Up to 95 percent (noncondensing).
c. Altitude: 5300 feet.

4. Minimum Efficiency: 96 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 95 percent without harmonic filter, 98 percent with harmonic filter.
6. Overload Capability: 1.05 times the full-load current for 7 seconds.
7. Starting Torque: As required by compressor-drive assembly.
8. Speed Regulation: Plus or minus 1 percent.
9. Isolated control interface to allow controller to follow control signal over a 10:1 speed range.
10. To avoid equipment resonant vibrations, provide critical speed lockout circuitry to allow bands of operating frequency at which controller shall not operate continuously.
11. Capable of being restarted into a motor coasting in either the forward or reverse direction without tripping.

I. Internal Adjustability Capabilities:

1. Minimum Output Frequency: 6 Hz.
2. Maximum Output Frequency: 60 Hz.
3. Acceleration: 2 seconds to a minimum of 60 seconds.
4. Deceleration: 2 seconds to a minimum of 60 seconds.
5. Current Limit: 30 percent to a minimum of 100 percent of maximum rating.

J. Self-Protection and Reliability Features: Subjecting the controller to any of the following conditions shall not result in component failure or the need for replacement:

1. Overtemperature.
2. Short circuit at controller output.
3. Ground fault at controller output. Variable frequency controller shall be able to start a grounded motor.
4. Open circuit at controller output.
5. Input undervoltage.
6. Input overvoltage.
7. Loss of input phase.
8. Reverse phase.
9. AC line switching transients.
10. Instantaneous overload, line to line or line to ground.
11. Sustained overload exceeding 100 percent of controller rated current.
12. Starting a rotating motor.

K. Motor Protection: Controller shall protect motor against overvoltage and undervoltage, phase loss, reverse phase, overcurrent, overtemperature, and ground fault.

L. Automatic Reset and Restart: Capable of three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Controller shall be capable of automatic restart on phase-loss and overvoltage and undervoltage trips.

M. Visual Indication: On face of controller enclosure or chiller control enclosure; indicating the following conditions:

1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.
7. Motor speed (percent).
8. Fault or alarm status (code).
9. DC-link voltage.
10. Motor output voltage.
11. Input kilovolt amperes.
12. Total power factor.
13. Input kilowatts.
14. Input kilowatt-hours.
15. Three-phase input voltage.
16. Three-phase output voltage.
17. Three-phase input current.
18. Three-phase output current.
19. Three-phase input voltage total harmonic distortion.
20. Three-phase input current total harmonic distortion.
21. Output frequency (Hertz).
22. Elapsed operating time (hours).
23. Diagnostic and service parameters.

N. Operator Interface: At controller or chiller control panel; with start-stop and auto-manual selector with manual-speed-control potentiometer.

O. Control Signal Interface:

1. Electric Input Signal Interface: A minimum of two analog inputs (0 to 10 V or 0/4-20 mA) and six programmable digital inputs.

P. Active Harmonic Distortion Filter: Factory mounted and wired to limit total voltage and current distortion to less than 5 percent.

Q. Cooling: Air cooled.

R. Accessories: Devices shall be factory installed in controller enclosure unless otherwise indicated.

1. Control Relays: Auxiliary and adjustable time-delay relays.

S. Chiller Capacity Control Interface: Equip chiller with adaptive control logic to automatically adjust the compressor motor speed and the compressor pre-rotation inlet vane position independently to achieve maximum part-load efficiency in response to sensor inputs that are integral to the chiller controls.

2.10 CONTROLS

A. Chillers CH-100, CH-200.

B. Control: Standalone and microprocessor based, with all memory stored in nonvolatile memory so that reprogramming is not required on loss of electrical power

C. Enclosure: Unit mounted, NEMA 250, Type 4 hinged or lockable; factory wired with a single-point, field-power connection and a separate control circuit.

D. Operator Interface: Multiple-character digital or graphic display with dynamic update of information and with keypad or touch-sensitive display located on front of control enclosure. In either imperial or metric units selectable through the interface, display the following information:

1. Date and time.
2. Operating or alarm status.
3. Fault history with not less than last 10 faults displayed.
4. Set points of controllable parameters.
5. Trend data.
6. Operating hours.
7. Number of chiller starts.
8. Entering- and leaving-fluid temperatures of evaporator and condenser.
9. Difference in fluid temperatures of evaporator and condenser.
10. Fluid flow of evaporator and condenser.
11. Fluid pressure drop of evaporator and condenser.
12. Refrigerant pressures in evaporator and condenser.
13. Refrigerant saturation temperature in evaporator and condenser shell.
14. Compressor refrigerant suction and discharge temperature.
15. Compressor bearing temperature.
16. Motor bearing temperature.
17. Motor winding temperature.
18. Oil temperature.
19. Oil discharge pressure.
20. Phase current.
21. Percent of motor rated load amperage.
22. Phase voltage.
23. Demand power (kilowatts).
24. Energy use (kilowatt-hours).
25. Power factor.
26. Purge suction temperature if purge system is provided.
27. Purge elapsed time if purge system is provided.

E. Control Functions:

1. Manual or automatic startup and shutdown time schedule.
2. Entering and leaving chilled-water temperatures, control set points, and motor load limits. Evaporator fluid temperature shall be reset based on return-water temperature.
3. Current limit and demand limit.
4. Condenser-fluid temperature.
5. External chiller emergency stop.

6. Variable evaporator flow.

F. Manually Reset Safety Controls: The following conditions shall shut down chiller and require manual reset:

1. Low evaporator pressure or temperature; high condenser pressure.
2. Low evaporator fluid temperature.
3. Low oil differential pressure.
4. High or low oil pressure.
5. High oil temperature.
6. High compressor-discharge temperature.
7. Loss of condenser-fluid flow.
8. Loss of evaporator fluid flow.
9. Motor overcurrent.
10. Motor overvoltage.
11. Motor undervoltage.
12. Motor phase reversal.
13. Motor phase failure.
14. Sensor- or detection-circuit fault.
15. Processor communication loss.
16. Motor controller fault.
17. Extended compressor surge.

G. Variable Primary Flow Control: Include any manufacturer's option control programming or hardware to compensate for variable flow through the evaporator bundle. The chiller will be operating in a variable primary pumped system and will require variable-flow compensation.

H. Trending: Capability to trend analog data of up to five parameters simultaneously over an adjustable period and frequency of polling.

I. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: view only; view and operate; and view, operate, and service.

J. Control Authority: At least four conditions: Off, local manual control at chiller, local automatic control at chiller, and automatic control through a remote source.

K. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer and a notebook computer.

L. Control Interface: Factory- and/or field-installed hardware and software to enable the Direct Digital Control System (DDCS) to monitor, control, and display chiller status and alarms.

1. Hardwired Points:

a. Monitoring: Chiller Trouble/Fault Alarm.
b. Control: Chiller On/Off and Chilled Water Discharge Temperature Set-point Adjustment.

2. Network/Software Points: Refer to “DDCS Point Function Schedule” on the mechanical plans for a complete list of control and monitoring points. At the minimum, the following monitoring points shall be available at the DDCS via network interface:

   a. Monitoring: Chiller On/Off Status, Chiller Amperage, Chilled Power Demand (kW), Chilled Water Supply/Return Temperatures, Condenser Water Supply/Return Temperatures, Chilled Water Supply/Return Pressure Switch, Condenser Water Supply/Return Pressure Switch, Chilled Water Supply Flow Switch, and Condenser Water Supply Flow Switch.

3. Provide a network interface between the chiller control panel and the DDCS that is fully compatible with the DDCS to allow remote control and monitoring of chiller. If a remote panel is required for the interface, provide conduit and wiring between chiller control panels and remote panel. For the specific communication protocol and network characteristics required for the DDCS network interface connection, refer to Division 23, “Instrumentation and Controls for HVAC.”

2.11 FINISH

A. Paint chiller, using manufacturer's standard procedures.

B. Provide FAA with spray container of paint used in application of topcoat to use in touch-up applications after Project Closeout.

2.12 ACCESSORIES

A. Flow Switches:

1. Chiller manufacturer shall furnish a switch for each evaporator and condenser and verify field-mounting location before installation.

2. Pressure Differential Switches:

   a. Construction: Wetted parts of body and trim constructed of Type 316 stainless steel.
   b. Performance: Switch shall withstand, without damage, the full-pressure rating of the heat exchanger applied to either port and exhibit zero set-point shift due to variation in working pressure.
   c. Set Point: Screw type, field adjustable.
   d. Electrical Connections: Internally mounted screw-type terminal blocks.
   e. Switch Enclosure: NEMA 250, Type 4.
   f. Switch Action: Double-pole, double-throw switch with one pole field wired to the chiller control panel and the other pole field wired to the BAS.

B. Vibration Isolation:

1. Chiller manufacturer shall furnish vibration isolation for each chiller.
2. Neoprene Pad:

a. Two layers of 0.375-inch- thick, ribbed- or waffle-pattern neoprene pads separated by a 16-gage, stainless-steel plate.
b. Fabricate pads from 40- to 50-durometer neoprene.
c. Provide stainless-steel square bearing plate to load the pad uniformly between 20 and 40 psig with a 0.12- to 0.16-inch deflection.

C. Tool Kit: Chiller manufacturer shall assemble a tool kit specially designed for use in serving the chiller(s) furnished. Include special tools required to service chiller components not readily available to FAA service personnel in performing routine maintenance. Place tools in a lockable case with hinged cover. Provide a list of each tool furnished and attach the list to underside of case cover.

2.13 SOURCE QUALITY CONTROL

A. Perform functional run tests of chillers before shipping.

B. Factory performance test chillers, before shipping, according to ARI 550/590.

1. Test the following conditions:

a. Design conditions indicated.
b. Reduction in capacity from design to minimum load in steps of 10 with varying entering condenser-fluid temperature from design to minimum conditions in 5 deg F increments.
c. At four point(s) of varying part-load performance to be selected by FAA at time of test.

2. Allow Government access to place where chillers are being tested. Notify COR 14 days in advance of testing.
3. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

C. Factory sound test chillers, before shipping, according to ARI 575.

1. Test the following conditions:

a. Design conditions indicated.
b. Chiller operating at calculated worst-case sound condition.
c. At four point(s) of varying part-load performance to be selected by FAA at time of test.

2. Allow Government access to place where chillers are being tested. Notify COR 14 days in advance of testing.
3. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

D. For chillers using R-123 refrigerant, factory test and inspect evaporator and condenser according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

E. For chillers located indoors, rate sound power level according to ARI 575.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine chillers before installation. Reject chillers that are damaged.

B. Examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting chiller performance, maintenance, and operations before equipment installation.

1. Final chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CHILLER INSTALLATION

A. Install chillers on support structure indicated.

B. Equipment Mounting: Install chiller on concrete bases using elastomeric pads. Comply with requirements for concrete bases specified in Section 03 30 00 "Cast-in-Place Concrete." Comply with requirements for vibration isolation devices specified in Section 23 05 48 "Vibration Controls for HVAC Piping and Equipment."

1. Minimum Deflection: 1/2 inch.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Maintain manufacturer's recommended clearances for service and maintenance.

A. If chiller requires disassembly for transportation or installation, manufacturer’s representative shall do disassembly and assembly.

B. Charge chiller with refrigerant and fill with oil if not factory installed.

C. Install separate devices furnished by manufacturer and not factory installed.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Section 23 21 13 "Hydronic Piping". Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to chiller to allow service and maintenance.

C. Evaporator Fluid Connections: Connect to evaporator marine water box inlet with shutoff valve, flexible connector, thermometer, and plugged tee with pressure gage. Connect to evaporator marine water box outlet with shutoff valve, flow control valve, flexible connector, flow switch, thermometer, plugged tee with shutoff valve and pressure gage, and drain connection with valve. Make connections to chiller with a flange.

D. Condenser-Fluid Connections: Connect to condenser marine water box inlet with shutoff valve, flexible connector, thermometer, and plugged tee with pressure gage. Connect to condenser marine water box outlet with shutoff valve, flow control valve, flexible connector, flow switch, thermometer, plugged tee with shutoff valve and pressure gage, and drain connection with valve. Make connections to chiller with a flange.

E. Refrigerant Pressure Relief Device Connections: For chillers installed indoors, extend vent piping for each chiller to the outdoors without valves or restrictions. Comply with ASHRAE 15. Connect to chiller pressure relief device with flexible connector and dirt leg with drain valve.

F. Connect each chiller drain connection with a union and drain pipe, and extend pipe, full size of connection, to floor drain. Provide a shutoff valve at each connection.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that refrigerant charge is sufficient and chiller has been leak tested.
3. Verify that pumps are installed and functional.
4. Verify that thermometers and gages are installed.
5. Operate chiller for run-in period.
6. Check bearing lubrication and oil levels.
7. Verify that refrigerant pressure relief device is vented outside.
8. Verify proper motor rotation.
9. Verify static deflection of vibration isolators, including deflection during chiller startup and shutdown.
10. Verify and record performance of fluid flow and low-temperature interlocks for evaporator and condenser.
11. Verify and record performance of chiller protection devices.
12. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assembly, installation, and connection.

C. Prepare test and inspection startup reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train FAA's maintenance personnel to adjust, operate, and maintain chillers. Video record the training sessions**.** Submit to FAA two copies on DVD.

END OF SECTION 23 64 16

SECTION 23 65 00 - COOLING TOWERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Open-circuit, induced-draft, counter-flow cooling towers.

B. Related Sections:

1. 01 79 00 “Demonstration and Training”.

1.2 DEFINITIONS

A. ECMS: Energy Control and Management System

B. FRP: Fiber-reinforced polyester.

C. SS: Stainless Steel

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, pressure drop, fan performance data, rating curves with selected points indicated, furnished specialties, and accessories.

1. Maximum flow rate.
2. Minimum flow rate.
3. Drift loss as percent of design flow rate.
4. Performance curves for the following:

    a. Varying entering-water temperatures from design to minimum.
    b. Varying ambient wet-bulb temperatures from design to minimum.
    c. Varying water flow rates from design to minimum.
    d. Varying fan operation (off, minimum, and design speed).

5. Fan airflow, brake horsepower, and drive losses.
6. Motor amperage, efficiency, and power factor at 100, 75, 50, and 25 percent of nameplate horsepower.
7. Electrical power requirements for each cooling tower component requiring power.
8. Reports for aquatic toxicity testing of lubricants in accordance with ASTM D6081.

B. Shop Drawings: Complete set of manufacturer's prints of cooling tower assemblies, control panels, sections and elevations, and unit isolation. Include the following:

1. Assembled unit dimensions.
2. Weight and load distribution.
3. Required clearances for maintenance and operation.
4. Sizes and locations of piping and wiring connections.
5. Wiring Diagrams: For power, signal, and control wiring.

C. Coordination Drawings: Floor plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Structural supports.
2. Piping roughing-in requirements.
3. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
4. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.
5. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
6. Detailed description of equipment anchorage devices and their installation requirements.
7. Phasing Plan: This facility is a mission critical 24/7 operation. The facility must remain in operation during all phases of construction. Temporary tower and pumps will be required. Hot taps and line stops/bypasses will be required. Prepare a phasing plan with points indicated where FAA Facilities Operations will need to isolate systems. Do not to open or close valves that are an active part of the plant operation.

D. Startup service reports.

E. Operation and Maintenance Data: For each cooling tower to include in emergency, operation, and maintenance manuals.

F. Warranty: Sample warranty.

1.4 PERFORMANCE REQUIREMENTS

A. Alternate Cooling Tower Manufacturer or Model Delegated Design: Design cooling tower support structure, wind restraints and catwalk access platforms, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Cooling tower shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to SEI/ASCE 7, IBC 2012, and the additional requirements:

1. The term "withstand" will be defined as "the unit will remain in place, without separation of any parts from the device when subjected to the forces specified and the unit will be fully operational after the event." This includes components to remain intact: Fan Discharge Stack, Intake Louvers, Fill, Drift Eliminators, Fan and Blades, Motor and Tower Casing.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Certified by CTI.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

D. CTI Certification: Cooling tower thermal performance according to CTI STD 201, "Certification Standard for Commercial Water-Cooling Towers Thermal Performance."

1.6 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.

C. Coordinate piping connection to riser. Refer to section 23 21 13 HYDRONIC PIPING.

1.7 WARRANTY

A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace the following components of cooling towers that fail in materials or workmanship within specified warranty period:

1. Fan assembly including fan, drive system, and motor.
2. All components of cooling tower including warranty against leaks.
3. Warranty Period: Five years parts and labor from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 OPEN-CIRCUIT, INDUCED-DRAFT, COUNTERFLOW COOLING TOWERS

A. Known Acceptable Source: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include but are not limited to the following:

1. Tower Tech Inc.

B. Fabricate cooling tower mounting base with reinforcement strong enough to resist cooling tower movement during a wind event when cooling tower is anchored to field support structure.

C. Casing and Frame:

1. Casing Material: FRP (Fiberglass Reinforced Plastic)
2. Frame Material: FRP

3. Fasteners: 304 or 316 stainless steel.
4. Joints and Seams: Sealed watertight.

D. Collection Basin:

1. Strainer: Removable 304 or 316 stainless steel strainer with openings smaller than nozzle orifices.
2. Overflow connection.
3. Outlet Connection: ASME B16.5, Class 150 flange.
4. Isolation plate between adjacent cells of multiple-cell towers.

E. Pressurized Water Distribution Piping: Main header and lateral branch piping designed for even distribution over heat-exchanger coil or fill throughout the flow range without the need for balancing valves and for connecting individual, removable, non-clogging spray nozzles.

1. Pipe Material: PVC headers and laterals.
2. Spray Nozzle Material: HDPE/Stainless Steel
3. Piping Supports: 304 or 316 stainless steel hangers and supports to resist movement during operation and shipment.
4. Point of connection to field piping shall be flanged.

F. Fill:

1. Materials: PVC, resistant to rot, decay, and biological attack; with maximum flame-spread index of 5 according to ASTM E 84.
2. Minimum Thickness: 15 mils before forming.
3. Fabrication: Fill-type sheets, fabricated, formed, and bonded together after forming into removable assemblies that are factory installed by manufacturer.
4. Fill Material Operating Temperature: Suitable for entering-water temperatures up through 120 deg F.

G. Removable Drift Eliminator:

1. Material: PVC; resistant to rot, decay, and biological attack; with maximum flame-spread index of 5 according to ASTM E 84.
2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
3. Configuration: Multi-pass, designed and tested to reduce water carryover to achieve performance indicated.

H. Air-Intake Louvers:

1. Material: FRP or PVC.
2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
3. Louver Blades: Arranged to uniformly direct air into cooling tower, to minimize air resistance, and to prevent water from splashing out of tower during all modes of operation including operation with fans off.

I. Axial Fan: Balanced at the factory after assembly.

1. Blade Material: FRP, low-noise.
2. Blade Pitch: Field adjustable.

3. Protective Enclosure: Removable, 304 stainless steel, wire-mesh screens, complying with OSHA regulations.

J. Fan Motor:

1. General Requirements for Fan Motors: Comply with NEMA designation and temperature-rating requirements specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment" and as indicated below.
2. Motor Enclosure: Totally enclosed fan cooled (TEFC).
3. Energy Efficiency: NEMA Premium Efficient.
4. Service Factor: 1.15.
5. NEMA Design B.
6. Insulation: Class H.
7. Severe-duty IEEE-841, Inverter-duty rated variable-speed motors with the following features:
    a. Inverter-duty rated per NEMA MG-1, Section IV, "Performance Standard Applying to All Machines," Part 31, "Definite-Purpose, Inverter-Fed, Polyphase Motors."
    b. Motors shall have shaft mounted static grounding ring similar to Aegis SGR.
    c. Rotor and stator protected with corrosion-inhibiting epoxy resin.
    d. Double-shielded, vacuum-degassed bearings lubricated with premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F.
    e. Internal heater automatically energized when motor is de-energized.
    f. Minimum ingress protection rating of IP-55.
    g. Tested and certified to IEEE-841 standard for harsh environment.
8. Motor Location: Mounted outside of cooling tower discharge airstream.

K. Vibration Switch: For each fan drive.

1. Enclosure: NEMA 250, Type 4X.
2. Vibration Detection: Sensor with a field-adjustable, acceleration-sensitivity set point in a range of 0 to 1 g and frequency range of 0 to 3000 cycles per minute. Cooling tower manufacturer shall recommend switch set point for proper operation and protection.
3. Provide switch with manual-reset button for field connection to the plant controls system and hardwired connection to fan motor electrical circuit. Locate manual-reset button beside or near motor local disconnect on tower and within reach from an access platform.
4. Switch shall, on sensing excessive vibration, signal an alarm through the plant controls system and shut down the fan.

L. Controls: Comply with requirements in Section 23 09 00 "HVAC Instrumentation and Controls."

M. Personnel Access Components:

1. Door: Large enough for personnel to access cooling tower internal components. Door shall be operable from both sides of the door.

N. Capacities and Characteristics: Refer to Mechanical Equipment Schedule on Drawings.

2.2 SOURCE QUALITY CONTROL

A. Verification of Performance: Test and certify cooling tower performance according to CTI STD 201, "Certification Standard for Commercial Water-Cooling Towers Thermal Performance."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before cooling tower installation, examine roughing-in for tower support, anchor-bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting tower performance, maintenance, and operation.

1. Cooling tower locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install cooling towers on support structure indicated. Additional structure required for installation of a specific manufacturer’s product will be the responsibility of that manufacturer at no additional cost.

B. Equipment Mounting: Install cooling tower on structural supports.

C. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Maintain manufacturer's recommended clearances for service and maintenance.

E. Loose Components: Install electrical components, devices, and accessories that are not factory mounted. Tower manufacturer shall provide electrical and controls conduit from the base of each tower to connection point of each component located on the tower.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to cooling towers to allow service and maintenance.

C. Provide drain piping with valve at cooling tower drain connections and at low points in piping.

D. Supply and Return Piping: Comply with applicable requirements in Section 23 21 13 "Hydronic Piping." Connect to cooling tower with manual isolation valve, automatic control valve and riser drain connection with valve. Make connections to cooling tower with a flange. Riser piping after the control valve and basin discharge piping shall be schedule 10, 304 or 316

stainless steel for connection of the tower with flange. Riser connection shall have a stainless steel flexible connector as final connection to tower flange.

3.4 FIELD QUALITY CONTROL

A. Testing Personnel: Engage a qualified testing person to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform field tests, inspections and motor alignment.

C. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections: Comply with CTI ATC 105, "Acceptance Test Code for Water Cooling Towers."

E. Cooling towers will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Perform startup service.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.

C. Obtain performance data from manufacturer.

1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

a. Clean entire unit including basins.
b. Verify that accessories are properly installed.
c. Verify clearances for airflow and for cooling tower servicing.
d. Check for vibration isolation and structural support.
e. Lubricate bearings.
f. Verify fan rotation for correct direction and for vibration or binding and correct problems.
g. Operate variable-speed fans through entire operating range and check for harmonic vibration imbalance. Set motor controller to skip speeds resulting in abnormal vibration.
h. Check vibration switch setting. Verify operation.
i. Verify water level in sump. Fill to proper startup level. Check makeup water-level and blowdown control valves.
j. Replace defective and malfunctioning units.

