Oakland ARTCC (ZOA)
Fremont, California

Control Wing Basement Renovation and Chillers/Cooling Tower Replacement (Major Mechanical) Project

Final Design Submittal Specifications

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DOCUMENT 00 01 10 – TABLE OF CONTENTS

DIVISION	SECTION TITLE

DIVISION	SECTION TITLE

END OF TABLE OF CONTENTS

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SECTION 01 11 00 - SUMMARY OF WORK

PART 1 – GENERAL

1.1 SCOPE OF WORK: These Contract Documents cover the requirements of the Federal Aviation Administration (FAA), Northwest Mountain Region hereinafter referred to as the Government, for the work associated with the Air Route Traffic Control Center (ARTCC) Control Wing Basement and Major Mechanical Sustainment Project, located at 5125 Central Avenue in Fremont, California 94536.

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.

1.2 SUMMARY OF WORK: The work includes the abatement of hazardous materials (asbestos and lead containing coatings) in the ARTCC Control Wing's Basement, and demolition of and/or upgrades to existing partitions, ceilings, finishes, fixtures and appurtenances in the project area. The Work also includes demolition of Mechanical (HVAC), Plumbing, and Electrical power and lighting systems, equipment, and distribution components, both in the Control Wing Basement and outside at the Cooling Tower Plant.

The Project Area is comprised of the following rooms and areas:

Control Wing: IFD B101, Electronic Equipment Room (North) B120, Electronic Equipment Room (South) B120, Comm Work Area B120A