D. Start cooling tower and associated water pumps. Follow manufacturer's written starting procedures.

E. Prepare a written startup report that records the results of tests and inspections.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train FAA's maintenance personnel to adjust, operate, and maintain cooling towers. Video record the training sessions**.** Submit to FAA two copies on DVD.

END OF SECTION 23 65 00

SECTION 237313.13 - INDOOR, BASIC AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes: Factory-assembled, indoor air-handling units with limited features.

1.3 ACTION SUBMITTALS

A. Product Data: For each air-handling unit.

1. Unit dimensions and weight.
2. Cabinet material, metal thickness, finishes, insulation, and accessories.
3. Fans:

    a. Certified fan-performance curves with system operating conditions indicated.
    b. Certified fan-sound power ratings.
    c. Fan construction and accessories.
    d. Motor ratings, electrical characteristics, and motor accessories.

4. Certified coil-performance ratings with system operating conditions indicated.
5. Dampers, including housings, linkages, and operators.
6. Filters with performance characteristics.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Mechanical-room layout and relationships between components and adjacent structural and mechanical elements.
2. Support location, type, and weight.
3. Field measurements.

B. Seismic Qualification Data: Certificates for indoor, basic air-handling units, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Source quality-control reports:

D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set for each air-handling unit.
2. Gaskets: One set for each access door.
3. Fan Belts: One set for each air-handling unit fan.

1.7 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Structural Performance: Casing panels shall be self-supporting and capable of withstanding positive/negative 4-inch wg of internal static pressure, without exceeding a midpoint deflection of 0.005 inches/inch of panel span.

F. Seismic Performance: Air-handling units shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Component Importance Factor: 1.5.

2.2 CAPACITIES AND CHARACTERISTICS

A. Supply Fan:

1. Type: DWDI, forward-curved centrifugal fan.
2. Class I: AMCA 99-2408.
3. Drive: V-belt.
4. Number of Fan Wheels: One.
5. Motor: See Drawings

B. Heating Coil: See Drawings

C. Cooling Coil: See Drawings

D. Filters: See Drawings

1. Minimum Efficiency Reporting Value:

a. MERV Rating: MERV 13, according to ASHRAE 52.2.

2.3 INDOOR, BASIC AIR-HANDLING UNIT MANUFACTURERS

A. Manufacturers:

1. Carrier Corporation; a member of the United Technologies Corporation Family.
2. McQuay
3. Temtrol
4. Trane; American Standard Inc.
5. YORK International Corporation.

2.4 UNIT CASINGS

A. General Fabrication Requirements for Casings:

1. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
2. Casing Joints: Sheet metal screws or pop rivets.
3. Sealing: Seal all joints with water-resistant sealant.

4. Factory Finish for Steel and Galvanized-Steel Casings: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on enamel finish, consisting of prime coat and thermosetting topcoat.
5. Casing Coating: Manufacturer’s standard coating.
6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

B. Casing Insulation and Adhesive:

1. Materials: ASTM C 1071, Type I or Type II.

2. Location and Application: Encased between outside and inside casing.

C. Inspection and Access Panels and Access Doors:

1. Panel and Door Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as casing.
2. Inspection and Access Panels:

   a. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
   b. Gasket: Neoprene, applied around entire perimeters of panel frames.
   c. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.

3. Access Doors:

   a. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
   b. Gasket: Neoprene, applied around entire perimeters of panel frames.
   c. Size: At least 18 inches wide by full height of unit casing up to a maximum height of 72 inches.

4. Locations and Applications:

   a. Fan Section: Doors.
   b. Access Section: Doors.
   c. Coil Section: Inspection and access panel.
   d. Damper Section: Doors.
   e. Filter Section: Doors large enough to allow periodic removal and installation of filters.

D. Condensate Drain Pans:

1. Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.

   a. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1-2004.

b. Depth: A minimum of 2 inches deep.

2. Formed sections.
3. Double-wall, stainless-steel sheet with space between walls filled with foam insulation and moisture-tight seal.
4. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.

a. Minimum Connection Size: NPS 1.

5. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

E. Air-Handling-Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs.

2.5 FAN, DRIVE, AND MOTOR SECTION

A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.

1. Shafts: Designed for continuous operation at maximum-rated fan speed and motor horsepower, and with field-adjustable alignment.

a. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
b. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

B. Centrifugal Fan Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.

1. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.
2. Horizontal-Flanged, Split Housing: Bolted construction.
3. Housing for Supply Fan: Attach housing to fan-section casing with metal-edged flexible duct connector.
4. Flexible Connector: Factory fabricated with a fabric strip 3-1/2 inches wide attached to 2 strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized-steel sheet or 0.032-inch- thick aluminum sheets; select metal compatible with casing.

a. Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.

1) Fabric Minimum Weight: 26 oz./sq. yd.
2) Fabric Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3) Fabric Service Temperature: Minus 40 to plus 200 deg F.

C. Fan Shaft Bearings:

1. Grease-Lubricated, Tapered-Roller Bearings: Self-aligning, pillow-block type with double-locking collars and 2-piece, cast-iron housing with grease lines extended to outside unit and a rated life of 120,000 hours according to ABMA 11.
2. Grease-Lubricated Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing with grease lines extended to outside unit.

D. Belt Drives: Factory mounted, with adjustable alignment and belt tensioning, and with 1.5 service factor based on fan motor.

1. Pulleys: Cast iron or cast steel with split-tapered bushing; dynamically balanced at factory.
2. Motor Pulleys: Adjustable pitch for use with 5 -hp motors and smaller; fixed pitch for use with motors larger than 5 hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.
3. Belts: Oil resistant, nonsparking, and nonstatic; in matched sets for multiple-belt drives.
4. Belt Guards: Comply with requirements specified by OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; 0.1046-inch- thick, 3/4-inch diamond-mesh wire screen, welded to steel angle frame; prime coated. Alternatively, interlock motor section door with fan motor and provide a lockable diamond-mesh wire screen internal door.

E. Internal Vibration Isolation Control: Fans shall be factory mounted with manufacturer's standard restrained vibration isolation mounting devices having a minimum static deflection of 1 inch.

F. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."

1. Enclosure Type: Totally Enclosed Fancooled.
2. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
5. Mount unit-mounted disconnect switches on exterior of unit.

2.6 COIL SECTION

A. General Requirements for Coil Section:

1. Comply with AHRI 410.
2. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
3. Coils shall not act as structural component of unit.

2.7 AIR FILTRATION SECTION

A. Particulate air filtration is specified in Section 234100 "Particulate Air Filtration."

B. Panel Filters:

1. Description: [Flat, non-pleated] [Pleated] factory-fabricated, self-supported disposable air filters with holding frames.
2. Filter Unit Class: UL 900.
3. Media: Interlaced glass, synthetic, or cotton fibers coated with nonflammable adhesive.
4. Filter-Media Frame: [High wet-strength beverage board] <Insert material> with perforated metal retainer, or metal grid, on outlet side.

C. Side-Access Filter Mounting Frames:

1. Particulate Air Filter Frames: Match inner casing and outer casing material, and insulation thickness. [Galvanized steel] <Insert material> track.

a. Sealing: Incorporate positive-sealing device to ensure seal between gasketed material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.

2.8 AIR FILTRATION SECTION

A. General Requirements for Air Filtration Section:

1. Comply with NFPA 90A.
2. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
3. Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

B. Extended-Surface, Disposable Panel Filters:

1. Factory-fabricated, dry, pleated extended-surface type. Refer to Section 23 41 13, “Panel Air Filters” for requirements.
2. Thickness: 2 inches Prefilter, 4 inches Final filter.
3. Mounting Frames: Welded, galvanized steel, with gaskets and fasteners, suitable for bolting together into built-up filter banks.

C. Extended-Surface, Nonsupported-Media Filters:

1. Factory-fabricated, dry, pleated extended-surface, self-supporting type. Refer to Section 23 41 13, “Panel Air Filters” for requirements.
2. Mounting Frames: Welded, galvanized steel, with gaskets and fasteners, suitable for bolting together into built-up filter banks with space for prefilter.

D. Filter Gages:

1. 3-1/2-inch- diameter, diaphragm-actuated dial in metal case.
2. Vent valves.
3. Black figures on white background.
4. Front recalibration adjustment.
5. 2 percent of full-scale accuracy.
6. Range: 0- to 2.0-inch wg.
7. Accessories: Static-pressure tips with integral compression fittings, 1/4-inch aluminum tubing, and 2- or 3-way vent valves.

2.9 DAMPERS

A. Comply with requirements in Section 23 09 00 "HVAC Instrumentation and Controls."

B. Damper Operators: Comply with requirements in Section 23 09 00 "HVAC Instrumentation and Controls."

C. Controls: Refer to Section 23 09 00 “HVAC Instrumentation and Controls.

2.10 CAPACITIES AND CHARACTERISTICS

A. Casing:

1. Outside Casing: Galvanized steel, minimum 0.052 inch thick.
2. Inside Casing: Galvanized steel, solid, minimum 0.052 inch thick.
3. Floor Plate: Galvanized steel, minimum 0.052 inch thick.
4. Insulation Thickness: 2 inches.
5. Static-Pressure Classifications for Unit Sections before Fans: 4-inch wg.
6. Static-Pressure Classifications for Unit Sections after Fans: 3-inch wg.

B. Supply Fan:

1. Class I or Class II: AMCA 99-2408.
2. Drive: V-belt.
3. Type: As scheduled on plans.
4. Number of Fan Wheels: 1.
5. Unit sound power shall be tested in accordance with ARI-260 (2000):

C. Preheat and Heating Coils:

1. Coil Type: Continuous circuit.
2. Piping Connections: Threaded or Flanged, same end of coil.
3. Tube Material: Copper.
4. Tube Thickness: Minimum of 0.025 inches.
5. Fin Type: Plate or Spiral.
6. Fin Material: Aluminum.
7. Fin and Tube Joint: Mechanical bond.
8. Headers: Headers must be installed inside of the unit casing.

    a. Seamless copper tube with brazed joints, prime coated.

b. Fabricated steel, with brazed joints, prime coated.

9. Frames: Channel frame, 0.064-inch- thick galvanized steel.
10. Coil Working-Pressure Ratings: 200 psig, 325 deg F.

D. Cooling Coil:

1. Coil Type: Continuous circuit.
2. Piping Connections: Threaded or Flanged, same end of coil.
3. Tube Material: Copper.
4. Tube Thickness: Minimum of 0.025 inches.
5. Fin Type: Plate or Spiral.
6. Fin Material: Aluminum.
7. Fin and Tube Joint: Mechanical bond.
8. Headers: Headers must be installed inside of the unit casing.

a. Seamless copper tube with brazed joints, prime coated.
b. Fabricated steel, with brazed joints, prime coated.

9. Frames: Channel frame, 0.064-inch- thick galvanized steel.
10. Coil Working-Pressure Ratings: 200 psig, 325 deg F.

2.11 SOURCE QUALITY CONTROL

A. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.

B. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."

C. Water Coils: Factory tested to 300 psig according to ARI 410 and ASHRAE 33.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before air-handling unit installation. Replace with new insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Equipment Mounting: Install air-handling units on concrete bases using elastomeric pads. Secure units to anchor bolts installed in concrete bases. Comply with requirements for concrete bases specified in Section 03 30 00 "Cast-in-Place Concrete." Comply with requirements for vibration isolation devices specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC Piping and Equipment."

1. Minimum Deflection: 1/2 inch.
2. Install galvanized -steel plate to equally distribute weight over elastomeric pad.
3. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
4. Install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
5. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
6. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.

D. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to air-handling unit to allow service and maintenance.

C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.

D. Connect condensate drain pans using NPS 1-1/4, ASTM B 88, Type M copper tubing unless noted otherwise. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

E. Hot- and Chilled-Water Piping: Comply with applicable requirements in Section 23 21 13 "Hydronic Piping." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

F. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 23 30 00 "Duct Accessories."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Leak Test: After installation, fill water and steam coils with water, and test coils and connections for leaks.
2. Charge refrigerant coils with refrigerant and test for leaks.
3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connection to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
6. Verify that outdoor-air dampers open and close.
7. Comb coil fins for parallel orientation.
8. Verify that proper thermal-overload protection is installed for electric coils.
9. Install new, clean filters.
10. Verify that manual and automatic volume control dampers in connected duct systems are in fully open position.

B. Starting procedures for air-handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing" for air-handling system testing, adjusting, and balancing.

3.7 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train FAA's maintenance personnel to adjust, operate, and maintain air-handling units. Provide two shifts of training 4 hours each session. Refer to Section 01 79 00 "Demonstration and Training."

END OF SECTION 237313.13

SECTION 238119 - SELF-CONTAINED AIR-CONDITIONERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes packaged air-conditioning units with chilled water cooling coil and controls intended for indoor installations.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

C. Samples for Initial Selection: For units with factory-applied color finishes.

1.4 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For self-contained air conditioners to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set(s) of filters for each unit.
2. Fan Belts: One set(s) of belts for each unit.

3. Gaskets: One set(s) for each access door.
4. Fuses: One set(s) for each air-handling unit.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ARI Compliance:

1. Applicable requirements in ARI 210/240.
2. Applicable requirements in ARI 340/360.
3. Applicable requirements in ARI 390.

C. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of self-contained air conditioners that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

a. For Parts: One year(s) from date of Substantial Completion.
b. For Labor: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements available manufacturers offering products that may be incorporated into the Work include, but are not limited to:

1. Carrier Corporation
2. Trane Inc.
3. Whalen Company

2.2 PACKAGED UNITS

A. Description: Factory assembled, wired, and tested; and fully charged with refrigerant and oil.

B. Configuration: Vertical, floor mounted; vertical discharge.

C. Disconnect Switch: Factory mounted in control panel.

2.3 Cabinet

A. Frame and Panels: Structural-steel frame with galvanized-steel panels and access doors or panels.

1. Exterior-Surface Finish: Galvanized.
2. Interior-Surface Finish: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

B. Insulation: 1-inch thick, glass-fiber duct liner complying with ASTM C 1091 and having a microbial coating on cabinet interior and control panel. 1/2-inch thick liner is acceptable for units smaller than 15 tons.

C. Return-Air Opening: Rear, open.

D. Corrosion-Resistant Treatment: Phenolic coating on unit interior and exterior.

2.4 Supply-air Fan

A. Fan Material: Galvanized steel.

B. Configuration: Double-width, double-inlet, forward-curved centrifugal fan; statically and dynamically balanced. Vertical discharge with flexible discharge collar.

C. Drive: Belt, with fan mounted on permanently lubricated bearings.

D. Fan Sheaves: Variable pitch, dynamically balanced, bored to fit shafts, and keyed for initial startup.

E. Motor Sheave: Variable and adjustable pitch, dynamically balanced, and selected to achieve specified rpm when set at midposition.

F. Belt Rating: As recommended by manufacturer or a minimum of one and one-half times nameplate rating of motor.

G. Bearings: Grease lubricated with grease lines extended to exterior of unit with L-50 life at 200,000 hours.

H. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."

1. Special Motor Features: Premium efficiency, as defined in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."

I. Isolation: Mount fan and motor on common subbase and mount assembly on spring isolators with minimum static deflection of 1 inch.

2.5 CONTROLS

A. Control equipment and sequence of operation are specified in Section 23 09 00 "Instrumentation and Control for HVAC".

B. Adjustable Thermostat: Remote to control the following:

1. Supply fan.

C. Fan Control Switch: Auto-on.

D. Microprocessor Control Panel: Controls unit functions as standalone or network operation. Reconnect all existing control functions including safety controls to DDC system:

1. Supply fan.
2. Supply-fan motor speed.
3. Time-of-day control to cycle unit on and off.
4. Panel-mounted control switch to operate unit in remote or local control mode or to stop or reset.
5. Panel-mounted indication of the following:

a. Operating status.
b. System diagnostics and safety alarms.
c. Supply-air temperature set point.
d. Zone heating-temperature set point.
e. Supply-air pressure set point.
f. Monitor cooling load.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Anchor units to structure.

C. Install seismic restraints.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

1. Water Coil Connections: Comply with requirements in Section 23 21 13 "Hydronic Piping". Connect to supply and return coil with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.

B. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

C. Duct Connections: Duct installation requirements are specified in Section 23 31 13 "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply ducts to self-contained air conditioners with flexible duct connectors. Flexible duct connectors are specified in Section 23 33 00 "Air Duct Accessories."

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation, and inspect for refrigerant leaks.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Units will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 238119

SECTION 238123.12 – LARGE CAPACITY (7 TONS (25 KW) AND LARGER), COMPUTER-ROOM AIR-CONDITIONERS, FLOOR-MOUNTED UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes floor-mounted, computer-room air conditioners of 7 tons and larger.

1.3 DEFINITIONS

A. COP: Coefficient of performance.

B. EER: Energy efficiency ratio.

C. SCR: Silicon controlled rectifier.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include material descriptions, dimensions of individual components and profiles, and finishes for computer-room air-conditioning units.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For computer-room air conditioners.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Color Samples: For unit cabinet, discharge grille, and exterior louver and for each color and texture specified.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, and other details, drawn to scale, using input from installers of the items involved.

B. Seismic Qualification Data: Certificates, for computer-room air conditioners, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

D. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For computer-room air conditioners to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan Belts: **One** set for each belt-driven fan.
2. Filters: **One** set of filters for each unit.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of computer-room air conditioners that fail in materials or workmanship within specified warranty period.
1. Warranty Period for Humidifiers: Manufacturer's standard, but not less than one year from date of Substantial Completion.
2. Warranty Period for Control Boards: Manufacturer's standard, but not less than one year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include but are not limited to the following:

1. Liebert.
2. DataAire

B. Description: Packaged, factory assembled, prewired, and pre-piped; consisting of cabinet, fans, filters, humidifier, and controls.

C. Cabinet and Frame: Welded steel, braced for rigidity, and supporting compressors and other mechanical equipment and fittings.

1. Doors and Access Panels: Galvanized steel with polyurethane gaskets, hinges, and concealed fastening devices.
2. Insulation: Thermally and acoustically insulate cabinet interior with 1-inch- thick duct liner.
3. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
4. Finish of Exterior Surfaces: Baked-on, textured vinyl enamel; color as selected from manufacturer's standard colors.
5. Floor Stand: Welded tubular steel, 18 inches high, with adjustable legs and vibration isolation pads.

D. Supply-Air Fan(s):

1. Electronically Commutated (EC) motor with attached plug/plenum fan
2. Drive: Direct

E. Hydronic Cooling Coil: Seamless copper tubes expanded into aluminum fins with three-way modulating control valve.

1. Cooling Medium: Water.
2. Control Valve: Class 125 body.

a. Maximum Pressure Drop: 3 psig at design flow rate.
b. Close-Off (Differential) Pressure Rating: 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

3. Mount coil assembly over stainless-steel drain pan complying with ASHRAE 62.1.

4. Disconnect Switch: Non-automatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

F. Hot-Water Heating Coil: Seamless copper tubes expanded into aluminum fins with three-way modulating control valve and strainer.

1. Control Valve: Class 125 body.

    a. Maximum Pressure Drop: 3 psig at design flow rate.
    b. Close-Off (Differential) Pressure Rating: 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

G. Extended-Surface, Disposable, Panel Filter: Pleated, lofted, nonwoven, reinforced cotton fabric; supported and bonded to welded-wire grid; enclosed in cardboard frame with 2-inch-thick, disposable, glass-fiber prefilter.

1. Thickness: 2 inches.
2. Arrestance (ASHRAE 52.1): 90 percent.
3. Merv (ASHRAE 52.2): 8.

H. Electrode Steam Humidifier: Self-contained, microprocessor-controlled unit with disposable, polypropylene-plastic cylinders, and having field-adjustable steel electrodes and stainless-steel steam dispersion tube.

1. Plumbing Components and Valve Bodies: Plastic, linked by flexible rubber hosing, with water fill with air gap and solenoid valve incorporating built-in strainer, pressure-reducing and flow-regulating orifice, and drain with integral air gap.
2. Control: Fully modulating to provide gradual 0 to 100 percent capacity with field-adjustable maximum capacity; with high-water probe.
3. Drain Cycle: Field-adjustable drain duration and drain interval.

I. Integral Electrical Controls: Unit-mounted electrical enclosure with piano-hinged door, grounding lug, combination magnetic starters with overload relays, circuit breakers and cover interlock, and fusible control-circuit transformer.

J. Disconnect Switch: Non-automatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

K. Electronic-Control System: Solid state, with start button, stop button, temporary loss of power indicator, manual-reset circuit breakers, temperature control, humidity control, and monitor panel.

1. Monitor Panel: Backlighted, with no visible indicator lights until operating function is activated; indicators include cooling, humidification, loss of airflow, change filters, high temperature, low temperature, high humidity, low humidity, high head pressure (each compressor), and low suction pressure (each compressor).
2. Temperature- and Humidity-Control Modules: Solid state, plug-in; with adjustable set point, push-to-test calibration check button, and built-in visual indicators to show mode of operation.
3. Location: Behind hinged door in front of unit; isolated from conditioned airstream to allow service while system is operating.

L. Microprocessor-Control System: Continuously monitors operation of process cooling system; continuously displays room temperature and room relative humidity; sounds alarm on system malfunction and simultaneously displays problem. If more than one malfunction occurs, system displays fault in sequence with room temperature and continues to display fault when malfunction is cleared until system is reset.

1. Malfunctions:

    a. Power loss.
    b. Loss of airflow.
    c. Clogged air filter.
    d. High room temperature.
    e. Low room temperature.
    f. High humidity.
    g. Low humidity.
    h. Smoke/fire.
    i. Supply fan overload.

2. Digital Display:

    a. Control power on.
    b. Humidifying.
    c. Dehumidifying.
    d. Heat operating.

3. Push buttons shall stop and start process cooling system, silence audible alarm, test indicators, and display room's relative humidity.
4. Interface with DDC System for HVAC: Factory-installed hardware and software to enable the DDC system for HVAC to monitor, control, and display unit status and alarms.

    a. Hardwired Points:

        1) Monitoring: On-off status, space temperature, space relative humidity and filter status.
        2) Control: On-off operation, space temperature set-point adjustment, space relative humidity set-point adjustment.

    b. Industry-accepted, open-protocol communication interface with the DDC system for HVAC shall enable the DDC system for HVAC operator to remotely control and monitor the unit from an operator workstation. Control features and monitoring points displayed locally at unit control panel shall be available through the DDC system for HVAC.

2.2 FAN MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for hydronic piping systems to verify actual locations of piping connections before equipment installation.

C. Examine walls, floors, and roofs for suitable conditions where computer-room air conditioners will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install computer-room air conditioners level and plumb, maintaining manufacturer's recommended clearances. Install according to ARI Guideline B.

B. Computer-Room Air-Conditioner Mounting: Comply with requirements for vibration isolation devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

1. Minimum Deflection: 1/4 inch.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other heating, ventilating, and air-conditioning Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Water and Drainage Connections: Provide adequate connections for water-cooled units, condensate drain, and humidifier flushing system.

D. Hot-Water Heating Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties." Provide shutoff valves in inlet and outlet piping to heating coils.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
2. After installing computer-room air conditioners and after electrical circuitry has been energized, test for compliance with requirements.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Computer-room air conditioners will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

F. After startup service and performance test, change filters and flush humidifier.

3.5 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain computer-room air conditioners.

END OF SECTION 238123.12

SECTION 238239.16 - PROPELLER UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes propeller unit heaters with hot-water coils.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. PTFE: Polytetrafluoroethylene plastic.

C. TFE: Tetrafluoroethylene plastic.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include location and size of each field connection.
4. Include details of anchorages and attachments to structure and to supported equipment.
5. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
6. Indicate location and arrangement of piping valves and specialties.
7. Indicate location and arrangement of integral controls.
8. Wiring Diagrams: Power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members to which propeller unit heaters will be attached.
2. Method of attaching hangers to building structure.

B. Seismic Qualification Certificates: Submit certification that propeller unit heaters, accessories, and components will withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Include detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For propeller unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements available manufacturers offering products that may be incorporated into the Work include, but are not limited to:

1. Airtherm
2. Trane Inc.
3. Mcquay International
4. Engineered Air, Ltd.
5. Rosemex Products

2.2 DESCRIPTION

A. Assembly including casing, coil, fan, and motor in horizontal discharge configuration with adjustable discharge louvers.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with UL 2021.

D. Comply with UL 823.

2.3 PERFORMANCE REQUIREMENTS

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

C. Seismic Performance: Propeller unit heaters shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.4 HOUSINGS

A. Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heaters before shipping.

B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

2.5 COILS

A. General Coil Requirements: Test and rate hot-water propeller unit-heater coils according to ASHRAE 33.

B. Hot-Water Coil: Steel tube, minimum 0.049-inch wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 400 psig and a maximum entering-water temperature of 450 deg F, with manual air vent. Test for leaks to 600 psig underwater.

C. Hot-Water Coil: Copper tube, minimum 0.025-inch wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 325 deg F, with manual air vent. Test for leaks to 350 psig underwater.

2.6 FAN AND MOTOR

A. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.

B. Motor: Permanently lubricated, explosion proof. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

2.7 CONTROLS

A. Control Devices:

1. Unit-mounted thermostat.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive propeller unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping and electrical connections to verify actual locations before unit-heater installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install propeller unit heaters to comply with NFPA 90A.

B. Install propeller unit heaters level and plumb.

C. Suspend propeller unit heaters from structure with all-thread hanger rods and elastomeric hangers. Hanger rods and attachments to structure are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment." Vibration hangers are specified in Section 230548 "Vibration and Seismic Controls for HVAC."

D. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Section 232113 "Hydronic Piping," Section 232116 Hydronic Piping Specialties," Section 232213 "Steam and Condensate Heating Piping," and Section 232216 Steam and Condensate Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect piping to propeller unit heater's factory, hot-water piping package. Install the piping package if shipped loose.

D. Comply with safety requirements in UL 1995.

E. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of propeller unit heater. Hydronic specialties are specified in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties."

F. Unless otherwise indicated, install union and gate or ball valve on steam-supply connection and union, strainer, steam trap, and gate or ball valve on condensate-return connection of propeller unit heater. Steam specialties are specified in Section 232216 Steam and Condensate Piping Specialties."

G. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

H. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Units will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature set points.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain propeller unit heaters.

END OF SECTION 238239.16

SECTION 238413.29 - SELF-CONTAINED STEAM HUMIDIFIERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Self-contained electrode humidifiers.

1.3 DEFINITIONS

A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail fabrication and installation of humidifiers. Include piping details, plans, elevations, sections, details of components, distributer tubes/manifolds, and attachments to other work.

   1. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Detail humidifiers and adjacent equipment. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

   1. Structural members to which humidifiers will be attached.
   2. Size and location of initial access modules for acoustical tile.

B. Seismic Qualification Data: Certificates, for humidifiers, accessories, and components from manufacturer.

   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For humidifiers to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: An NRTL.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Supply one replacement electrode cylinder with each self-contained humidifier.

1.9 COORDINATION

A. Coordinate location and installation of humidifiers with distributer tubes/manifolds in ducts and plenums or occupied space. Revise locations and elevations to suit field conditions and to ensure proper humidifier operation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with AHRI 640.

C. Comply with UL 998.

D. Listed and labeled by ETL.

E. Seismic Performance: Self-contained steam humidifiers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

F. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

2.2 SELF-CONTAINED ELECTRODE HUMIDIFIERS

A. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include but are not limited to the following:

1. Armstrong

B. Capacities and Characteristics: See Drawings

1. Steam Distribution Method – Dispersion Tube:

C. Water Type: Suitable for use with tap water.

D. Cylinders: Replaceable or Cleanable plastic humidifier water reservoir, steel electrode assembly, suitable for use with tap water.

E. Cabinet:

1. Baked-enamel, or Powder-coated-steel enclosure houses heater cylinder, electrical wiring, components, controls, and control panel. Cabinet is factory insulated for safe operating surface temperature.
2. Hinged or removable cover, keyed to restrict unauthorized access.
3. Plumbing and electrical components housed in separate compartments of the cabinet.
4. Threaded outlet in bottom of cabinet for drain piping.

F. Control Panel:

1. Microprocessor-based control system for modulating control.
2. Factory-wired disconnect switch.
3. Liquid-crystal display.
4. Programmable keypad.
5. Low-voltage control circuit.
6. Diagnostic, maintenance, alarm, and status features.
7. Safety switch interlocked to shut off heaters when cabinet is open.
8. Internal electrical controls prewired to appropriately marked terminals for field connection.
9. Electrical terminals for connection to each controlling device and alarm.
10. NEMA 250, type 4, to comply with environmental conditions at installed locations.
11. Building Automation System Interface:

a. Full communication interface: BACnet

G. Controls:

1. Solenoid fill valve and automatic drain valve or drain pump maintain water level. Include bronze inlet strainer, bronze solenoid fill valve with flow regulator, bronze solenoid drain valve or drain pump, and fill tee with built-in air gap to prevent back siphoning.
2. Set-point adjustment.
3. Electrode current shutdown upon sensing unsafe condition (e.g., drain system malfunction, fill system malfunction, or overcurrent malfunction).
4. Tri-conductivity sensor probes for water-level control.
5. Foaming detection and correction.

H. Atmospheric Steam Distributer Tube(s): Single or multiple, atmospheric steam distributer tube extending across entire width of duct or plenum and equipped with mounting brackets on ends. Nozzles/metered orifices are spaced evenly along distributer tubes and provide dry and uniform steam distribution.

1. Material: Stainless steel
2. Insulation: Insulated

I. Accessories:

1. Humidity Sensor: Wall mounted.
2. Duct-mounted, high-limit humidity sensor.
3. Airflow switch prevents humidifier operation without airflow.
4. Steam and Condensate Hoses: For interconnection of humidifier to distributer tube(s).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, air-handling units, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before humidifier installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install humidifiers with required clearance for service and maintenance. Maintain path, downstream from humidifiers, clear of obstructions as required by ASHRAE 62.1.

B. Seal all duct and plenum penetrations with flange.

C. Install humidifier assemblies in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

D. Install galvanized-steel drain pan under each manifold mounted in duct.

1. Construct drain pans with connection for drain; and complying with ASHRAE 62.1.

2. Connect to condensate trap and drainage piping.
3. Extend drain pan upstream and downstream from tube(s)/manifold a minimum distance recommended by manufacturer but not less than required by ASHRAE 62.1.

E. Install tube(s)/manifold supply piping pitched to drain condensate back to humidifier or as recommended by manufacturer.

F. Equipment Mounting:
1. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

G. Install all manufacturer-furnished accessories in accordance with manufacturer's written installation instructions.

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

1. Install piping adjacent to humidifiers to allow service and maintenance.
2. Install shutoff valve, strainer, backflow preventer, and union in humidifier makeup line.

B. Install piping specialties furnished by manufacturer but not factory mounted.

C. Install piping from safety relief valves to nearest floor drain.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Locate nameplate where easily visible.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between control devices.

C. Connect control wiring according to Section 260523 "Control Voltage Electrical Power Cables."

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service agent:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Humidifier will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain humidifiers.

END OF SECTION 238413.29

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. General: Materials and equipment shall comply with all requirements of the contract documents. Materials furnished by the contractor shall be new, the standard products of manufacturers regularly engaged in the production of such materials, and of the manufacturer's latest designs that comply with the specification requirements. If material and equipment requirements conflict, the order of precedence for selection shall be as follows: special contract provisions, this specification, the contract drawings; and then in continuing order of precedence, FAA Orders and Standards, NFPA Publications, IEEE standards, UL standards and NEMA standards. Wherever standards have been established by Underwriters Laboratories, Inc., the material shall bear the UL label.

B. Provide the following electrical equipment and systems:

1. Equipment, wiring devices, branch circuits, and electrical connections required for installation of electrical and electronic equipment.
2. Indoor and outdoor lighting systems.
3. Raceways, conductors, and cables for power and controls.
4. Panelboards, feeders and associated branch circuit wiring.
5. Grounding systems.
6. Supporting devices for electrical components.
7. Electrical identification.
8. Electrical demolition.
9. Cutting and patching for electrical construction.
10. Touch-up painting.
11. All other work indicated on drawings or specifications or that is necessary for the operation of the complex.

C. This Section includes limited general scope of general construction materials for application with electrical installation as indicated:

1. Cutting and patching.
2. Electrical demolition.
3. Testing.

D. Minor departures from exact dimensions shown in electrical plans may be permitted when required to avoid conflict or unnecessary difficulty in placement of a dimensioned item, provided all contract requirements are met. The contractor shall promptly obtain approval from the COR prior to undertaking any such departures, and shall provide appropriate documentation of the departure.

1.3 REFERENCE STANDARDS

A. General: Comply with the standards in effect as of the date of the Contract Documents as applicable to the extent specified in Division 26. The rules, regulations and reference specifications enumerated in these specifications shall be considered as minimum requirements. Adherence to other standards shall not relive the contractor from furnishing and installing higher grades of materials and workmanship when so required by the contract drawings or special contracts provisions. This specification shall govern when conflicts occur between it and the documents referenced in Article 1.1, Summary of this section.

B. Federal Aviation Administration

1. FAA-C-1217g: Electrical Work, Interior
2. FAA-STD-019e: Lightning and Surge Protection, Grounding, Bonding, and Shielding Requirements for Facilities and Electronic Equipment
3. Order 6470.33B: Control of Power and Space; and Environmental Interfaces at EnRoute Air Traffic Control Facilities

C. Institute of Electrical and Electronic Engineers (IEEE)

1. 519: Recommended practices and requirements for harmonic control and electrical power systems.

D. National Electrical Manufacturers Association (NEMA)

1. WC 70: Power cables rated 2000 volts or less for the distribution of electrical energy.

E. National Fire Protection Association (NFPA)

1. 70: National Electrical Code (NEC), 2017 edition.
2. 780: Standard for the Installation of Lightning Protection Systems

F. National Electrical Contractors Association (NECA)

1. Standard of installation.

G. Occupational Safety and Health Administration (OSHA)

1. 29 CFR 1910.7: Description and requirements for a nationally recognized testing laboratory (NRLT).

H. Underwriters Laboratory (UL)

1. 486A: Wire connectors and soldering lugs for use with copper conductors.

1.4 SUBMITTALS

A. Contractor Provided Electrical Equipment Reference Manual: Provide operating and maintenance instructions, equipment service manuals, catalog cuts and illustration as described in this section and Section 01 78 23 "Operation and Maintenance Data." The Operations and Maintenance (O&M) data shall be placed in suitable binders for use by maintenance personnel. The material shall include equipment model and serial numbers, performance characteristics, power and utility requirements, and manufacturers recommended maintenance schedules. Final acceptance of this equipment is contingent upon submission of required documents to, and approval by, the COR prior to facility turnover.

1. Minimum data required: Operating and maintenance instructions shall contain the following minimum data and shall comply with submittal requirements specified in individual Division 26 Sections.

    a. Operating instructions shall include illustrations and explanations for controls, initial set points, and startup and shutdown procedures for both normal and emergency conditions.
    b. Maintenance instructions shall include periodic inspection and lubrication requirements, and where applicable, equipment performance verification requirements.
    c. Troubleshooting and fault diagnosis data shall list trouble symptoms, instructions necessary to determine cause of trouble and the action required to restore equipment to operating condition.
    d. Include a list of required tools and equipment to maintain the system.
    e. Provide names, addresses, and telephone numbers of all service organizations that supply repair parts for the systems to be furnished.

2. Repair instructions shall include equipment disassembly, repair, replacement, and reassembly. Checkout or test data shall also be provided. Reprogramming instructions shall be provided for equipment having a programmable memory. Repacking instructions shall be provided for sending equipment to the manufacturer or to a repair depot for repairs.
3. A parts list shall be furnished that includes part names and part numbers that are shown on illustrations or tables. The parts list shall identify the actual manufacturer of the part, replacement cost, and shall also contain a notation of identifying products as commercial grade for common non-special design hardware.
4. The instructions shall contain a list of spare parts recommended by the equipment manufacturer to support the operation of the equipment for a one year time period.
5. The O&M data shall include overhaul instructions that are required to return the equipment to full operational capacity in the event that the machinery stops working properly.
6. The O&M data shall contain as appropriate, the following:

    a. Wiring diagrams
    b. Electrical schematics.
    c. Control diagrams.
    d. Wire terminal assignments.
    e. Equipment layouts.
    f. Electrical drawings, modified to record actual conditions and modifications,

including dimensions.
g. Approved shop drawings.
h. A list of all subcontractors used on the project with address and phone number.

B. Project Record Documents: Maintain at the job site a separate set of white prints of the Contract Documents for the purpose of recording the system and dimension changes of those portions of work in which actual construction is significantly at variance with the Contract Documents. The contractor shall record changes to reflect installed equipment condition. Upon acceptance of the project, submit documents to the COR, with verification of data accuracy. Mark the drawings with colored pencil. Prepare the drawings as the work progresses. Upon completion of work submit drawings clearly indicating the following:

1. Locations of devices, conduits, equipment and other pertinent items; indicate the depth of buried ducts and direct buried cables;
2. Schematic and interconnection wiring diagrams of the completed power and control system incorporating the data derived from the equipment shop drawings, and the cable and conduit schedule. The drawings shall be detailed to indicate the wire and terminal block numbers, conductor color coding, device designations, locations, and shall indicate identifications established at the site; and
3. Cable, conductor, and conduit schedule for cables, conductors and conduits actually installed; include the type, size, origin, destination, and approximate length for each cable, conductor, and conduit. Indicate for each cable the voltage rating, number of conductors, cable number, color coding, and routing.

C. Samples: When the adequacy, quality, and safety of the material will be better demonstrated and it will expedite approval, provide single samples of items proposed for use. Conform to the procedures specified.

D. Submit a summary of the Electrical Test Report and Motor Test Report, noting deviation from the requirements listed below:

1. Maximum plus or minus 5% variation between nominal system voltage and no load voltage;
2. Variation between motor average phase current and measured individual phase currents does not exceed the manufacturer's specified limits; and
3. Maximum plus or minus 10% variation between average phase current and measured individual phase currents for panelboards.

E. Submit a proposed conduit layout for all conduit routing.

1. Coordinate conduit routing plan with the COR to ensure minimal impact to existing utilities and areas known to contain hazardous material.

1.5 QUALITY ASSURANCE

A. Comply with NFPA 70 for components and installation.

B. Listing and Labeling: Provide products specified in this section that are listed and labeled.

1. The terms "Listed and Labeled": As defined in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: NRTL as defined in OSHA Regulation 1910.7.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Contractor Provided Equipment: To the greatest extent possible, do not deliver equipment to the site until it is needed. On-site storage of equipment and materiel is to be actively avoided. Equipment shall be protected from damage and stored in a dry location from the time of site delivery. Provide and energize space heaters or provide desiccant recommended by the equipment manufacturer to prevent condensation. Conduct routine inspections of stored equipment to check equipment condition. At certain periods in accordance with the manufacturer's instructions, each stored battery shall be reconnected; the batteries shall be charged.

1.7 SEQUENCING AND SCHEDULING

A. Coordinate arrangement, mounting, and support of electrical equipment with other building components.

B. Arrange for chases, slots, and openings in building structure during progress of construction to allow for electrical installation.

C. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete and other structural components as they are constructed.

D. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the work.

E. Coordinate connecting electrical service to components furnished under other sections.

F. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Section 08 71 00 "Metal Doors and Frames."

G. Coordinate sleeve selection and application with selection and application of fire-stopping specified in Section 07 84 13 "Penetration Fire-stopping."

H. Coordinate installing electrical identification after completion of furnishing where identification is applied to field-furnished surfaces.

I. Coordinate installing electrical identifying devices and marking prior to installing acoustical ceilings and similar finishes that conceal such items.

J. Interruption of Power: Contractor is advised that this facility includes a fully operational Air Route Traffic Control Center (ARTCC). The electrical power system is comprised of three types: critical, essential, and building service. Work shall be performed on the critical, essential, and building service power as indicated on the drawings. Unscheduled interruptions of the electrical service may cause aircraft accidents and loss of life. Contractor is advised that failure to establish and maintain proper means and methods during the work, resulting in accidents or loss of life, may result in charges of criminal negligence.

1. Work requiring a temporary or permanent de-energizing of critical, essential, and building service power systems shall be scheduled and approved in writing by the COR at least 14 calendar days in advance of performance of work.

2. Work may not commence until written authorization is received from the COR.
3. Unscheduled interruptions of power shall be allowed at any time.
4. Only government personnel are authorized to energize or de-energize equipment, to operate circuit breakers, switches, or fuses in this facility. Only the FAA shall authorize the utility company to turn on, or turn off, the commercial power to this facility.

PART 2 - PRODUCTS

2.1 SUPPORTING DEVICES

A. Channel and Angle Supports, Raceways Supports, Sleeves, and Fasteners: As specified in Section 26 05 29 "Hangers and Supports for Electrical Systems."
B. Restraint channel bracings, Restraint cables Seismic-restraint accessories, Mechanical anchor bolts, Adhesive anchor bolts: As specified in Section 26 05 48 "Seismic Controls for Electrical Systems."

2.2 ELECTRICAL IDENTIFICATION

A. General: Provide electrical identification as specified in Section 26 05 53 "Identification for Electrical Systems."

B. Manufacturers Standard Products: Use colors prescribed by ANSI A13.1, NFPA 70.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION REQUIREMENTS

A. All materials and equipment shall be installed in accordance with the Contract Drawings, and in accordance with FAA standard 1217g "Electrical Work, Interior.".

B. Where manufacturer's recommended installation methods conflict with contract requirements, difference shall be resolved by the COR.

C. The installation shall be accomplished by skilled workers regularly engaged in this type of work. Where required by local regulation, the workers shall be properly licensed.

D. Install components and equipment to provide maximum possible headroom where mounting heights or other location criteria are not indicated.

E. Install items level, plumb, and parallel and perpendicular to other building systems and components, except where otherwise indicated.

F. Install equipment to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

G. Give right of way to raceways and piping systems installed at a required slope.

H. Removal and Relocation of the Existing Work: The drawings indicate the extent of modifications to existing work. Electrical equipment which is part of, or operates in conjunction with, indicated equipment shall be disconnected or relocated as shown on drawings. Equipment and materials indicated to be relocated with be inspected by the COR prior to removal. The work shall be performed with care in order not to damage the existing equipment and materials. Repair or replace equipment and materials damaged. Notify the COR prior to removal of equipment and materials indicated on the drawings to be removed and relocated.

3.2 INSTALLATION

A. Contract Drawings: Where the drawings schematically indicate the work, diagrammatically or otherwise, furnish and install equipment, material, and labor for a complete and proper installation. Ensure that electrical and communications work is coordinated and compatible with Architectural, Mechanical, and Structural work.

B. Fire-stopping: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with fire-stop materials. Comply with requirements in Section 07 84 13 "Penetration Fire-stopping."

C. Fastening: Unless otherwise indicated, securely fasten electrical items and their supporting hardware to the building structure in accordance with Section 26 05 29 “Hangers and Supports for Electrical Systems,” and Section 26 05 48 “Seismic Controls for Electrical Systems.”

C. Install identification devices where required in accordance with the requirements of Division 26 Section 26 05 53 “Identification for Electrical Systems.”

D. Wiring Methods:

1. General: All wiring shall consist of insulated copper conductors installed in metallic raceways, unless otherwise specified.
2. Conductor Routing: Panelboards, surge arresters, disconnect switches, etc., shall not be used as raceway for conductor routing other than conductors that originate or terminate in these enclosures.
3. Conductor Separation: Power conductors shall be routed separately from all other conductor types.

    a. Power conductors with equivalent conductor insulation rating and of less than 600V may be installed in the same duct.
    b. Power conductors shall not be installed in the same duct with control, telephone, or signal types.

4. Neutral Conductor: Shared/common neutrals shall not be permitted, i.e., each overcurrent device shall have its own separate neutral conductor. Neutral conductor sizes shall not be less than the respective feeder or phase conductor sizes.

5. Ground Conductor: Shared/common grounding conductors shall not be permitted, i.e., each overcurrent device shall have its own separate ground conductor.

3.3 DEMOLITION

A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.

B. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.

C. Existing Work: Verify size, type, and condition of existing motor control centers, fuses, circuit overcurrent protection devices, disconnecting means, conductors, etc., in or immediately adjacent to equipment directly impacted by this project. Verify against contract drawings and note discrepancies on “red-line” drawings.

D. Existing Conductors: Existing power conductors shall be retained for re-use wherever it is practicable. Conductors shall be visually inspected for evidence of overheating and environmental degradation. Insulation shall be tested by means described in paragraph 3.5.C of this Section. Approved splicing methods may be used to increase length where necessary, provided the splice meets all requirements of Section 26 05 19, “Low-Voltage Electrical Power Conductors and Cables,” and NFPA-70 (NEC). In no case shall any splice be rendered inaccessible.

E. Abandoned Work: Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.

F. Remove demolished material from Project site.

G. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

3.4 CUTTING AND PATCHING

A. Cutting, channeling, chasing, and drilling of floors, walls, partitions, ceilings, and other surfaces requires an asbestos permit, to be issued by the FAA SECM. Coordinate such permitting with the COR.

B. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to allow electrical installations. Perform cutting by skilled mechanics of trades involved, or in compliance with instructions from the SECM, if issued.

C. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.5 TESTING

A. General: Perform the tests specified and other tests necessary to establish the adequacy, quality, safety, completed status and suitable operation of each system. Repair or replace equipment that does not meet test requirements and retest. Tests shall be scheduled and approved in writing by the COR at least 21 days prior to conducting tests. Unless otherwise indicated, the contractor shall furnish all test instruments, materials and labor necessary to preform tests designated in Division 26 Sections. All tests shall be performed in the presence of the COR. All instruments shall have been calibrated to applicable industry recognized standards.

An interim operating and performance test shall be performed for each major equipment item after installation is complete and before the item is placed in service. After mechanical systems have been completely installed and balanced, test each system for proper operation. Tests shall be conducted in the presence of the COR under design conditions to ensure proper sequence and operation throughout the range of operation. Make adjustments as required to ensure proper functioning of the systems. Special tests on individual systems are specified under individual sections. Provide 21 days written notice to the COR for major tests. Contractor shall demonstrate, to the COR's satisfaction, proper operation of control devices by simulating actual operating conditions. Devices tested shall include, but not limited to, flow and pressure controls, temperature controls and system interlocks and alarms.

B. After final tests and adjustments have been completed, fully instruct the government's facilities personnel and other personnel as directed by the COR in details of operation and maintenance of electrical equipment, including control systems and fire alarm systems as installed.

C. Insulation Resistance Tests: Feeder and branch circuit insulation tests shall be performed after installation, but before connection to equipment.

1. Conductors shall test free from short circuits and grounds, and have a minimum phase-to-phase and phase-to-ground insulation resistance of 30 megohms when measured with a 500V DC insulation resistance. The contractor shall submit a letter type test report to the Construction Manager prior to final inspection of the work. The report shall list the tests performed and results obtained.

    a. Apply the test voltage for at least one minute after motor reading has stabilized.

2. Use the FAA megohmeter form located at the end of this section (attachment 2).
3. In Lighting, Power, Miscellaneous Power and Receptacle single pole branch circuit Panelboards, test any random four branch circuits (consisting of a phase, neutral, and grounding conductor) within a 42 pole panelboard or test one branch circuit per every ten branch circuits. If more than ten test points are above the specified value, then all branch circuit wiring for both 120V and 277V shall be tested.
4. Insulation resistance meggering tests, continuity tests, open and short circuiting testing that fail to meet the minimum standards as set forth in these electrical specifications shall have their feeder or branch circuit conductors (phase, neutral, and ground) removed and replaced. If after retesting, these feeder conductors fail to meet minimum requirements, the work shall be re-performed until such work and retesting passes the minimum design parameter requirements as set forth in these electrical specifications.

5. For receptacle and miscellaneous power branch circuits, the following test procedures shall be used:

    a. Open circuit the Overcurrent Circuit Protection Device (OCPD), which will be a single pole, 15 amp or 20 amp, molded case branch circuit breaker and remove all plugs from all of the single, duplex, and quadruplex convenience receptacle outlets. For switched receptacles and for single phase, thermal manual motor starters used with fractional horsepower supply and exhaust fan motors, close the circuit switch.
    b. Perform a continuity test and then an insulated resistance meggering test. If there are no open circuits nor any short circuits and continuity testing results and meggering testing results are within specified design parameters, then disconnect all testing equipment and close the OCPD/Molded Case Branch Circuit Breaker.

6. For lighting fixture branch circuit wiring, the following test procedures shall be used:

    a. For meggering test purposes to obtain insulation resistance values, open circuit the OCPD, which will be a single pole, 20 amp molded case branch circuit breaker, then close circuit all light switches in the branch circuit wiring prior to the first lighting fixture and then disconnect (open circuit) the branch conductors from the first lighting fixture in the circuit. Failure to do so can damage all lighting fixture ballasts in the circuit and will also give very false, very poor, and very low readings. A continuity test can be performed with all of the lighting fixtures connected, provided all of their respective light switches are on/close circuited and their OCPD is open circuited. Incandescent, tungsten halogen, quartz iodide, and halogen iodide lamp lighting fixtures may be left in the circuit and successfully tested for continuity and can be successfully meggered without any dire circumstances or consequences and without their causing false, low, or poor readings.
    b. Perform both the continuity test and then the insulation resistance meggering test. If there are no open, circuits nor any short circuits, and continuity testing results and resistance meggering testing results are within specified design parameters, then disconnect all testing equipment and close the OCPD/Molded Case Branch Circuit Breaker.

D. No 120V, single pole, 100 amp, E-frame nor any 277V, single pole, 150 amp, EH frame, molded case circuit breaker is required to be tested. All two pole and all three pole molded case, insulated case, and draw out power circuit breakers in both 208V and 480V ratings shall be tested for short circuit armature operation and for long term thermal overload protection operation to ascertain that they conform to within the manufacturer's recommended tolerances and design parameters. They shall be tested trip free of the handle operation, trip resetting and mechanical freedom of movement. The circuit breakers shall have factory recommended electrical insulation resistance and factory recommended electrical conductivity path resistance.

E. Load Balancing: After Substantial Completion of electrical systems, redistribute the loads where there is a greater that a 20% difference between readings in two or more phases, in accordance with Section 26 24 16 "Panelboards."

END OF SECTION 260500

ATTACHMENT NO. 1

Electrical Test Report

Project Name_____ Date_____Sheet No.___of ___
Project No._____ Address_____

SERVICE TRANSFORMER SIZE									
NL SERVICE VOLTAGE									
FL SERVICE VOLTAGE									
PANEL OR SWBD SERVED FROM									
PANEL OR									
LOCATION									
MANUFACTURER									
TYPE									
FEEDER OC									
FEEDER CONDUCTOR									
GROUND CONDUCTOR SIZE									
MEASURED CONDITIONS	PHASE			PHASE			PHASE		
	A	B	C	A	B	C	A	B	C
NO LOAD FEEDER VOLTAGE									
OPERATING LOAD FEEDER VOLTAGE									
OPERATING LOAD FEEDER CURRENT									
CONDUCTOR INSUL RESISTANCE Ø AB									
CONDUCTOR INSUL RESISTANCE Ø BC									
CONDUCTOR INSUL RESISTANCE Ø CA									
CONDUCTOR INSUL RESISTANCE TO									
NEUTRAL INSUL RES TO GR W/GR CONN REMOVED									

ATTACHMENT NO. 2

Megger Test Report
600 V CABLE INSULATION AND CONTINUITY TEST
(power/control wire & cable)

Project Name _____ Date_____Sheet No.___of ___
Project No._____ Address_____

NOTE: 500 VOLT MEGOHMETER, MEGGER ALL PHASES, RECORD MINIMUM READING

Panel No. Ckt. No. Feeder	VOLTS	A-B	A-C	B-C	A-N	B-N	C-N	A-G	B-G	C-G	N-G	SUPERVISOR

DISTRIBUTION: CENTRAL RECORDS
RE/ENGINEER

E/ENG/DATE
CONTRACTOR

_____

R

_____

Contractor Supervisor/Date

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.
3. Variable Frequency Drive (VFD) cable rated 1000V and less

1.3 Related Sections include the following:

1. Division 26 Section 26 05 00 "Common Work Results for Electrical" for sleeves and sleeve seals.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Qualification Data: For testing agency.

C. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the International Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70,

National Electric Code 2017 and

NFPA 70E Arc Flash.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Alcan Products Corporation; Alcan Cable Division.
2. American Insulated Wire Corp.; a Leviton Company.
3. General Cable Corporation.
4. Senator Wire & Cable Company.
5. Southwire Company.
6. Belden.
7. Encore wire and cable.

B. Copper Conductors: Comply with NEMA WC 70.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN.

D. Flexible Cord: Comply with NEMA WC 70 for Type 50.

E. VFD Cable: UL 1277 Type TC-ER with XLPE isolation, 3 stranded conductors plus ground, overall 100% foil, 85% braid shield, drain wire, oil resistant PVC jacket

1. Belden 29505 for #12
2. Belden 29503 for #10
3. Belden 29504 for #8
4. Belden 29505 for #6
5. Belden 29506 for #4

2.2 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.
6. Ilsco.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

C. Connectors

1. Connectors shall be factory-fabricated connectors of size, ampacity rating, material, type, and class for application and service indicated.

2. Connectors shall be of the following types:

   a. Solderless, uninsulated high conductivity, corrosion resistant, compression connectors conforming to UL 486
   b. Insulated, indenter-type compression butt connectors
   c. Insulated, integral self-locking flexible shell, expandable spring connectors
   d. Uninsulated, indenter-type compression pigtail connectors
   e. Welded-type connectors

3. For splices of #10 AWG and smaller building wires in lighting circuits, use tin plated copper compression type connector caps with nonflammable, self-extinguishing insulation grip with temperature rating equal to that of conductor insulation.

4. Use ring tongue compression type terminators with insulated barrel on all stranded conductors used in control wiring.

5. Crimp type connectors are not permitted on solid conductors.

D. Terminals:

1. Terminals shall be factory-fabricated connectors of size, ampacity rating, material, type, and class for application and service indicated.

2. Terminals shall be of the following types:

   a. Solderless, uninsulated, high conductivity, corrosion resistant, compression terminals conforming to UL 467 and IEEE 837
   b. Insulated, compression terminals
   c. Solderless, high-conductivity, corrosion resistant, hex screw type, bolted terminals
   d. Welded type terminals

E. Insulating Tape: ASTM D1000. As a minimum, rate equal to conductor insulation. Rubber tape shall be silicon rubber with silicon pressure sensitive adhesive.

F. Bundling Straps: Nylon straps with a locking hub or head on one end and a taper on the other.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine raceways and building finishes to receive wires and cables for compliance with installation tolerances and other conditions. Verify that the duct or conduit is open, continuous, and clear of debris before installing cable. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.3 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Feeders: Type THHN-THWN, single conductors in raceway.

B. Branch Circuits: Type THHN-THWN, single conductors in raceway.

C. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

D. Class 1 Control Circuits: Type THHN-THWN, in raceway.

E. Class 2 Control Circuits: Type THHN-THWN, single conductors in raceway.

3.4 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Support cables according to Division 26 Section 26 05 29 "Hangers and Supports for Electrical Systems."

F. Identify and color-code conductors and cables according to Division 26 Section 26 05 53 "Identification for Electrical Systems."

1. Feeder conductors to panels and three phase circuits shall be factory color coded as indicated:

a. 208/120 Volt System:

1) Phase A: Black
2) Phase B: Red
3) Phase C: Blue

4) Neutral: White
5) Ground: Green

b. 480/277 Volt System:

1) Phase A: Yellow*
2) Phase B: Brown*
3) Phase C: Orange*
4) Neutral: Grey
5) Ground: Green

* Verify and Confirm with COR for site-specific system compliance prior to ordering.

3.5 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

D. Splicing

1. Splicing and terminating shall be as specified in this Section. Details of special splicing and terminating shall be as shown on the Contract Drawings. Any splicing or terminating methods other than those specified below, for which the components are in accordance with the requirements of this Section, shall be submitted to the Engineer for approval.

2. General Purpose Wires and Cables

a. Splices in dry locations for sizes #10 and smaller shall use one of the following:

1) Insulated, integral, self-locking flexible shell, expandable spring connectors shall be applied to the twisted conductors. Two, half-lapped layers of vinyl tape, extending to a distance of not less than one inch from the connector, shall be applied.
2) Compression type, insulated butt connectors shall be applied to the butted conductors by means of an appropriate crimping tool, providing controlled indentation. Two, half-lapped layers of vinyl tape, extending to a distance of not less than one inch from the connector, shall be applied.
3) Compression type, pigtail connectors shall be applied to the conductors by means of an appropriate crimping tool, providing controlled indentation.

The connector shall be covered with a polyamide cap and two, half-lapped layers of vinyl tape, extending to a distance of not less than one inch from the connector, shall be applied.

b. Splices in dry locations for sizes #8 and larger shall use all of the following:

1) Connectors shall be split sleeve solderless type or solderless compression type.
2) Fill indents of connectors with Scotchfil.
3) Apply rubber splicing tape equal to the original insulation rating.
4) Apply two, half-lapped layers of vinyl tape, or a shrinkable tubing

c. Splices in wet locations for all sizes

1) Same as dry location specified above, with two coats of sealer or shrinkable tubing over the vinyl tape

E. Terminations

1. Terminations in dry locations for sizes #10 and smaller shall be with compression terminals, insulated or uninsulated.
2. Terminations in dry locations for sizes #8 AWG through 3/0 AWG shall be either solderless uninsulated compression crimp type ring tongue terminals or bolted hex screw type ring tongue lugs.
3. Terminations in dry locations for sizes 4/0 AWG and larger shall be solderless, uninsulated compression crimp type ring tongue terminals.
4. Terminations in wet locations shall be as dry location terminations above, plus cover the entire termination area with two, half-lapped layers of vinyl tape and apply two coats of sealer over the tape.

3.6 FIRESTOPPING

A. Apply fire-stopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section 07 84 13"Penetration Fire stopping."

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors, and conductors. Tests shall be performed in the presence of the COR.

2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

3. Perform insulation resistance tests on feeder and branch circuits after installation, but before connection to equipment.

a. Conductors shall test free from short circuits and grounds, and have a minimum phase-to-phase and phase-to-ground insulation resistance of 30 megohms when measured with a 500V DC insulation resistance.
b. Apply the test voltage for at least one minute after motor reading has stabilized.
c. Contractor shall use the Megger Test Report Form located at the end of Section 26 05 00"Common Work Results for Electrical."

C. Test Reports: Prepare a written report and submit to the COR prior to final inspection of the work to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes: Grounding systems and equipment.

B. Section includes grounding systems and equipment, plus the following special applications:

1. Underground distribution grounding.
2. Ground bonding common with lightning protection system.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:

1. Test wells.
2. Ground rods.
3. Counterpoise.

C. Qualification Data: For qualified testing agency and testing agency's field supervisor.

D. Field quality-control reports.

E. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data."

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.2 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions. Exothermic welds in the FAA occupied areas shall be low odor and smokeless products.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 3/4 inch in diameter by 10 feet long.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 10 AWG and smaller, and stranded conductors for No. 8 AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install bare copper conductor, 4/0 AWG minimum.

1. Bury at least 24 inches below grade.

C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

D. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

3.3 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Armored and metal-clad cable runs.
8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct- mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

3.4 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.

D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

E. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install braided-type bonding straps to bond across flexible duct connections to achieve continuity.

3.5 LABELING

A. Comply with requirements in Section 26 05 00 "Identification for Electrical Systems" Article for instruction signs. The label or its text shall be green.

3.6 FIELD QUALITY CONTROL

A. Independent Testing Agency: Arrange and pay for the services of a qualified independent electrical testing organization to perform tests and inspections. Ensure no connection to utility power is made during testing.

B. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.

    a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    b. Perform tests by fall-of-potential method according to IEEE 81.
    c. Refer to Section 09 69 00 "Access Flooring" for access flooring resistance testing.

C. Earth electrode system ground shall not exceed 5 ohms.

D. Bolting Resistance: Spot test to verify that ground cable bolted connections have DC resistance of one milliohm maximum, when measured with a bridge type milliohmeter or similar instrument.

E. Continuity: Test grounding conductors, sheet metal, metallic conduits, equipment enclosures, metallic enclosures, and lighting fixtures for continuity to grounding system.

F. Excessive Ground Resistance: If resistance to ground exceeds specified values, modify the grounding system to reduce ground resistance.

G. Report: Prepare test reports, certified by the testing organization, of the ground resistance at each test location. Include observations of weather and other phenomena that may affect test results.

H. Test Procedure:

1. All grounds, bonds, and continuity tests that fail to meet minimum standards and resistivity levels as set forth in these electrical specifications shall have their materials removed and replaced and shall have all their workmanship redone. If after retesting they fail to meet minimum requirements, the work shall be re-performed until such work and retesting passes the minimum design parameter requirements.
2. All sections of joined conduit, cable tray or structural steel columns and beams shall have the first ten consecutive connections of each system tested for continuity/grounding/bonding and if they test within acceptable specified limits, the test every tenth connection thereafter.
3. If any test point is higher than specified in these electrical
4. If more than ten test points of each system are above the specified values, then all continuity/grounding/bonding points in that system shall be tested.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS PART

1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.
B. IMC: Intermediate metal conduit.
C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.
2. Nonmetallic slotted support systems.

B. Shop drawings of supports shall meet seismic requirements to withstand the IBC seismic design Category “D”.

1.6 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Electrical components shall be listed and labeled by UL or other approved, nationally recognized testing and listing agency that provides third party certification follow-up services.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
2. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
3. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
4. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened Portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
2. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
3. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
4. Toggle Bolts: All-steel springhead type.
5. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 05 50 00 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

E. Sleeves: Install in concrete slabs and walls and all other fire-rated floors and walls for raceways and cable installations. For sleeves through fire-rated wall or floor construction, apply UL listed fire-stopping sealant in gaps between sleeves and enclosed conduits and cables in accordance with the requirements of Section 07 84 13 “Penetration Fire-stopping.” For sleeves through non-fire rated wall or floor construction, apply UL listed fire-stopping sealant in gaps between sleeves and enclosed conduits and cables in accordance with the requirements of Section 07 92 00 “Joint Sealants.”

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.

7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 05 50 00 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 03 01 30 "Cast-in-Place Concrete"

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

END OF SECTION 260529

SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. FMC: Flexible metal conduit.

D. LFMC: Liquid-tight flexible metal conduit.

E. NBR: Acrylonitrile-butadiene rubber.

F. PVC-RGS: PVC coated type RGS conduit.

G. RGS: Rigid galvanized steel conduit.

H. VFD: Variable frequency Drive.

1.4 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.

C. Source quality-control test reports.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems, Inc.
2. Alflex Inc.
3. Allied Tube & Conduit; a Tyco International Ltd. Co.
4. Anamet Electrical, Inc.; Anaconda Metal Hose.
5. Electri-Flex Co.
6. Manhattan/CDT/Cole-Flex.
7. Maverick Tube Corporation.
8. O-Z Gedney; a unit of General Signal.
9. Wheatland Tube Company.

B. Manufacturers for PVC-RGS:
1. Perma-cote; Robroy Industries.
2. Approved Equal.

C. Rigid Steel Conduit: ANSI C80.1.

D. IMC: ANSI C80.6.

E. PVC-RGS: PVC-coated rigid galvanized steel conduit.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch, minimum.

F. EMT: ANSI C80.3.

G. FMC: Zinc-coated steel.

H. LFMC: Flexible steel conduit with PVC jacket.

I. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
2. Fittings for EMT: Steel, compression type.
3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch, with overlapping sleeves protecting threaded joints.

J. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

K. PVC-RGS Steel Conduit and Fittings

1. The PVC-RGS conduit shall be UL Listed.
2. The PVC coating shall be investigated by UL as providing the primary corrosion protection for the rigid metal conduit. Ferrous fittings for general service locations shall be UL Listed with PVC as the primary corrosion protection. Hazardous location fittings, prior to plastic coating shall be UL listed. All conduit and fittings shall be new, unused material. Applicable UL standards may include: UL 6 Standard for Safety, Rigid Metal Conduit, UL514B Standard for Safety, Fittings for Conduit and Outlet Boxes.
3. The PVC-RGS conduit shall be ETL Verified to the Intertek ETL SEMKO High Temperature H2O PVC Coating Adhesion Test Procedure for 200 hours. The PVC-RGS conduit shall bear the ETL Verified PVC-001 label to indicate compliance with the adhesion performance standard
4. The PVC-RGS conduit shall be hot dip galvanized inside and out with hot galvanized threads
5. A PVC sleeve extending one pipe diameter or two inches, whichever is less, shall be formed at every female fitting opening except unions. The inside sleeve diameter shall be matched to the outside diameter of the conduit.
6. The PVC coating on the outside of conduit couplings shall have a series of longitudinal ribs not less than 40 mils in thickness to protect the coating from tool damage during installation.
7. Form 8 Condulets, 1/2" through 2" diameters, shall have a tongue-in-groove gasket to effectively seal against the elements. The design shall be equipped with a positive placement feature to ease and assure proper installation. Certified results confirming seal performance at 15 psig (positive) and 25 in. of mercury (vacuum) for 72 hours shall be available.
8. Form 8 Condulets shall be supplied with plastic encapsulated stainless steel cover screws
9. A urethane coating shall be uniformly and consistently applied to the interior of all conduit and fittings. This internal coating shall be not less than 2 mil thickness.
10. The PVC exterior and urethane interior coatings applied to the conduit shall afford sufficient flexibility to permit field bending without cracking or flaking at temperatures above 30°F.
11. All male threads on conduit, elbows and nipples shall be protected by application of a urethane coating. All female threads on fittings or conduit couplings shall be protected by application of a urethane coating.
12. Independent certified test results shall be available to confirm coating adhesion under the following conditions.

    a. Conduit and condulet exposure to 150°F and 95% relative humidity with a minimum mean time to failure of 30 days. (ASTM D1151)

b. The interior coating bond shall be confirmed using the Standard Method of Adhesion by Tape Test (ASTM D3359).
c. No trace of the internal coating shall be visible on a white cloth following six wipes over the coating, which has been wetted with acetone (ASTM D1308).
d. The exterior coating bond shall be confirmed using the methods described in Section 3.8, NEMA RN1. After these tests the physical properties of the exterior coating shall exceed the minimum requirements specified in Table 3.1, NEMA RN1.

13. Right angle beam clamps and U bolts shall be specially formed and sized to snugly fit the outside diameter of the coated conduit. All U bolts will be supplied with plastic encapsulated nuts that cover the exposed portions of the threads.

L. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. EGS/Appleton Electric.
3. Erickson Electrical Equipment Company.
4. Hoffman.
5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
6. O-Z/Gedney; a unit of General Signal.
7. RACO; a Hubbell Company.
8. Robroy Industries, Inc.; Enclosure Division.
9. Scott Fetzer Co.; Adalet Division.
10. Spring City Electrical Manufacturing Company.
11. Thomas & Betts Corporation.
12. Walker Systems, Inc.; Wiremold Company (The).
13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary

B. General

1. Interior Outlet Boxes

a. Boxes shall be 4” square, minimum 2 1/8” deep, for up to two devices.
b. Provide single gang tile ring as required for single device applications.

2. Exterior Outlet Boxes

a. Provide corrosion-resistant, cast metal, weatherproof outlet box of types, shapes, sizes, depths as required for respective location.
b. For recessed in exterior wall application, provide galvanized sheet steel boxes with suitable depth.

C. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

D. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.

E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

F. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.

G. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

H. Cabinets:

1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:

1. Exposed Conduit: PVC coated RGS.
2. Concealed Conduit, Aboveground: PVC coated RGS.
3. Underground Conduit: PVC coated RGS.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 4X.
6. Use polyvinyl chloride conduit for lightning protection or grounding system as indicated on drawings.

B. Comply with the following indoor applications, unless otherwise indicated:

1. Exposed: RGS (EMT may be used in the electrical/mechanical room to a height of 8 feet above finished floor except for panelboard and transformer feeders).
2. Concealed in Ceilings and Interior Walls and Partitions: RGS, (EMT shall only be used for lighting branch circuits, receptacles branch circuits, communications, fire alarm, security and environmental controls).
3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
4. Damp or Wet Locations: Rigid steel conduit.

5. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.

C. Minimum Raceway Size: 1/2-inch trade size, by FAA-STD-1217g.

1. For variable frequency drive (VFD) cables, the following minimum raceway sizes shall be used:

a. #2 conductor size: 1 ½”
b. #1 conductor size: 2 ½”

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.

3.2 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Raceways installed near uninsulated flues and steam or hot water pipes shall be subject to the approval of the COR. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

F. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

G. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.

H. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound

manufacturer's written instructions.

I. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

J. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.

K. Raceways for Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:

1. 3/4-Inch Trade Size: Install raceways in maximum lengths of 50 feet.
2. 1 Inch Trade Size and Larger: Install raceways in maximum lengths of 100 feet.
3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

L. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where otherwise required by NFPA 70.

M. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semi-recessed lighting fixtures, equipment subject to vibration, noise transmission, o r movement; and for transformers and motors.

N. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

O. Set metal floor boxes level and flush with finished floor surface.

3.3 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

SECTION 26 05 48 - SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Restraint channel bracings.
2. Restraint cables.
3. Seismic-restraint accessories.
4. Mechanical anchor bolts.
5. Adhesive anchor bolts.

B. Related Requirements:

1. Section 26 05 29 "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.

    a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
    b. Annotate to indicate application of each product submitted and compliance with requirements.

B. Delegated-Design Submittal: For each seismic-restraint device.

1. Include design calculations and details for selecting seismic restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
2. Design Calculations: Calculate static and dynamic loading caused by equipment weight, operation, and seismic forces required to select seismic restraints and for designing vibration isolation bases.

    a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.

3. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.

4. Field-fabricated supports.
5. Seismic-Restraint Details:

    a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
    b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
    c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
    d. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.

B. Qualification Data: For professional engineer and testing agency.

C. Welding certificates.

D. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis. They shall bear anchorage preapproval from OSHPD in addition to preapproval, showing maximum seismic-restraint ratings, by ICC-ES or another agency acceptable to authorities having jurisdiction. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) that support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

E. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:

1. Site Class as Defined in the IBC: D
2. Seismic Design Category: C
3. Component Importance Factor, Ip = 1.5.
4. Design Spectral Response Acceleration at Short Periods, Sds = 0.203g
5. Design Spectral Response Acceleration at 1.0 second period, Sd1 = 0.095g
6. Select the applicable component amplification factor, ap, and component response modification factor, Rp, from Table 13.6-1 of ASCE 7-10 *Minimum Design Loads for Buildings and Other Structures.*

2.2 GENERAL REQUIREMENTS FOR RESTRAINT COMPONENTS

A. Rated strengths, features, and application requirements shall be as defined in reports by an evaluation service member of ICC-ES.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

2.3 RESTRAINT CHANNEL BRACINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper B-Line, Inc.; a Division of Cooper Industries.
2. Hilti, Inc.
3. Unistrut; Atkore International.

B. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end, with other matching components, and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.4 RESTRAINT CABLES

A. Manufacturers: Subject to compliance with requirements, products by one of the following:

1. Kinetics Noise Control, Inc.
2. Loos & Co., Inc.
3. Vibration Mountings & Controls, Inc.

B. Restraint Cables: ASTM A 492 stainless-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

2.5 SEISMIC-RESTRAINT ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, products by one of the following:

1. Cooper B-Line, Inc.; a Division of Cooper Industries.
2. Kinetics Noise Control, Inc.
3. Mason Industries, Inc.
4. TOLCO; a brand of NIBCO INC.

B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.

C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.

D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.

E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.

F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.6 MECHANICAL ANCHOR BOLTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper B-Line, Inc.; a Division of Cooper Industries.
2. Hilti, Inc.
3. Kinetics Noise Control, Inc.
4. Mason Industries, Inc.

B. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.7 ADHESIVE ANCHOR BOLTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hilti, Inc.
2. Kinetics Noise Control, Inc.
3. Mason Industries, Inc.

B. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Adhesive anchor bolts shall not be used in applications where subjected to permanently sustained tension loads.

2.8 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an evaluation service member of ICC-ES.

B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods caused by seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 03 30 00 "Cast-in-Place Concrete."

B. Equipment and Hanger Restraints:

1. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
2. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES providing required submittals for component.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

E. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

F. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where connection is terminated to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform the following tests and inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
7. Remove and replace malfunctioning units and retest as specified above.

C. Seismic controls will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 260548

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Warning labels and signs.
5. Instruction signs.
6. Equipment identification labels.
7. Miscellaneous identification products.

1.3 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.4 QUALITY ASSURANCE

A. Comply with ANSI A13.1.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 – PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage and service type.

C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

D. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

2.2 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

D. Snap-Around Labels: Slit, pre-tensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Snap-Around, Color-Coding Bands: Slit, pre-tensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.3 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Snap-Around Labels: Slit, pre-tensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

D. Snap-Around, Color-Coding Bands: Slit, pre-tensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.4 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Baked-Enamel Warning Signs (Interior):

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 7 by 10 inches.

C. Metal-Backed, Butyrate Warning Signs (Exterior):

1. Weather-resistant, non-fading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 10 by 14 inches.

D. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.5 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16-inch-thick for signs up to 20 sq. inches and 1/8-inch-thick for larger sizes.

1. Engraved legend with white letters on black face.
2. Punched or drilled for mechanical fasteners.

2.6 EQUIPMENT IDENTIFICATION LABELS

A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.

B. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

2.7 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black except where used for color-coding.

2.8 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Alkyd-urethane enamel over primer as recommended by enamel manufacturer. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 APPLICATION

A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A: Identify with orange self-adhesive vinyl label.

B. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands:

1. Fire Alarm System: Red.
2. Combined Fire Alarm and Security System: Red and blue.
3. Security System: Blue and yellow.
4. Mechanical and Electrical Supervisory System: Green and blue.
5. Telecommunication System: Green and yellow.
6. Control Wiring: Green and red.

C. Power-Circuit Conductor Identification: For conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and hand holes use color-coding conductor tape AND metal tags. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.

D. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use marker tape. Identify each ungrounded conductor according to source and circuit number.

E. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.

F. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning labels. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.

1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:

   a. Power transfer switches.
   b. Controls with external control power connections.
   c. Elevator Control Panels

2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.

G. Instruction Signs:

1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8-inch high letters for emergency instructions at equipment

used for power transfer.

H. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch high letters on 1-1/2-inch high label; where 2 lines of text are required, use labels 2 inches high.
b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

2. Equipment to Be Labeled:

a. Panelboards, electrical cabinets, and enclosures.
b. Access doors and panels for concealed electrical items.
c. Transformers.
d. Disconnect switches.
e. Motor starters.
f. Monitoring and control equipment.

3.2 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

D. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

E. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

END OF SECTION 260553

SECTION 26 09 23 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Photoelectric switches.

B. Related Requirements:

1. Section 26 27 26 "Wiring Devices" for manual light switches.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show installation details for occupancy and light-level sensors.

1. Interconnection diagrams showing field-installed wiring.
2. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 OUTDOOR PHOTOELECTRIC SWITCHES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper Industries, Inc.
2. NSi Industries LLC; TORK Products.
3. Tyco Electronics; ALR Brand.

B. Description: Solid state, with SPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Light-Level Monitoring Range: 1.5 to 10, with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off.
3. Time Delay: Fifteen second minimum, to prevent false operation.
4. Surge Protection: Metal-oxide varistor.
5. Mounting: Twist lock complies with NEMA C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

C. Description: Solid state, with SPST dry contacts rated for 1800 VA, to operate connected load, complying with UL 773.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range.
3. Time Delay: Thirty-second minimum, to prevent false operation.
4. Lightning Arrester: Air-gap type.
5. Mounting: Twist lock complying with NEMA C136.10, with base.

2.2 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

2.3 OCCUPANCY SENSORS:

A. Multi Technology Ceiling Occupancy Sensor:

CUL/US Certified, meets energy code requirements for ASHRAE standard 90.1 and CA Title 24. UL 773A Occupancy Standard. Dual technology ceiling sensor. Five Year Limited Warranty.

Ceiling mount 8-12 feet. Power Requirements: 24 VDC from Power Pack or Power Base. Power Consumption: 0.25 mA – 35 mA. Power Output: 24 VDC active high logic control signal.

Operating Temperature: 32 to 104 Degree F; Storage Temperature: -15 to 160 Degree F.

Relative Humidity: 0% to 90% non-condensing; indoor use

Line Voltage Sensor 120-277 volt; Coverage: 500 sq. feet – 2000 sq. feet

Ultrasonic Sensitivity: 0 – 100%; Infrared Sensitivity: 0 – 10; Light Sensor: 2 fc – 300 fc; Time Delay: 30 sec. – 3 min

B. Wall Mount Occupancy Sensor:

Dual technology wall mount sensors combine PIR and ultrasonic technologies.

Response Time; 15 seconds to 30 minutes.Light Output: Automatic

Load: 1 Amp. Voltage: 24 VDC

Dual element, temperature compensated pyroelectric sensor.

360 degree coverage. Coverage 2000 sq. feet.

Built-in light level sensor. Isolated relay

Turns lights ON and OFF based on occupancy.

User-adjustable time delay and sensitivity.

Reliability and Five Year Limited Warranty.

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

A. Wiring Method: Comply with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate lighting control devices and perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections:

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Lighting control devices will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
2. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 260923

SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:

1. Distribution transformers.
2. Buck-boost transformers.

1.3 SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Qualification Data: For testing agency.

D. Source quality-control test reports.

E. Manufacturer Seismic Qualification Certification.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

D. The manufacturer shall be a member of NEMA. The transformers shall meet standard, equal to or in excess of those specified by NEMA, AIEE, MEC, or ANSI.

1. ANSI/NEMA ST 20 - Dry Type Transformers for General Application

2. ANSI/NEMA TP-1 - Guide for Determining Energy Efficiency for Distribution Transformers.

3. IEEE-519 - Recommended Practices and Requirements for Harmonic Control in Electric Power Systems.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.6 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Products.
2. General Electric Company.
3. Hammond Co.; Matra Electric, Inc.
4. Siemens Energy & Automation, Inc.

5. Square D; Schneider Electric.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.

1. Internal Coil Connections: Brazed or pressure type.
2. Coil Material: Copper.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Cores: One leg per phase.

C. Enclosure: Ventilated, NEMA 250, Type 3R.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

D. Transformer Enclosure Finish: Comply with NEMA 250.

1. Finish Color: Gray.

E. Taps for Transformers Smaller Than 3 kVA: None.

F. Taps for Transformers 7.5 to 24 kVA: Two 5 percent taps below rated voltage.

G. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

H. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

I. Energy Efficiency for Transformers Rated 15 kVA and Larger:

1. Complying with NEMA TP 1, Class 1 efficiency levels.
2. Tested according to NEMA TP 2.

J. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for non-sinusoidal load current-handling capability to the degree defined by designated K-factor.

1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.

2. Indicate value of K-factor on transformer nameplate.

K. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize inter-winding capacitance.

1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
2. Include special terminal for grounding the shield.
3. Shield Effectiveness:

a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picoFarads over a frequency range of 20 Hz to 1 MHz.
b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.

L. Wall Brackets: Manufacturer's standard brackets.

M. Fungus Proofing (Outdoor): Permanent fungicidal treatment for coil and core.

N. Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

2.4 BUCK-BOOST TRANSFORMERS

A. Description: Self-cooled, two-winding dry type, rated for continuous duty and with wiring terminals suitable for connection as autotransformer. Transformers shall comply with NEMA ST 1 and shall be listed and labeled as complying with UL 506 or UL 1561.

B. Enclosure: Ventilated, NEMA 250, Type 2.

1. Finish Color: Gray.

2.5 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section26 05 53 "Identification for Electrical Systems."

2.6 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

2.7 VIBRATION MOUNTINGS

A. All dry-type transformers 15 KVA and larger shall be supported by external vibration mountings, comprised of heavy structural steel angle iron bases or rails, and unit isolators.

B. Units shall be Vibration Eliminator Company Type “D” (with “SN” isolators), Korfund, Amber/Booth, Consolidated Kinetics, Mason Industries, or equal as approved.

C. Isolators shall have steel springs seated in rubber with provisions for leveling and bolding to equipment and to the concrete floor pad or suspension rods or wall framing as is applicable.

D. To insure adequate stiffness, height or depth of structural members shall be a minimum of 8% of the longest base dimension.

E. The isolator manufacturer shall determine the O.D., free, operating and solid heights for the springs; quantity and location of unit isolators, spring deflation; isolation efficiency; prepare tabulation of this and correlate with transformer manufacturer; and submit copies of tabulations and required Drawings through the Electrical Contractor, for approval by the Architect/Engineer.

F. In addition to the isolators, provide a neoprene “transformer pad” ¼” minimum thickness mat, between the pad and the isolators.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

B. Transformers shall be set on vibration isolation mounts. Bolt neoprene mounts to floor and bold transformer skids to mounts.

C. Where the primary feeder comes from the floor below, it shall terminate at the end of transformer enclosure with a metal grounding bushing with neoprene throat insert.

D. Where the primary feeder comes from overhead, the conduits shall enter the side of the transformer enclosure. The conduit within 36 inches of the enclosure shall be flexible steel.

E. Where transformers indicated to be supported from ceiling structure, provide necessary supports, and vibration isolation.

F. Clean all ventilation openings.

G. Install vibration mountings in a neat and workmanlike manner.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Remove and replace units that do not pass tests or inspections and retest as specified above.

C. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.

1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
2. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.
3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

D. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.

C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262200

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Lighting and appliance branch-circuit panelboards.

1.3 SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated, include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
6. Include wiring diagrams for power, signal, and control wiring.

C. Qualification Data: For qualified testing agency.

D. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Panelboard Schedules: For installation in panelboards, Submit final versions after load balancing

F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application. Contractor shall provide Arc Flash Label for the new panelboard installation.

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NECA 407 and NEMA PB 1.

1.6 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weather-tight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

    a. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify COR no fewer than 15 days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without COR's written permission.
3. Comply with NFPA 70E.

1.7 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1.9 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: 6 spares for each type of panelboard cabinet lock. Consult with COR for keying requirements.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Fabricate and test panelboards according to IEEE 344 to withstand IBC seismic design category "2B"."

B. Enclosures: Surface-mounted cabinets.

1. Rated for environmental conditions at installed location.
   a. Pump House Areas: NEMA 250, Type 12, painted steel.

b. Other Indoor Locations: NEMA 250, Type 3R.

2. Hinged Front Cover: Entire front trim hinged to box and with standard door in door hinged trim cover.
3. Finishes:

a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
b. Back Boxes: Same finish as panels and trim.

4. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.

C. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

D. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Mechanical type.
3. Ground Lugs and Bus-Configured Terminators: Mechanical type.

E. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

F. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or Main lugs only as scheduled.

D. Sub-feed lugs: As scheduled, at opposite end from main device.

E. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

F. Doors: Door-In-Door Construction.

1. Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

a. Standard frame sizes, trip ratings, and number of poles.
b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.

2.4 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NECA 407 and NEMA PB 1.1.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install panelboards and accessories according to NECA 407 and NEMA PB 1.1.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

C. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

D. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges to achieve correct coordination.

E. Install filler plates in unused spaces.

F. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

G. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 26 05 53: "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:
   a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
   b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
   c. Instruments and Equipment:
      1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as indicated.

C. Circuit changes made during load balancing may negate color-coding of phases and circuits. If load balancing proves undesirable or is to be performed by others, delete paragraph below.

D. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Snap switches.
3. Solid-state fan speed controls.
4. Communications outlets.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

E. TVSS: Transient voltage surge suppressor.

F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 5362 (duplex).
b. Hubbell; 5362 (duplex).
c. Leviton; 5362 (duplex).
d. Pass & Seymour; 5362 (duplex).

2. “Stab” type connections are not approved for use.

2.3 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).

b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).

2. "Stab" type connections are not approved for use.

2.4 WALL PLATES

A. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.

2.5 TELECOMMUNICATIONS OUTLET/CONNECTORS

A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-B.1.

B. Legend: Snap-in, clear-label covers and machine-printed paper inserts.

2.6 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.

1. Wiring Devices Connected to Essential Power System: Ivory, unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Building Service Power System: Brown, unless otherwise indicated or required by NFPA 70 or device listing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:

1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint

unless the joint is troweled flush with the face of the wall.

4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:

   a. Cut back and pigtail, or replace all damaged conductors.
   b. Straighten conductors that remain and remove corrosion and foreign matter.
   c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
3. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw. “Stab” type connections are not approved for use.
5. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
6. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
7. Tighten unused terminal screws on the device.
8. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

F. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.

G. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Comply with Section 26 05 53 "Identification for Electrical Systems."

1. Receptacles: Identify panelboard and circuit number from which served. Use hot,

stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
   1. Test Instruments: Use instruments that comply with UL 1436.
   2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:

   1. Line Voltage: Acceptable range is 105 to 132 V.
   2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
   3. Ground Impedance: Values of up to 2 ohms are acceptable.
   4. Using the test plug, verify that the device and its outlet box are securely mounted.
   5. Correct polarity and grounding.
   6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION 262726

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Non-fusible switches.
3. Molded-case circuit breakers (MCCBs).
4. Enclosures.

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Include evidence of NRTL listing for series rating of installed devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

C. Qualification Data: For qualified testing agency.

D. Field quality-control reports.

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22-degree F and not exceeding 104-degree F.
2. Altitude: Not exceeding 6600 feet.

1.7 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Lugs: Mechanical type, suitable for number, size, and conductor material.
5. Service-Rated Switches: Labeled for use as service equipment.

2.2 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

1. Instantaneous trip.
2. Long- and short-time pickup levels.
3. Long- and short-time time adjustments.
4. Ground-fault pickup level, time delay, and I^2t response.

F. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

C. Install fuses in fusible devices.

D. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

D. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and

circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.

b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.

c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

E. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION 262816

SECTION 262913 - ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes the following enclosed controllers rated 600 V and less:

1. Across the line, manual and magnetic controllers.

B. Related Section:

1. Division 26 Section "Variable-Frequency Motor Controllers" for general-purpose, ac, adjustable-frequency, pulse-width-modulated controllers for use on constant torque loads in ranges up to 200 hp.

1.3 SUBMITTALS

A. Product Data: For each type of enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.

B. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.

1. Show tabulations of the following:

a. Each installed unit's type and details.
b. Nameplate legends.
c. Short-circuit current rating of integrated unit.
d. Listed and labeled for integrated short-circuit current (withstand) rating of OCPDs in combination controllers by an NRTL acceptable to authorities having jurisdiction.
e. Features, characteristics, ratings, and factory settings of individual OCPDs in combination controllers.

2. Wiring Diagrams: For power, signal, and control wiring.

C. Qualification Data: For qualified testing agency.

D. Manufacturer Seismic Qualification Certification: Submit certification that enclosed controllers, accessories, and components will withstand IBC seismic design category “C”:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Field quality-control reports.

F. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Routine maintenance requirements for enclosed controllers and installed components.
2. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.

G. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

H. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

1.4 QUALITY ASSURANCE

A. Retain first Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Testing Agency Qualifications: Member company of NETA or an NRTL.
1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NFPA 70, 70E.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive

substances, and physical damage.

B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install temporary electric heating, with at least 250 W per controller.

1.6 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

D. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.

E. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.7 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses for Fused Switches: Equal to 5 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Control Power Fuses: Equal to 5 percent of quantity installed for each size and type, but no fewer than two of each size and type.
3. Indicating Lights: Three of each type and color installed.
4. Auxiliary Contacts: Furnish one spare N.O and N.C. for each size and type of magnetic controller installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.
2. Eaton Corporation; Cutler-Hammer Products.
3. General Electrical Company; GE Industrial Systems.
4. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group.
5. Siemens/Furnas Controls.
6. Square D.

2.2 ACROSS-THE-LINE ENCLOSED CONTROLLERS

A. Combination Magnetic Controller: Factory-assembled combination controller and disconnect switch.

1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by an NRTL.
2. Nonfusible Disconnecting Means: NEMA KS 1, heavy-duty, nonfusible switch.
3. Circuit-Breaker Disconnecting Means: NEMA AB 1, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

2.3 ENCLOSURES

A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.

1. Dry and Clean Indoor Locations: Type 1.
2. Outdoor Locations: Type 3R.
3. Other Wet or Damp Indoor Locations: Type 4.
4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

2.4 ACCESSORIES

A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.

1. Push Buttons, Pilot Lights, and Selector Switches: Heavy duty, oil-tight type.
2. Meters: Panel type, 2-1/2-inch minimum size with 90- or 120-degree scale and plus or minus two percent accuracy. Where indicated, provide selector switches with an off position.

B. N.C. and N.O. auxiliary contact(s).

C. Control Relays: Auxiliary and adjustable time-delay relays.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

B. Seismic Bracing: Comply with IBC seismic category “C” requirements.

C. Install fuses in each fusible-switch enclosed controller.

3.3 IDENTIFICATION

A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

1. Label each enclosure with engraved nameplate.

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers and remote devices. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control selection devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
2. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 CONNECTIONS

A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

2. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

3.7 ADJUSTING

A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

3.8 DEMONSTRATION

A. Manufacturer's maintenance personnel to adjust, operate, and maintain enclosed controllers.

END OF SECTION 262913

SECTION 262923 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes separately enclosed, pre-assembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. CE: Conformite Europeene (European Compliance).

C. CPT: Control power transformer.

D. EMI: Electromagnetic interference.

E. IGBT: Insulated-gate bipolar transistor.

F. LAN: Local area network.

G. LED: Light-emitting diode.

H. MCP: Motor-circuit protector.

I. NC: Normally closed.

J. NO: Normally open.

K. OCPD: Overcurrent protective device.

L. PCC: Point of common coupling.

M. PID: Control action, proportional plus integral plus derivative.

N. PWM: Pulse-width modulated.

O. RFI: Radio-frequency interference.

P. TDD: Total demand (harmonic current) distortion.

Q. THD(V): Total harmonic voltage demand.

R. VFC: Variable-frequency motor controller, or Variable Frequency Drive, (VFD).

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: VFCs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.5 SUBMITTALS

A. Product Data: For each type and rating of VFC indicated. Include features, performance, electrical ratings, operating characteristics, shipping and operating weights, and furnished specialties and accessories.

B. Shop Drawings: For each VFC indicated. Include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.

   1. Show tabulations of installed devices, equipment features, and ratings. Include the following:

      a. Each installed unit's type and details.
      b. Factory-installed devices.
      c. Enclosure types and details.
      d. Nameplate legends.
      e. Short-circuit current (withstand) rating of enclosed unit.
      f. Features, characteristics, ratings, and factory settings of each VFC and installed devices.
      g. Specified modifications.

   2. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring.

C. Harmonic Analysis Study and Report: Comply with IEEE 399 and NETA Acceptance Testing Specification; identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system. Analyze possible operating scenarios, including recommendations for VFC input filtering to limit TDD and THD(V) at each VFC to specified levels.

D. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required ventilation spaces above and around VFCs. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

E. Qualification Data: For qualified testing agency.

F. Seismic Qualification Certificates: For VFCs, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based, and their installation requirements.

G. Product Certificates: For each VFC, from manufacturer.

H. Source quality-control reports.

I. Field quality-control reports.

J. Operation and Maintenance Data: For VFCs to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and MCP trip settings.
2. Manufacturer's written instructions for setting field-adjustable overload relays.
3. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
4. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

K. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.

L. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NFPA 70, 70E.

D. IEEE Compliance: Fabricate and test VFC according to IEEE 344 to withstand IBC seismic

design category “C” forces."

1.7 DELIVERY, STORAGE, AND HANDLING

A. To the greatest extent possible, do not deliver equipment to the site until it is needed. On-site storage of equipment and materiel is to be actively avoided.
B. Equipment shall be protected from damage and stored in a dry location from the time of site delivery.
C. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and install temporary electric heating, with at least 250 W per controller.
D. Conduct routine inspections of stored equipment to check equipment condition.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than 0 deg F and not exceeding 114 deg F.
2. Ambient Storage Temperature: Not less than minus 4 deg F and not exceeding 140 deg F.
3. Humidity: Less than 95 percent (condensing).
4. Altitude: Not exceeding 4500 feet.

B. Interruption of Existing Electrical Systems: Do not interrupt electrical systems in facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify COR no fewer than 14 days in advance of proposed interruption of electrical systems.
2. Indicate method of providing temporary electrical service.
3. Do not proceed with interruption of electrical systems without COR’s written permission.
4. Comply with NFPA 70E.
5. Comply with FAA Lock-Out/Tag-Out protocols.
6. Only designated ESU personnel may energize or de-energize switches, circuits, valves, hydraulic cylinders, or other devices that store electrical or potential or energy.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items.

1.9 COORDINATION

A. Coordinate features of motors, load characteristics, installed units, and accessory devices to be compatible with the following:

1. Torque, speed, and horsepower requirements of the load.
2. Ratings and characteristics of supply circuit and required control sequence.

3. Ambient and environmental conditions of installation location.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

1.11 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
3. Indicating Lights: Two of each type and color installed.
4. Auxiliary Contacts: Furnish one spare for each size and type of magnetic controller installed.
5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB.
2. Baldor Electric Company.
3. Danfoss Inc.; Danfoss Drives Div.
4. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
5. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
6. Rockwell Automation, Inc.; Allen-Bradley Brand.
7. Siemens Energy & Automation, Inc.
8. Square D; a brand of Schneider Electric.

B. General Requirements for VFCs: Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.

C. Application: Constant torque and variable torque.

D. VFC Description: Variable-frequency power converter (rectifier, dc bus, and IGBT, PWM inverter) factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.

1. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

E. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

F. Output Rating: Three-phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

G. Unit Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
2. Input AC Voltage Unbalance: Not exceeding 3 percent.
3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
4. Minimum Efficiency: 96 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or speed condition.
6. Minimum Short-Circuit Current (Withstand) Rating: 10 kA.
7. Ambient Temperature Rating: Not less than 14 deg F and not exceeding 104 deg F.
8. Ambient Storage Temperature Rating: Not less than minus 4 deg F and not exceeding 140 deg F.
9. Humidity Rating: Less than 95 percent (noncondensing).
10. Altitude Rating: Not exceeding 3300 feet.
11. Vibration Withstand: Comply with IEC 60068-2-6.
12. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
13. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
14. Speed Regulation: Plus or minus 5 percent.
15. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
16. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

H. Inverter Logic: Microprocessor based, 16 bit, isolated from all power circuits.

I. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1

speed range.

1. Signal: Electrical.

J. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 0.1 to 999.9 seconds.
4. Deceleration: 0.1 to 999.9 seconds.
5. Current Limit: 30 to minimum of 150 percent of maximum rating.

K. Self-Protection and Reliability Features:

1. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
3. Enable/Disable from Local Disconnecting Means: An input to accept an auxiliary contact from the disconnecting means located at the motor, intended to instruct the VFD to conduct to perform a controlled shutdown prior to the motor leads being opened. This is to prevent damage to the VFD caused by the motor leads being disconnected while in operation. Contact may be normally open or normally closed, depending on the requirements of the VFD's input signal requirements.
4. Under- and overvoltage trips.
5. Inverter overcurrent trips.
6. VFC and Motor Overload/Over temperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC over temperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
7. Critical frequency rejection, with three selectable, adjustable deadbands.
8. Instantaneous line-to-line and line-to-ground overcurrent trips.
9. Loss-of-phase protection.
10. Reverse-phase protection.
11. Short-circuit protection.
12. Motor over temperature fault.

L. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

M. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.

N. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

O. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

P. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

Q. Integral Input Disconnecting Means and OCPD: NEMA AB 1, instantaneous-trip circuit breaker with pad-lockable, door-mounted handle mechanism.
1. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.
2. NO alarm contact that operates only when circuit breaker has tripped.

2.2 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicators displaying the following conditions:

1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.

B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.

a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.

C. Historical Logging Information and Displays:

1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last four faults with time and date stamp for each.

D. Indicating Devices: Digital display and additional readout devices as required, mounted flush in VFC door and connected to display VFC parameters including, but not limited to:

1. Output frequency (Hz).

2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (V dc).
9. Set point frequency (Hz).
10. Motor output voltage (V ac).

E. Control Signal Interfaces:

1. Electric Input Signal Interface:

   a. A minimum of two> programmable analog inputs: 0- to 10-V dc.
   b. A minimum of six multifunction programmable digital inputs.

2. Pneumatic Input Signal Interface: 3 to 15 psig.
3. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems:

   a. 0- to 10-V dc.
   b. 4- to 20-mA dc.
   c. Potentiometer using up/down digital inputs.
   d. Fixed frequencies using digital inputs.

4. Output Signal Interface: A minimum of one programmable analog output signal(s) (0- to 10-V dc), which can be configured for any of the following:

   a. Output frequency (Hz).
   b. Output current (load).
   c. DC-link voltage (V dc).
   d. Motor torque (percent).
   e. Motor speed (rpm).
   f. Set point frequency (Hz).

5. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:

   a. Motor running.
   b. Set point speed reached.
   c. Fault and warning indication (over temperature or overcurrent).
   d. PID high- or low-speed limits reached.

F. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display VFC status and alarms. Allows VFC to be used with an external system within a multidrop LAN configuration; settings retained within VFC's nonvolatile memory.

1. Network Communications Ports: Ethernet and RS-422/485.
2. Embedded BAS Protocols for Network Communications: ASHRAE 135 BACnet protocols accessible via the communications ports.

3. Installed BAS is Schneider Electric StruxureWare hardware and software architecture.

2.3 LINE CONDITIONING AND FILTERING

A. Input Line Conditioning: Based on the harmonic analysis study and report, provide input filtering, as required, to limit TDD at input terminals of all VFCs to less than 5 percent and THD(V) to 5 percent.

B. Input Line Conditioning: Based on the harmonic analysis study and report, provide input filtering, as required, to limit TDD and THD(V) at the defined PCC per IEEE 519.

C. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.

2.4 BYPASS SYSTEMS

A. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.

B. Bypass Mode: Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic control system feedback.

C. Bypass Controller: Three-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter input and output and permit safe testing and troubleshooting of the power converter, both energized and de-energized, while motor is operating in bypass mode.

1. Bypass Contactor: Load-break, NEMA-rated contactor.
2. Input and Output Isolating Contactors: Non-load-break, NEMA-rated contactors.
3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

D. Bypass Contactor Configuration: Full-voltage (across-the-line).

1. NORMAL/BYPASS selector switch.
2. HAND/OFF/AUTO selector switch.
3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.
4. Contactor Coils: Pressure-encapsulated type with coil transient suppressors.
    a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
    b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
5. Control Circuits: 120 V ac; obtained from integral CPT, with primary and secondary

fuses, with control power source of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.

a. CPT Spare Capacity: 50 VA.

6. Overload Relays: NEMA ICS 2.

a. Melting-Alloy Overload Relays:

1) Inverse-time-current characteristic.
2) Class 20 tripping characteristic.
3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

b. Bimetallic Overload Relays:

1) Inverse-time-current characteristic.
2) Class 20 tripping characteristic.
3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
4) Ambient compensated.
5) Automatic resetting.

c. Solid-State Overload Relays:

1) Switch or dial selectable for motor-running overload protection.
2) Sensors in each phase.
3) Class 20 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
4) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
5) Analog communication module.

d. NO isolated overload alarm contact.
e. External overload reset push button.

2.5 OPTIONAL FEATURES

A. Damper control circuit with end of travel feedback capability.

B. Sleep Function: Senses a minimal deviation of a feedback signal and stops the motor. On an increase in speed-command signal deviation, VFC resumes normal operation.

C. Motor Preheat Function: Preheats motor when idle to prevent moisture accumulation in the motor.

D. Firefighter's Override (Smoke Purge) Input: On a remote contact closure from the firefighter's control station, this password-protected input:

1. Overrides all other local and external inputs (analog/digital, serial communication, and all keypad commands).
2. Forces VFC to transfer to Bypass Mode and operate motor at full speed.

3. Causes display of Override Mode on the VFC display.
4. Reset VFC to normal operation on removal of override signal automatically.

E. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.

F. Remote digital operator kit.

G. Communication Port: RS-232 port, RS-485 port, Ethernet port, USB 2.0 port, or equivalent connection capable of connecting a printer and a notebook computer.

2.6 ENCLOSURES

A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.

1. Dry and Clean Indoor Locations: Type 1.
2. Outdoor Locations: Type 4X.
3. Other Wet or Damp Indoor Locations: Type 4X.
4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFC as "Plenum Rated."

2.7 ACCESSORIES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.

1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, gloved hand type.

a. Push Buttons: Covered types; momentary.
b. Pilot Lights: LED types; green; push to test.
c. Selector Switches: Rotary type.
d. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

B. NO bypass contactor auxiliary contact(s).

C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.

E. Supplemental Digital Meters:

1. Elapsed-time meter.
2. Kilowatt meter.
3. Kilowatt-hour meter.

F. Cooling Fan and Exhaust System: For NEMA 250, Type 1; UL 508 component recognized: Supply fan, with stainless steel intake and exhaust grills; 120 V ac; obtained from integral CPT.

G. Spare control-wiring terminal blocks**;** unwired.

2.8 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.

1. Test each VFC while connected to its specified motor.
2. Verification of Performance: Rate VFCs according to operation of functions and features specified.

B. VFCs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 HARMONIC ANALYSIS STUDY

A. Perform a harmonic analysis study to identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system. Analyze possible operating scenarios, including recommendations for VFC input filtering to limit TDD and THD(V) at each VFC to specified levels.

B. Prepare a harmonic analysis study and report complying with IEEE 399 and NETA Acceptance Testing Specification.

C. Comply with IEEE 519.

3.3 INSTALLATION

A. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Wall-Mounting Controllers: Install VFCs on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

C. Floor-Mounting Controllers: Install VFCs on 4-inch nominal thickness concrete base. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Seismic Bracing: Comply with IBC design seismic category “C” requirements.."

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

F. Install fuses in each fusible-switch VFC.

G. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

H. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

I. Comply with NECA 1.

J. For VFD cable type, refer to the drawing for information.

3.4 IDENTIFICATION

A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

2. Label each VFC with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units or in other location readily visible from VFC units.

3.5 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic control devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic control devices that have no safety functions when switches are in manual-control position.
2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Acceptance Testing Preparation:

1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

E. Tests and Inspections:

1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated

voltages. If outside this range for any motor, notify COR before starting the motor(s).

5. Test each motor for proper phase rotation.
6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each VFC. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each VFC 11 months after date of Substantial Completion.
    c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

F. VFCs will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.8 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify COR before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

E. Set field-adjustable circuit-breaker trip ranges.

F. Set field-adjustable pressure switches.

3.9 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

END OF SECTION 262923

SECTION 264113 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes lightning protection for building site components.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For air terminals and mounting accessories.

1. Layout of the lightning protection system, along with details of the components to be used in the installation.
2. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.

C. Qualification Data: For qualified Installer and manufacturer. Include data on listing or certification by UL.

D. Certification, signed by Contractor, that roof adhesive is approved by manufacturer of roofing material.

E. Field quality-control reports.

F. Other Informational Submittals: Plans showing locations of grounding features, including the following:

1. Ground rods.
2. Ground loop electrode / conductor (Counterpoise).

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Certified by UL as a Master Installer/Designer, trained and approved for installation of units required for this Project.

B. System Certificate:

1. UL Master Label.
2. UL Master Label Recertification.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

1.5 COORDINATION

A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.

B. Coordinate installation of air terminals attached to handrails with cooling tower manufacturer and Installer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Harger Lightning Protection, Inc.
2. Heary Bros. Lightning Protection Co. Inc.
3. Independent Protection Co.
4. Thompson Lightning Protection, Inc.

2.2 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. Comply with UL 96 and NFPA 780.

B. Roof-Mounted Air Terminals: NFPA 780, Class II, aluminum unless otherwise indicated.

1. Air Terminals More than 24 Inches long: With brace attached to the terminal at not less than half the height of the terminal.

C. Main and Bonding Conductors: Class II, Aluminum.

D. Ground Loop Conductor (Counterpoise): #4/0 Bare Copper.

E. Ground Rods: Copper-clad steel; 3/4 inch in diameter by 10 feet long.

F. Heavy-Duty, Stack-Mounted, Lightning Protection Components: Solid copper.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lightning protection components and systems according to UL 96A and NFPA 780.

B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends.

C. Conceal the following conductors:

1. System conductors.
2. Down conductors.
3. Interior conductors.
4. Conductors within normal view of exterior locations at grade within 200 feet of building.

D. Cable Connections: Use exothermic-welded connections for all conductor splices and connections between conductors and other components.

1. Exception: In single-ply membrane roofing, exothermic-welded connections may be used only below the roof level.

E. Air Terminals on Single-Ply Membrane Roofing: Comply with roofing membrane and adhesive manufacturer's written instructions.

F. Bond extremities of vertical metal bodies exceeding 50 feet in length to lightning protection components.

G. Ground Loop: Install ground-level, potential equalization conductor and extend around the perimeter of structure.

1. Bury ground ring not less than 24 inches from building foundation.
2. Bond ground terminals to the ground loop.
3. Bond grounded building systems to the ground loop conductor.

3.2 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.
B. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

3.3 FIELD QUALITY CONTROL

A. Notify COR at least 48 hours in advance of inspection before concealing lightning protection components.

B. UL Inspection: Meet requirements to obtain a UL Master Label for system.

END OF SECTION 264113

SECTION 265100 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Interior lighting luminaires, lamps, and ballasts.
2. Emergency lighting units.
3. Exit signs.
4. Luminaire supports.

B. Related Sections:

1. Division 26 Section 26 09 23 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

A. BF: Ballast factor.

B. CRI: Color-rendering index.

C. LER: Luminaire efficacy rating.

D. Lumen: Measured output of lamp and luminaire, or both.

E. Luminaire: Complete luminaire, including ballast housing if provided.

1.4 SUBMITTALS

A. Product Data: For each type of luminaire, arranged in order of luminaire designation. Include data on features, accessories, finishes, and the following:

1. Physical description of luminaire including dimensions.
2. Emergency lighting units including battery and charger.
3. Ballast, including BF.

4. Energy-efficiency data.
5. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.
6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the luminaire as applied in this Project.

    a. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Shop Drawings: For nonstandard or custom luminaires. Include plans, elevations, sections, details, and attachments to other work.

    1. Wiring Diagrams: For power, signal, and control wiring.

C. Qualification Data: For qualified agencies providing photometric data for luminaires.

D. Field quality-control reports.

E. Operation and Maintenance Data: For lighting equipment and luminaires to include in emergency, operation, and maintenance manuals.

F. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for class and division of hazard by FM Global.

1.6 COORDINATION

A. Coordinate layout and installation of luminaires and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire- suppression system, and partition assemblies.

1.7 WARRANTY

A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace

components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
2. Warranty Period for Emergency Fluorescent Ballast and Self-Powered Exit Sign Batteries: 7 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.

1.8 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: 1 for every 10 of each type and rating installed. Furnish at least one of each type.
2. Plastic Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
3. Fluorescent-luminaire-mounted, emergency battery pack: One for every 25 emergency lighting units.
4. Ballasts: One for every 100 of each type and rating installed. Furnish at least one of each type.
5. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide product indicated on Drawings.

2.2 GENERAL REQUIREMENTS FOR LUMINAIRES AND COMPONENTS

A. Recessed Luminaires: Comply with NEMA LE 4 for ceiling compatibility for recessed luminaires.

B. Fluorescent Luminaires: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components:
Steel unless otherwise indicated.
Form and support to prevent warping and sagging.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to

prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

F. Diffusers and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

   a. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
   b. UV stabilized.

2. Glass: Annealed crystal glass unless otherwise indicated.

G. Electromagnetic-Interference Filters: Factory installed to suppress conducted electromagnetic interference as required by FCC Title 47, Part 15. Fabricate luminaires with one filter on each ballast indicated to require a filter.

H. Air-Handling Fluorescent Luminaires: For use with plenum ceiling for air return and heat extraction and for attaching an air-diffuser-boot assembly specified in Division 23 Section "Diffusers, Registers, and Grilles."

1. Air-Supply Units: Slots in one or both side trims join with air-diffuser-boot assemblies.
2. Heat-Removal Units: Air path leads through lamp cavity.
3. Combination Heat-Removal and Air-Supply Unit: Heat is removed through lamp cavity at both ends of the luminaire door with air supply same as for air-supply units.
4. Dampers: Operable from outside luminaire for control of return-air volume.
5. Static Fixture: Air-supply slots are blanked off, and luminaire appearance matches active units.

2.1 LED LUMINAIRES

A. General Requirements

1. Each luminaire shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete luminaire shall consist of a housing, LED array, and electronic driver (power supply).
2. Each luminaire shall be rated for a minimum operational life of 50,000 hours.
3. Each luminaire shall be designed to operate at an average nighttime operating temperature of 50°F.
4. Each luminaire shall meet all parameters of this specification throughout the minimum operational life when operated at the average nighttime operating temperature.
5. Each luminaire shall be defined by the application (additional applications may be added as needed)
6. The individual LEDs shall be connected such that a catastrophic loss or the failure of one LED will not result in the loss of the entire luminaire.
7. Luminaires designated for wet or humid locations shall be listed with

Underwriters Laboratory, Inc. under UL 1598 for luminaires in wet locations, or an equivalent standard from a recognized testing laboratory.

8. Luminaires subject to compliance with requirements of 49 CFR FCC Part 15, Class A. Provide product data for each product proposed.

B. Technical Requirements

1. Power Consumption: Maximum power consumption allowed for the luminaire shall be by application.
2. Maximum power consumption shall comply with the Energy Independence and Security Act of 2007 (EISA 2007).
3. Operation Voltage
   a. The luminaire shall operate from a 60 HZ ±3 HZ AC power source. The fluctuations of line voltage shall have no visible effect on the luminous output.
   b. The operating voltage may range from 120 VAC to 480 VAC. The luminaire may operate over the entire voltage range or the voltage range may be selected from the two following options.
   c. The luminaire shall operate over a typical voltage range of 120 VAC to 277 VAC.
4. Power Factor: The luminaire shall have a power factor of 0.90 or greater.
5. THD: Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 20 percent.
6. Operational Performance: The LED circuitry shall prevent perceptible flicker to the unaided eye over the voltage range specified.
7. Compatibility: The luminaire shall be operationally compatible with currently used lighting control systems and photoelectric controls.
8. RF Interference: The luminaires and associated on-board circuitry shall meet Class A emission limits referred in Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 regulations concerning the emission of electronic noise.
9. Illuminance:
   a. The luminaire shall have a correlated color temperature (CCT) range of 3,500K to 6,500K.
   b. The color rendition index (CRI) shall be 65 or greater.

C. Physical and Mechanical Requirements

1. The luminaire shall be a single, self-contained device, not requiring on-site assembly for installation. The power supply for the luminaire shall be integral to the unit.
2. The housing shall be designed to prevent the buildup of water on the top of the housing.
3. Exposed heat sink fins shall be oriented so that water can freely run off the luminaire, and carry dust and other accumulated debris away from the unit.
4.
5. The optical assembly of the luminaire shall be protected against dust and moisture intrusion.

6. The electronics/power supply enclosure shall be protected against dust and moisture intrusion.

7. The power supply shall be contained inside the luminaire.

8. The power supply shall be rated for use in the appropriate location, e.g. wet location. The power supply shall be rated for a minimum life expectancy equal to or greater than the minimum operation life of the luminaire.

9. The power supply case temperature shall have a self rise of 45° F or less above ambient temperature in free air with no additional heat sinks.

D. Luminaire Identification

1. Each luminaire shall have the manufacturer's name, trademark, model number, serial number, date of manufacture (month-year), and lot number as identification permanently marked inside the each unit and the outside of each packaging box.

2. The following operating characteristics shall be permanently marked inside each unit: rated voltage and rated power in Watts and Volt-Ampere.

2.3 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction. LED Exit sign light fixture shall meet the Class A specification limits defined in FCC Title 47, Part 15, Subpart B.

B. Internally Lighted Signs:

1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.

   a. Battery: Sealed, maintenance-free, nickel-cadmium type.
   b. Charger: Fully automatic, solid-state type with sealed transfer relay.
   c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
   d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
   e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

2.4 LUMINAIRE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel-

and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single luminaire. Finish same as luminaire.

D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.

1. Wire rope with self-locking fastener may be used in lieu of hanger wire.

E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.

1. Stainless steel wire rope with stainless steel self-locking fastener may be used in lieu of hanger wire.

F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

G. Hook Hangers: Integrated assembly matched to luminaire and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Luminaires:

1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
2. Install lamps in each luminaire.

B. Remote Mounting of Ballasts: Distance between the ballast and luminaire shall not exceed that recommended by ballast manufacturer. Verify, with ballast manufacturers, maximum distance between ballast and luminaire.

C. Lay-in Ceiling Luminaires Supports: Use grid as a support element.

1. Install ceiling support system rods or wires**,** independent of the ceiling suspension devices, for each luminaire. Locate not more than 6 inches from luminaire corners.
2. Support Clips: Fasten to luminaires and to ceiling grid members at or near each luminaire corner with clips that are UL listed for the application.
3. Luminaires of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support luminaires independently with at least two 3/4- inch metal channels spanning and secured to ceiling tees.
4. Install at least four independent support wires from structure to a tab on luminaire. Wire shall have breaking strength of the weight of luminaire at a safety factor of 3.

D. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.

2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hanger

3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis, including one at each end.
4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.

E. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

2.5 LED LAMPS

2x4 LED prismatic troffer fixtures shall compliant to FCC Part 15, Subpart BClassA.

High efficiency acrylic center lens features linear prisms.
High performance reflector and 60,000 hour LEDs.
Long life LEDs (at 80% lumen maintenance).
Color Rendering Index is greater than 80.
Input Voltage range 120-277 vac.
Power Factor is greater than 0.90 at full load.
Harmonic Distortion: THD < 20% at full load.
Optional Emergency Battery Pack.
Suitable for dry and wet locations.
Color Temperature: 4000 K
Test UL 8750 standard
Five Year Warranty.

1x4 LED Wrap:

a. Electrical System: Integral, high efficiency driver. Power factor is greater than 0.9. Total Harmonic Distortion is less than 20%. Input Voltage is 120-277 volt, 60 Hz. Input Power: stays constant over life.

b. Optical System: Diffuse optical grade acrylic arc lens with matte finish. Provide 4.7% up-light.

c. Luminaire is post painted with a soft matte white paint. Steel frame provide strength and uniformity. Suitable for mounting in any orientation for uplight, downlight and wall. Suitable for through wiring.

d. Lifetime: 100000 hours at 25 Celsius degrees; Color temperature: 3000K-4000K. CRI: 80.

e. Others: Five Year Warranty; Battery Pack: minimum 90 minutes. Suitable for damp location. Design for indoor use. Mounting: Surface mount or suspended

Meets FCC Part 15, Subpart B, Class A standard. UL listed.

3.2 FIELD QUALITY CONTROL

F. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

G. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.2 STARTUP SERVICE

A. Burn-in all lamps that require specific aging period to operate properly for at least 100 hours at full voltage prior to occupancy by Owner.

END OF SECTION 265100

SECTION 265600 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Exterior luminaires with lamps and ballasts.
2. Luminaire-mounted photoelectric relays.

B. Related Sections:

1. Division 26 Section "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color-rendering index.

C. HID: High-intensity discharge.

D. LER: Luminaire efficacy rating.

E. LED: Light Emitting Diode

F. Luminaire: Complete lighting fixture, including ballast housing if provided.

1.4 SUBMITTALS

A. Product Data: For each luminaire, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:

1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
2. Details of attaching luminaires and accessories.
3. Details of installation and construction.
4. Luminaire materials.

5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.

    a. Manufacturer Certified Data: Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

6. Photoelectric relays.
7. Ballasts, including energy-efficiency data.
8. Lamps, including life, output, CCT, CRI, lumens, and energy-efficiency data.
9. Materials, dimensions, and finishes of poles.
10. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
2. Wiring Diagrams: For power, signal, and control wiring.

C. Field quality-control reports.

D. Operation and Maintenance Data: For luminaires to include in emergency, operation, and maintenance manuals.

E. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with IEEE C2, "National Electrical Safety Code."

C. Comply with NFPA 70.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

1. Warranty Period for Luminaires: Five years from date of Substantial Completion.

1.7 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: One for every 50 of each type and rating installed. Furnish at least one of each type.
2. Glass and Plastic Lenses, Covers, and Other Optical Parts: One for every 50 of each type and rating installed. Furnish at least one of each type.
3. Ballasts: One for every 50 of each type and rating installed. Furnish at least one of each type.
4. Globes and Guards: One for every 25 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide product indicated on Drawings.

2.2 GENERAL REQUIREMENTS FOR LUMINAIRES

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

B. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.

E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

G. Exposed Hardware Material: Stainless steel.

H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

J. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

M. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

a. Color: As indicated on drawings.

2.3 LED LUMINAIRES

A. General Requirements

1. Each luminaire shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete luminaire shall consist of a housing, LED array, and electronic driver (power supply).
2. Each luminaire shall be rated for a minimum operational life of 50,000 hours.
3. Each luminaire shall be designed to operate at an average nighttime operating temperature of 50°F.
4. Each luminaire shall meet all parameters of this specification throughout the minimum operational life when operated at the average nighttime operating

temperature.

5. Each luminaire shall be defined by the application (additional applications may be added as needed)

6. The individual LEDs shall be connected such that a catastrophic loss or the failure of one LED will not result in the loss of the entire luminaire.
7. Luminaires designated for wet or humid locations shall be listed with Underwriters Laboratory, Inc. under UL 1598 for luminaires in wet locations, or an equivalent standard from a recognized testing laboratory.

B. Technical Requirements

1. Power Consumption: Maximum power consumption allowed for the luminaire shall be by application.
2. Maximum power consumption shall comply with the Energy Independence and Security Act of 2007 (EISA 2007).
3. Operation Voltage
   a. The luminaire shall operate from a 60 HZ ±3 HZ AC power source. The fluctuations of line voltage shall have no visible effect on the luminous output.
   b. The operating voltage may range from 120 VAC to 480 VAC. The luminaire may operate over the entire voltage range or the voltage range may be selected from the two following options.
   c. The luminaire shall operate over a typical voltage range of 120 VAC to 277 VAC.
4. Power Factor: The luminaire shall have a power factor of 0.90 or greater.
5. THD: Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 20 percent.
6. Operational Performance:
   a. The LED circuitry shall prevent perceptible flicker to the unaided eye over the voltage range specified.
   b. A motion detecting sensor to dim the unit when persons are not present is required where light pollution will adversely impact neighboring residents or businesses.
7. Compatibility: The luminaire shall be operationally compatible with currently used lighting control systems and photoelectric controls.
8. RF Interference: The luminaires and associated on-board circuitry shall meet Class A emission limits referred in Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 regulations concerning the emission of electronic noise.
9. Illuminance:
   a. The luminaire shall have a correlated color temperature (CCT) range of 3,500K to 6,500K.
   b. The color rendition index (CRI) shall be 65 or greater.

C. Physical and Mechanical Requirements

1. The luminaire shall be a single, self-contained device, not requiring on-site assembly for installation. The power supply for the luminaire shall be integral to the unit.
2. The housing shall be designed to prevent the buildup of water on the top of the housing.

3. Exposed heat sink fins shall be oriented so that water can freely run off the luminaire, and carry dust and other accumulated debris away from the unit.
4. The optical assembly of the luminaire shall be protected against dust and moisture intrusion.
5. The electronics/power supply enclosure shall be protected against dust and moisture intrusion.
6. The power supply shall be contained inside the luminaire.
7. The power supply shall be rated for use in the appropriate location, e.g. wet location. The power supply shall be rated for a minimum life expectancy equal to or greater than the minimum operation life of the luminaire.
8. The power supply case temperature shall have a self rise of 45° F or less above ambient temperature in free air with no additional heat sinks.

D. Luminaire Identification

1. Each luminaire shall have the manufacturer's name, trademark, model number, serial number, date of manufacture (month-year), and lot number as identification permanently marked inside each unit and the outside of each packaging box.
2. The following operating characteristics shall be permanently marked inside each unit: rated voltage and rated power in Watts and Volt-Ampere.

2.4 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS

A. Comply with UL 773 or UL 773A.

B. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc and off at 4.5 to 10 fc with 15-second minimum time delay. Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff.

1. Relay with locking-type receptacle shall comply with ANSI C136.10.

Adjustable window slide for adjusting on-off set points.

2.5 LED WALL PACK LIGHT

RoHS Compliant, listed for wet location, DLC listed, ETL Listed, IP65, UL Listed.
Corrosion resistant die cast aluminum housing with bronze powder coat finish over Chromate conversion coating.
Mounts on an electrical box or directly to surface.
Rated Life: 100000 hours
Style: LED cutoff wall packs
Light Source: 21 watts LED; equivalence 100 watts Metal Halite
Light Source Lumens: 3129
Color Temperature: 4000K; Color Rendering Index (CRI): 70
Aluminum reflector, high impact and heat resistant tempered glass lens.
Voltage: 120v -277v; Ballast/Driver: Electronic
Five Year Warranty, Optional 10 years.

Photocell option

2.5 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

A. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

B. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

1. Materials: Shall not cause galvanic action at contact points.
2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
3. Anchor-Bolt Template: Plywood or steel.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

A. Install lamps in each luminaire.

B. Fasten luminaire to indicated structural supports.

1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

3.2 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.3 GROUNDING

A. Ground support structures according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
1. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

3.4 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

1. Verify operation of photoelectric controls.

C. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 265600

SECTION 28 31 00 - FIRE DETECTION AND ALARM

PART 1 - GENERAL

1.1 SUMMARY

A. This specification section provides the requirements for expanding and modifying the existing Notifier NFS2-3030 addressable fire alarm system and serving the Control Wing Basement Area to coordinate with any potential impact of architectural, mechanical or electrical changes in the Host Computer Room B134, Host Mechanical Room B119, the Electronic Equipment Room B120A, and the NEOF Area (Rooms B81, B86 and B88). Existing devices may be reused if Contractor will provide a warranty of at least one (1) year past the manufacturer's warranty. The work includes removing all wall mounted fire alarm appliances (notification or detection devices) within the Host Computer Room. The acoustical wall panels will be replaced in kind. Wall mounted appliances shall be re-installed after new acoustical panels have been provided. Devices in the Mezzanine will be removed in their entirety. Slab mounted smoke detectors shall be left in place, protected during demolition and construction activities, and additional detectors shall be provided in all areas of work as required by NFPA 72 and as shown on the drawings. Notification devices shall be as required by NFPA 72 whether shown on the drawings or not, in all areas of work.

1. The system shall be a complete and fully operational fire detection and alarm system designed, engineered, furnished, installed, and tested in accordance with NFPA 72, International Building Code, this Section, and the accompanying drawings. Contractor submitted shop drawings and design calculations shall be signed and sealed by a registered Professional Engineer in Fire Protection or certified National Institute for Certification in Engineering Technologies (NICET) Level IV Fire Alarm Technician. The design shown on the plans is schematic only, intended as a general guide to the Contractor.

2. System includes but is not limited to the Fire Alarm Control Panel (FACP) interface boards, FACP power supplies, FACP batteries, smoke detectors, duct smoke detectors, manual pull stations, addressable interface and control devices, relays, sprinkler system supervision, audible and visual alarms, wiring, conduits, signs, and appurtenances.

3. The system is configured with both Stage I and Stage II alarm notification appliances. Stage I notification alarm appliances consist of ceiling mounted red strobes in the DSR Control Room. Stage I circuits are dedicated to the Stage I notification devices in the DSR, and are routed within the boundaries of the fire resistance rated walls of the DSR Control Room.

4. Provide, configure and activate the alarm verification feature for new analog smoke detectors connected to the FACP.

5. Remove the existing fire alarm equipment as indicated on drawings. Also, remove wiring and exposed conduit associated with the removed equipment. The equipment shall be disposed of in accordance with the manufacturer's disposal procedures. Remove

associated wiring. Conduit that is concealed in concrete or in partitions shall be abandoned in place.

6. The existing Fire Alarm Control Panel serves other areas of this building. The fire alarm system must remain in service during all phases of abatement, demolition and construction.

1.2 AIR TRAFFIC CONTROL EQUIPMENT RESTRICTIONS

A. Job conditions: Do not permit interference with the air traffic control function at the ARTCC. Schedule and plan work to permit normal facility operations to continue with minimum disruption. Access to the facility shall be kept unobstructed at all times. If interference with the existing facility operations seems to be unavoidable, advise the Contracting Officer's Representative at least ten (10) days prior to such interference. Proceed as directed by the COR.

B. Equipment Shutdown: Each Air Route Traffic Control Center (ARTCC) maintains air traffic control continuously without shutdown. Various techniques are employed to achieve maximum system availability. Mechanical and electrical systems in direct support of air traffic operation and environmental systems have redundant configurations. Shutdown of equipment shall be scheduled with the COR at least ten (10) days prior to the contractor's need. The reliability of mechanical and electrical systems is compromised when redundant equipment is not available. Every effort will be made by the Government to allow work to be accomplished during the Contractor's normal working hours; however, the COR may require that certain equipment be shut down only during off normal hours and be restored to service immediately after this period. Government personnel shall accomplish shutdown and restoration of equipment.

C. Interruptions of the existing addressable fire alarm system shall be requested in writing to the COR at least five (5) days prior to the Contractor's needs. The fire alarm system, or portions thereof, shall only be taken out of service during off-normal hours, for intervals of no more than four (4) hours out of every eight (8) hours. The COR shall be contacted if these criteria cannot be met, so alternate protection can be provided.

1.3 RELATED SECTIONS

A. Section 01 78 23, "Operations and Maintenance Data."

B. Section 01 79 00, "Demonstration and Training."

C. Section 07 84 13, "Penetration Firestopping" for fire resistance rated construction firestopping.

D. Section 21 13 13, "Fire Suppression Systems" for coordinating sprinkler system alarm, trouble, and valve tamper switch monitoring requirements that relate to this Section.

E. Division 26 for electrical requirements for this Section including but not limited to Section 26 05 19, "Low Voltage Electrical Power Conductors and Cables" for power wiring requirements.

1.4 REFERENCE STANDARDS

A. Unless a specific edition is included, the current issues of the following documents, in effect on the date of the invitation for bid, form a part of this specification and are applicable to the extent specified herein. NFPA Appendices shall be considered mandatory for the purposes of this specification. In referenced NFPA publications, the advisory provisions shall be mandatory, as though the word "shall" had been substituted for "should" wherever it appears.

B. International Code Council

1. International Building Code (IBC) (2015 Edition).
2. International Mechanical Code (IMC) (2015 Edition).

C. Americans with Disabilities Act (ADA)

1. Accessibility Guidelines for Buildings and Facilities.

D. Factory Mutual (FM)

1. Factory Mutual Approval Guide.

E. National Fire Protection Association (NFPA)

1. 13: Installation of Sprinkler Systems (2016 Edition).
2. 51B: Fire Prevention During Welding, Cutting and Other Hot Work (2014 Edition)
3. 70: National Electrical Code (2017 Edition).
4. 72: National Fire Alarm and Signaling Code (2016 Edition).
5. 90A: Installation of Air Conditioning and Ventilating Systems (2015 Edition).

F. Occupational Safety and Health Administration (OSHA)

1. 1910.7 Nationally Recognized Testing Laboratories (NRTL).

G. Underwriters Laboratories (UL)

1. 38: Manually Actuated Signaling Boxes.
2. 268: Smoke Detectors for Fire Protective Signaling Systems.
3. 268A: Smoke Detectors for Duct Applications.
4. 464: Audible Signal Appliances.
5. 864: Control Units for Fire Protective Signaling Systems.
6. 1481: Power Supplies for Fire Protective Signaling Systems.
7. 1971: Signaling Devices for the Hearing Impaired.

H. Electronic Industries Association (EIA)

1. TIA-422: Electrical Characteristics of Balanced Voltage Digital Interface Circuits.

1.5 CONFLICTING REQUIREMENTS

A. In the case of a conflict within this specification, applicable codes, accompanying drawings, and other supplemental specifications, the Contractor shall submit the matter in writing to the COR who will provide written clarification. Alert the COR to any discrepancies found.

1.6 SYSTEM DESCRIPTION

A. Modify the existing fire alarm system as indicated on drawings and as necessary to coordinate with any impacting architectural, mechanical and electrical changes in the Control Wing Basement area. Activate alarms by manual pull stations, smoke detectors, or sprinkler system water flow. Duct smoke detectors shall be configured as supervisory.

B. Major components: Provide the following fire detection and alarm signaling system components:

1. Spot type Smoke detectors;
2. Duct smoke detectors;
3. Addressable control devices;
4. Interconnecting wiring;
5. Conduit;
6. Accessories.

C. Circuit supervision: Provide Class A wiring for signaling line circuits, Class A wiring for initiating device circuits, and Class A wiring for notification appliance circuits per NFPA 72.

D. Programming described in Items E-K is existing and does not require modification and shall be maintained as they are currently programmed and installed.

E. Sequence of Two Stage Alarm Operations (ARTCC)
1. Basic Operation

a. On first alarm signal, initiated from any portion of the facility (exception of detached buildings), ADA audio/visual notification appliances initiate an evacuation signal within the entire facility with the exception of the DSR Control Room. DSR initiates red strobes (on dedicated Class A circuits that are 2-hr separated between legs or are completely contained within the DSR 2-hr envelope, no allowable exceptions for 2-hr separation of DSR, NAC or an SLC, which is controlling NAC operation outside DSR). The FACP LCD shall show pertinent information and the printer shall print status change signal including date and time of occurrence.

b. On second alarm signal in any portion of the facility (exception of detached buildings), ADA audio/visual notification appliances continue throughout the facility.

c. On second alarm within DSR, red strobes deactivate; ADA strobes and chimes activate, ADA audio/visual notification appliances continue throughout the facility. The DACT shall transmit the alarm condition to the Protected Premises Digital Acquisition System at the Central Monitoring Station.

d. Operation of manual station within DSR causes a second-stage alarm (ADA Strobes and Chimes), within DSR at any time.

e. The chimes in DSR silence automatically after 15 seconds of operation or when manually deactivated from within the Control Room (remote annunciator in DSR silenced).

f. Operating the FACP silence switch will deactivate the audio evacuation signal (ADA strobes remain on) within the facility and will deactivate red strobes and/or ADA strobes and chimes (if active) within DSR.

g. In the event of any subsequent alarm (smoke detector, heat detector, pull station, beam detector, VESDA or suppression system) within the facility, the silence function described above will be negated and the system will revert to general alarm sequence of events with ARTCC. In the event of any subsequent alarm (smoke detector, heat detector, pull station, beam detector, VESDA or suppression system) within DSR, ADA strobe/chimes will activate and red strobes will deactivate, the remainder of the ARTCC will activate general alarm. All System Components (to include relays, control modules, etc.) and Software shall be UL Listed for Operations noted.

h. Duct detectors shall not initiate notification appliances.

i. Alarm detection in the Power Services Building shall send an alarm signal to the FACP, Annunciators, DACT, and a status change shall print from the printer including date & time of occurrence. Notification appliances in the building shall activate.

2. System Trouble Detection

a. When trouble condition occurs (sprinkler system panel, air sampling panel, non-addressable duct detector, circuit supervision fault, power supply fault) the following shall occur immediately:

1) Trouble lights on the FACP with trouble audible sounder and indication of pertinent information on the LCD and remote annunciator panels.

2) Indication on the Annunciator

3) DACT transmit trouble signal to the Protected Premises Digital Acquisition System at the Central Monitoring Station.

4) Appropriate status change print from the printer including date and time of occurrence.

3. Supervisory Signals:

a. When an off normal condition is indicated by a water valve tamper switch, a high/low sprinkler system air pressure condition of a duct smoke detector alarm occurs, the following functions shall occur immediately:

1) Supervisory lights on the FACP with supervisory audible sounder and indication of pertinent information on the LCD and remote annunciator panels.

2) Indication on the Annunciator

3) DACT transmit supervisory signal to the Protected Premises Digital Acquisition System at the Central Monitoring Station.

4) Appropriate status change print from the printer including date and time of occurrence.

F. Second alarm detection in DSR Control Room and M-1 Room and any first-floor smoke detector located between column lines 8 and 11 (Control Wing): When a second fire alarm initiating device is activated in the Control Room where a first alarm in the main building is still in alarm, excluding first alarms from the Power Service Building, the following shall occur immediately:

1. System alarm LED lights on the existing FACP.

2. Sounding of the local alarm sounding device at the existing FACP.

3. Indication of zone, floor, and type of initiating device shall appear on the existing LCD and GAP.

4. De-activation of the Stage I visual alarm appliances in the Control Room.

5. Activation of the Stage II audible (the chime shall automatically silence after 60 seconds) and visual alarm appliances in the DSR Control Room. Audible and visual alarm appliances in the remainder of the ARTCC and the Power Service Building shall remain activated, as applicable.

6. Transmit fire alarm signal to a U.L. Listed Central Station.

7. An appropriate status change message is sent to the existing printer, with the date and time of occurrence.

8. Activation of all other existing fire alarm and control functions currently activated by an alarm condition, unless otherwise modified by the specifications or drawings.

G. Actuation of Manual Pull Station in the DSR Control Room and M-1 Room: When a fire alarm pull station is activated in the DSR Control Room or M-1 Room, the following shall occur immediately:

1. System alarm LED lights on the existing FACP.

2. Sounding of the local alarm sounding device at the existing FACP.

3. Indication of zone, floor, and type of initiating device shall appear on the existing LCD and GAP.

4. The Stage II audible (the chime shall automatically silence after 60 seconds) and visual alarm appliances in the DSR Control Room shall activate.

a. If already operating, the Stage I visual alarm appliances in the DSR Control Room shall cease to activate.

5. Activation of the audible and visual alarm appliances in all areas of the facility outside of the DSR Control Room (Alarm appliances shall continue, even if previously actuated by a separate initiation device).

6. An appropriate status change message shall be sent to the existing printer, with the date and time of occurrence.

7. Transmit fire alarm condition to a UL Listed Central Station.

8. Activation of all other existing fire alarm and control functions currently activated by an alarm condition, unless otherwise modified by the specifications or drawings, as applicable.

H. System trouble detection: When a trouble condition is indicated by a malfunction of an initiating device circuit, signaling line circuit, or notification appliance circuit, the following functions shall occur immediately:

1. System trouble LED lights on the existing FACP.

2. Sounding of the local trouble sounding device at the existing FACP.

3. Indication of system trouble on the existing LCD and GAP.

4. Transmit trouble signal to a UL Listed Central Station.

5. An appropriate status change message is sent to the existing printer, with the date and time of occurrence.

I. Supervisory Signals: When an off normal condition is indicated by a water valve tamper switch, sprinkler panel trouble, activation of a duct smoke detector, analog addressable smoke detector alarm verification pre-alarm signal, or other off normal condition, the following functions shall occur immediately:

1. System supervisory LED lights on the existing FACP.

2. Sounding of the local supervisory sounding device at the existing FACP.

3. Indication of the supervisory condition on the existing LCD and GAP.

4. Transmit supervisory signal to a U.L. Listed Central Station.

5. An appropriate status change message is sent to the existing printer, with the date and time of occurrence.

J. Alarm Silencing: When the alarm silence button is activated at the FACP, the audible notification appliances shall stop, while the visible devices continue. If a subsequent alarm occurs, the audible devices shall re-activate.

1.7 SUBMITTALS

A. Product Data: Submit annotated product data for each type of system component specified including dimensioned plans and elevations showing minimum clearances and installed features and devices. Include list of materials and Nationally Recognized Testing Laboratory (NRTL) listing data. Product data shall also include, but not be limited to, manufacturers catalog cuts, wiring requirements, technical data, and warranty data for each component or device used in the system. Manufacturers' literature and technical data shall indicate the type, size, rating, style, catalog number, product names, photos, and catalog data for the following:

1. Spot type Smoke detectors;
2. Aspirating type Smoke detectors and appurtenances (as applicable);
3. Duct smoke detectors;
4. Addressable control devices;
5. System components to be placed within existing FACP;
6. Conduit, wire and cable;
7. Signs and labels;
8. Manufacturer's wiring guidelines; and
9. List of recommended spare parts, supply source, and cost for components of the system.

B. Calculations: Provide calculations required to verify compliance with NFPA 72 and this Specification Section:

1. Battery and battery charger calculations;
2. Conduit fill calculations;
3. Voltage drop calculations.

C. Shop Drawings: Drawings shall be signed and sealed by a registered Professional Engineer in Fire Protection or certified NICET Level IV Fire Alarm Designer. Drawings shall indicate locations, installation details and sequence of operation of devices and equipment associated with the system. Floor plans showing equipment locations, conduit sizes and runs, wire counts and sizes, and other details shall be provided. Ceiling detectors shall be shown on reflected ceiling plans, which show the locations of light/sound baffles, light fixtures, diffusers, registers, grilles and other equipment that affect the smoke detector layout. Wiring diagrams shall include diagrams for equipment and for the system with terminals and interconnections identified. Make diagrams specific to this Project and distinguish between field and factory wiring. Clearly identify interface requirements between fire alarm system and Section 21 13 13 "Fire Suppression Systems." All shop drawings shall be based on the existing facility As-Built drawings. The shop drawings shall be an update of the existing As-Built drawings. Obtain existing As-Built drawings from the COR.

D. Installer Qualifications: Submit resume listing installer's qualifications including manufacturer's certification as an approved system installer and a list of recently completed projects demonstrating five (5) years of system installation experience.

E. Startup Personnel Qualifications: Submit resume listing startup personnel qualifications including manufacturer's certification as an approved system technician and a list of recently completed projects demonstrating five (5) years of system startup experience.

F. As-Built Drawings: Upon completion of system update existing as-built drawings showing actual installation conditions. Show locations and identification addresses of manual stations, detectors, addressable interface devices, addressable control devices, flow switches and tamper

switches. Also show location of audible and visual notification appliances, conduit routing details, including conduit to existing FACP.

G. Test Plan: A test plan which describes the methods to be used for system testing shall be submitted. Include a step by step description of the tests, and indicate type and location of test apparatus to be employed. Demonstrate that the operation and installation requirements specified have been met. Test all new devices and appliances according to NFPA 72 requirements. Additionally, there are existing initiating devices and notification appliances connected to the FACP which serve other areas of the facility. Test at least 10% of existing initiating devices and all existing notification devices. All tests are to be conducted between the hours of 1 and 5 AM.

H. Operation and Maintenance Manuals: Update existing operation and maintenance instruction manuals. Notify COR if existing O & M manuals do not exist. The manuals shall detail aspects of system operation and maintenance, including electrical schematics, a written description of the system design, drawing illustrating control logic and equipment location, and technical bulletins describing each item of equipment used in the system. Include checklists and procedures for emergency situations and troubleshooting techniques. Include a list of required tools and equipment for site personnel to maintain system including detector testers etc. Provide the names, addresses, and telephone numbers of service organizations that carry stock of repair parts for the system to be furnished.

I. System Operation Description: Update existing system operation description, including method of operation and supervision of each type of circuit and sequence of operations for manually and automatically initiated system inputs and outputs. Notify COR if the existing system operation description does not exist. Manufacturer's standard descriptions for generic systems are unacceptable. Provide a copy of system operation description in a plastic sleeve, at the FACP.

J. Record of Field Tests of System: Submit a record of field tests for devices tested. Record shall include device location, type, address, and other relevant data as well as date of test and signature of startup personnel performing tests.

K. Inspection documents are specified in Part 3 of this Section.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Engage a factory-authorized Installer to perform work of this Section. Installer shall have a minimum of five (5) years' experience in design, installation, and testing of fire detection and alarm systems. Submit a list of systems of similar nature and scope, successfully completed within the last two years and provide proof of available telephone communications on a twenty-four (24) hour, seven (7) day a week basis. Be able to provide replacement parts on an emergency basis, and have experienced service personnel available for emergency service.

B. Single-Source Responsibility: Obtain fire alarm components from a single source who assumes responsibility for compatibility of system components.

C. Comply with NFPA 70 and NFPA 72.

D. Listing and Labeling: Provide fire alarm systems and components specified in this Section that are listed and labeled and maintain the overall listing for the entire fire detection and alarm system.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store equipment and materials inside and protected from weather.

1.10 SEQUENCING AND SCHEDULING

A. Existing Addressable Fire Alarm Equipment: Demolish existing addressable fire alarm equipment as indicated on drawings. Existing to remain equipment is to remain in service and only be modified as indicated on drawings or as needed for coordination.

B. Equipment Removal: Remove existing disconnected fire alarm equipment, wiring, and exposed conduit as indicated on the fire alarm demolition plans. Remove from site and legally dispose of material.

1.11 EXTRA MATERIALS

A. Furnish extra materials described below; that match products installed, are packaged with protective covering for storage, and are identified with labels clearly describing contents. Furnish a quantity equal to the percentage (rounded up to the next whole number) of the number of units installed under this contract as listed below, but not less than one. Turn over extra materials to the COR prior to the start of the final acceptance testing.

1. Smoke detectors of each type: 10 percent of each type within the total system if not available on site
2. Duct smoke detectors: 2 percent of each type within the total system if not available on site
3. Detector bases: 2 percent of each type within the total system if not available on site
4. Control devices: 2 percent of each type within the total system if not available on site
5. Relays: 2 percent of each type within the total system if not available on site

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide new system components designed and fabricated by one manufacturer with the following characteristics:

1. Equipment and materials: Design and fabricate in accordance with NFPA 13, 70, 72, 75, 90A, and 101.

2. Provide standard products of the manufacturer's latest design that are suitable to perform the functions intended. The name of the manufacturer and the serial number shall appear on major components. Equipment, material, devices, and accessories shall be NRTL listed and labeled for their intended use.

3. Manufacturers of NRTL listed or approved addressable fire detection systems shall have an established record of working installations and shall be capable of providing documentation showing experience with addressable systems.

4. Compatible with existing site FACP maintaining NRTL listing or approval (such as UL 864) of the overall system.

2.2 MANUFACTURERS

A. Acceptable manufacturers: Manufacturers of equipment compatible with the existing Siemens MXL addressable fire alarm system. Initiating devices, control devices, interface devices, and notification appliances provided under this contract shall be of the manufacturer's latest design and match existing facility equipment except where existing equipment does not match requirements of this specification.

B. Fire Alarm Control Panel (FACP): New system devices and appliances shall be wired to the existing FACP. Connection to the FACP shall provide the sequence of operation required by this specification. The existing addressable fire detection and alarm system in the building shall remain in service at all times during construction.

C. Circuit connections: Circuit conductors entering or leaving the panel shall be connected to screw type terminals with each terminal marked for identification.

2.3 ADDRESSABLE DEVICES

A. General: Provide new detection and alarm circuit devices, designed to interface with existing FACP for central alarm capability, and suitable for use in a Class A electrically supervised 24 VDC circuit.

B. Smoke Detectors:

1. General: Comply with UL 268. Include the following features:

   a. Factory Nameplate: Serial number and type identification.
   b. Operating Voltage: 24 VDC, nominal.
   c. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
   d. Plug-in Arrangement: Detector and associated encapsulated electronic components are mounted in a module that connects to a fixed base with a twist-locking plug connection. The plug connection requires no springs for secure mounting and contact maintenance. Terminals in the fixed base accept system wiring.

e. Integral Visual Indicating Light: Connect to indicate detector has operated.
f. Remote Controllability: Individually monitor detectors at the FACP for calibration, sensitivity, and alarm condition, and individually adjust for sensitivity from the FACP.
g. Ambient conditions: Detectors shall be rated for the ambient temperature, humidity, and air velocity conditions in which they are installed.

2. Alarm verification: Provide, configure and activate the alarm verification feature for existing and new analog addressable smoke detectors in accordance with NFPA 72 requirements for alarm verification. The FACP shall generate a pre-alarm supervisory signal whenever a detector activates/enters the 45 second alarm verification time period. The alarm verification feature shall reduce the possibility of unwanted alarm signals through one of the following methods:

a. A detector must report an alarm condition for 45 continuous seconds before the alarm condition is accepted as valid by the fire alarm control panel.
b. When a detector reports an alarm condition, the fire alarm control panel shall reset the detector. After reset, if the detector again reports an alarm condition at the end of 45 seconds, the alarm shall be accepted as valid by the fire alarm control panel.

3. Photoelectric Smoke Detectors: Include the following features:

a. Sensor: An infrared detector light source with matching silicon-cell receiver with minimum air velocity rating of 2500 FPM.
b. Detector Sensitivity: Between 2.5 and 3.5-percent-per-foot smoke obscuration when tested according to UL 268.

4. Duct Smoke Detector: Photoelectric type, UL 268A listed.

a. Duct detectors are integral to the Air Handling Units and are provided by the manufacturer of the unit.

C. Addressable Control Device: Respond to unique addressed command from existing FACP and operate SPDT output contacts. Contacts rating: 2 A at 28 VDC, 300 mA at 120 VAC. Integral red LED to indicate normal operation and contact activation.

2.4 FIRE ALARM CONTROL PANEL (EXISTING)

A. FACP Components: Provide as needed to meet requirements of this specification. Maintain UL 864 listing of entire FACP.

1. Power supply: Provide additional power supply assembly capable of converting 120 volt AC input through a transformer and rectifier to low voltage DC output to supply the power requirements of the new system components if the existing power supplies do not have adequate capacity. Power supply shall be capable of automatically transferring from normal to emergency power and from emergency to normal power without causing a false alarm. Equipment connected to AC circuits shall be protected from power line surges. Fuses shall not be used for surge protection. Power supply shall be listed under UL 1481.

2. Interface Boards: Provide additional interface boards, chassis, power supplies and appurtenances necessary to meet requirements of this specification and to provide a fully functional fire alarm system.

a. Analog sensor module: Shall provide the communication link between addressable devices and the central control unit. The addressable devices shall be analog smoke sensors, heat sensors, addressable interface devices and addressable control devices. Spare capacity for analog sensor modules was provided during a previous project. Verify if the spare modules exist, if not provide new to provide a complete functioning fire alarm system.

2.5 CABLE AND WIRING

A. Cable shall comply with Section 26 05 19 "Low Voltage Electrical Power Conductors and Cables" except as listed below. Provide power limited 300V, 75 C cable of the type indicated for the use below. Bell wire, intercom, or telephone wire is not acceptable. Comply with NEC Article 760 requirements and manufacturers recommendations.

B. For initiating device circuits, provide type FPL cable with red PVC jacket and 18 to 12 AWG, solid, twisted conductors.

C. For signaling line circuits and initiating device circuits, provide type FPL cable with red PVC jacket, and 18 to 12 AWG, solid, twisted conductors.

D. Power wiring shall be 12 AWG, Type THHN/THWN, solid wire in separate raceway.

2.6 FUNCTIONAL DESCRIPTION OF SYSTEM

A. Software: Existing to remain.

B. Include the following System Functions and Operating Features:

1. Priority of Signals: Accomplish automatic response functions by the first alarm initiated. The highest priority is an alarm signal. Supervisory and trouble signals have second- and third-level priority respectively. Higher-priority signals take precedence over signals of lower priority, even though the lower-priority condition occurred first. Annunciate alarm signals regardless of priority or order received.

2. Non-Interfering: Circuit wiring shall be configured for non-interfering operation. A signal on one circuit shall not prevent the receipt of signals from any other circuit. Circuits shall be manually resettable from the FACP after the initiating device or devices are restored to normal.

3. Silencing at the FACP: Switches provide capability for acknowledgment of alarm, supervisory, trouble, and other specified signals at the FACP, and capability to silence the local audible signal and light a light-emitting diode (LED). Subsequent alarms cause the audible signal to sound again until silenced by switch operation. Restoring alarm, supervisory, and trouble conditions to normal extinguishes the associated LED and

causes the audible signal to sound again until restoration is acknowledged by switch operation.

4. Loss of Primary Power Sounds a Trouble Signal at the FACP: The FACP indicates when the fire alarm system is operating on an alternate power supply.

5. FACP LCD Alphanumeric Display: Displays plain-English-language descriptions and addresses of initiating devices, alarms, trouble signals, supervisory signals, monitoring actions, system and component status, and system commands.

6. Remote Detector Sensitivity Adjustment: Manipulation of controls at the FACP allows the selection of specific addressable smoke detectors for adjustment, display of their current status and sensitivity settings, and control of changes in those settings. The same controls can be used to program repetitive, scheduled, automated changes in sensitivity of specific detectors. Sensitivity adjustments and sensitivity adjustment schedule changes are recorded by the system printer.

7. Independent System Monitoring: Supervise each Automatic On/Off Sprinkler system for both normal operation and trouble.

8. Circuit Supervision: Indicate circuit faults by a trouble signal at the FACP. Provide a distinctive indicating audible tone and LED-indicating light. The maximum permissible elapsed time between the occurrence of the trouble condition and its indication at the FACP is 200 seconds.

2.7 OVERVOLTAGE AND SURGE PROTECTION

A. Signaling Line Circuit Surge Protection: For systems having circuits located outdoors, communications equipment shall be protected against surges induced on any signaling line circuit and shall comply with the applicable requirements of IEEE C62.41.1 and IEEE C62.41.2. Cables and conductors, that serve as communications links, shall have surge protection circuits installed at each end that meet the following waveforms:
   1. A 10 microsecond by 1000 microsecond waveform with a peak voltage of 1500 volts and a peak current of 60 amperes
   2. An 8 microsecond by 20 microsecond waveform with a peak voltage of 1000 volts and a peak current of 500 amperes. Protection shall be provided at the equipment. Additional triple electrode gas surge protectors, rated for the application, shall be installed on each wire line circuit within 3 feet of the building cable entrance. Fuses shall not be used for surge protection

B. Sensor Wiring Surge Protection: Digital and analog inputs and outputs shall be protected against surges induced by sensor wiring installed outdoors and as shown. The inputs and outputs shall be tested with the following waveforms:
   1. A 10 by 1000 microsecond waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.
   2. An 8 by 20 microsecond waveform with a peak voltage of 1000 volts and a peak current of 500 amperes. Fuses shall not be used for surge protection.

2.8 PROTECTED PREMISES MONITORING – DIGITAL ACQUISITION SYSTEM AT THE CENTRAL MONITORING STATION (CENTRAL SECURITY COMMUNICATIONS INCORPORATED)

A. Signals that shall be transmitted to the Protected Premises location include the following:
1. Sprinkler water flow
2. Manual pull stations
3. Smoke detectors
4. Duct smoke detectors
5. Heat detectors
6. Sprinkler valve supervision
7. All other signals as required elsewhere in this specification or in NFPA 72.
8. Kitchen ANSUL system(s)

B. The signals listed above may be transmitted to the Protected Premises location in the form of Alarm, Supervisory, or Trouble condition signals.

C. The transmission of Alarm, Supervisory, or Trouble conditions from the Fire Alarm Control Panel to the Protected Premises location can be by Network (data cable), fiber or Fire Alarm copper wiring meeting the requirements of NFPA 72 and NFPA 70.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install system according to NFPA standards referenced in Parts 1 and 2 of this Section and Manufacturers recommendations. Except where noted otherwise, comply with Section 26 05 00, “Common Work Results for Electrical”, Section 26 05 33, “Raceways and Boxes for Electrical Systems”, Section 26 05 19, “Wires and Cables” and Section 26 05 53, “Identification for Electrical Systems”.

B. Design fastening and supports to support loads with a safety factor of five. Fasten equipment firmly in place.

3.2 EQUIPMENT INSTALLATION

A. Addressable Interface Devices: Mount each module within three feet of each device that is being monitored or controlled.

B. Smoke Detectors:

1. Detectors require a four inch by four-inch device box with a 3/0 ring; Locate on the highest part of a smooth ceiling so that the edge of the detector is no closer than three feet from a sidewall. Install in accordance with the manufacturer’s instructions. Ceilings with heights greater than 10 feet above the floor, or ceilings with beams, joists, soffits or other objects that exceed eight inches in depth require closer spacing than normally recommended by the manufacturer. Comply with NFPA 72 requirements.

2. The location and spacing of smoke detectors shall take into consideration the velocity and direction of air flow, ceiling construction, beam and truss locations, ceiling obstructions, the presence of areas with stagnant air, and the location of equipment in the area. Detectors located in areas with high air movement require closer spacing than normally recommended by the manufacturer. Comply with NFPA 72 requirements.

3. If it is necessary to mount a detector upon a sidewall, locate the top of the detector no closer than 4 inches from the ceiling and no further away than 12 inches.

4. Install smoke detectors to favor the air flow toward return openings; do not locate where detectors within 60 inches of air supply diffusers, or where detector performance is adversely affected. Detectors mounted on a suspended ceiling shall be mounted near the center of the ceiling tile.

5. Integral duct smoke detectors: Provided by Air Handling Unit manufacturer.

C. Addressable Control Devices: Mount each module within three feet of each device that is being monitored or controlled.

3.3 WIRING INSTALLATION

A. Wiring Method: Conceal raceway except in unfinished spaces and as indicated. Do not splice wire except where required to connect to a device. Where lengths of wire must be joined together to complete a long run, join them at a terminal strip mounted in a hinged or screw cover junction box. Do not transpose or change colors.

1. Install cable and wire in appropriately sized raceway, but not less than 3/4 inch diameter.

2. Install cable of the type indicated for the use, and install in accordance with NEC Article 760.

3. Leave eight inch wire tails at each device box.

4. Loop the cable for initiating device circuits from the addressable interface device to the initiating device, then back to addressable interface device.

5. Loop the cable for signaling line circuits from the FACP to the first addressable initiating device, then on to each successive addressable device, and then back to the FACP. Maintain continuity and connect to earth ground only at the FACP. Do not route intelligent detector wiring adjacent to, or in the same conduit with 120/240 VAC power wiring or other high current circuits.

6. Provide a minimum of two inches of separation between cable and open conductors, light, power, or class one circuits. Do not place cable in outlet boxes or raceways containing non fire alarm conductors.

7. When adding devices to an existing circuit, the existing circuit shall be interrupted between two existing devices. The circuit shall be re-routed from one existing device, to each successive new device, and then to the other (next) existing device. All circuit routing shall meet the NFPA requirements for Class A circuits.

B. Wiring within Enclosures: Install conductors parallel with or at right angles to the sides and back of the enclosure. Bundle, lace, and train the conductors to terminal points. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

C. Cable Connections: Use numbered terminal strips in junction, pull or outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

D. Color Coding: Color-code fire alarm conductors differently from the normal building power wiring. Paint fire alarm system junction boxes and covers red.

E. UL listed through-penetration firestop systems: Provide at fire alarm conduit penetrations through fire rated floors and walls in accordance with requirements of Section 07 84 13 “Penetration Firestopping”.

F. Risers: Risers shall be installed in utility chases.

3.4 IDENTIFICATION

A. Identify system components, raceway, wiring, cabling, and terminals according to Section 26 05 53, “Identification for Electrical Systems”.

B. Signs and Labels: Permanent nameplates shall be used in the FACP to identify control logic units, contacts and major circuits. Lettering except for within FACP shall be bold-face of minimum 1 inch in height and shall be of the engraved type. Provide a contrasting red background with white lettering.

3.5 GROUNDING

A. Ground equipment according to system manufacturer's instructions to eliminate shock hazard and to minimize, to the greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, and other impairments.

3.6 FIELD QUALITY CONTROL

A. General: Demonstrate that the entire Fire Alarm and Control system functions as designed and specified. Test circuits under automatic alarm conditions, manual alarm conditions, and equipment shutdown in accordance with NFPA 72. Test all new devices. Test at least 10 percent of the existing initiating devices and all notification appliances in accordance with NFPA 72. If the software is changed or a modification is performed that affects the system operation a 100% test shall be performed. In addition, test the complete system for power failure conditions. Tests shall be witnessed by the COR.

B. Manufacturers Field Service: Provide services of factory-authorized startup personnel to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.

C. Pretesting: After the installation is complete, have factory trained personnel inspect the system in accordance with the manufacturers recommended procedures, include testing the wiring for proper connection, continuity and resistance to ground. After installation, align, adjust, and balance the system and perform complete pretesting. Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.

D. Report of Pretesting: After pretesting is complete, provide a letter certifying the installation is complete and fully operable, including the names and titles of the witnesses to the preliminary tests.

E. Final Test Notice: Provide a ten (10) day minimum notice in writing when the system is ready for final acceptance testing.

F. Operations Test: Test all new devices. Functions including system and equipment interlocks shall be operational at least ten (10) days prior to the final acceptance test. Test each detector and properly set sensitivity in accordance with the manufacturer's recommended procedures. Verify the system and equipment interlocks, i.e., audible and visual alarms and equipment shutdowns, function at test time. Test each circuit for trouble by inducing a trouble condition to the system. All tests are to be conducted between the hours of 1 and 5 AM.

G. Minimum System Tests: Test the system according to the procedures outlined in NFPA 72. Certify system and provide test log per NFPA 72. Minimum required tests are as follows:

1. Verify the absence of unwanted voltages between circuit conductors and ground for all circuits affected by this project.

2. With each circuit pair, short circuit at the far end of the circuit and measure the circuit resistance with an ohmmeter. Record the circuit resistance of each circuit on the record drawings.

3. Verify that the control unit is in the normal condition as detailed in the manufacturers operation and maintenance manual.

4. Test initiating and indicating circuits for proper signal transmission under open circuit conditions. One connection each should be opened at not less than 10 percent of the initiating and indicating devices. Observe proper signal transmission according to class of wiring used.

5. Test each initiating and indicating device for alarm operation and proper response at the control unit.

6. Test the system for specified functions according to the approved operation and maintenance manual. Systematically initiate specified functional performance items at each station, including making all possible alarm and monitoring initiations and using all communications options. For each item, observe related performance at all devices required to be affected by the item under all system sequences. Observe indicating lights, displays, signal tones, and annunciator indications.

7. Test Both Primary and Secondary Power: Verify by test that the secondary power system is capable of operating the system for the period and in the manner specified.

H. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

I. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log. Submit log upon the satisfactory completion of tests.

J. Tag equipment, stations, and other components at which tests have been satisfactorily completed.

3.7 CLEANING AND ADJUSTING

A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Touch up scratches and marred finish to match original finish. Clean unit internally using methods and materials recommended by manufacturer.

B. Replace air filter in each respective VESDA aspirating unit detector after all work is complete in the area of work.

C. Safe guard all fire alarm devices during demolition and construction against damage and foreign matter using dust partitions or manufacturer recommended materials.

3.8 WARRANTY

. Include a service and parts guarantee of the system for a period of one year and provide any services and equipment incidental to the proper performance of the system under warranty at no additional cost to the Government. Contractor shall be available on a twenty-four (24) hour, seven (7) day a week basis during the warranty period. Response to the warranty request shall be within four hours of the initial contact.

3.9 FIRE WATCH

A. Contractor shall provide a fire watch program in accordance with NFPA 51B, utilizing facility-familiar and trained personnel who have knowledge of the inherent hot-work hazards ongoing during construction and who shall have portable fire extinguishing equipment ready at all times. The fire watch shall ensure that conditions are maintained safe during all operations whilst the fire suppression system is non-functional and shall stop any unsafe practice. During a cease work called by the fire watch, the watchman shall determine whether the best first action is to either extinguish the fire or sound the building fire alarm and perform the action immediately.

END OF SECTION 28 31 00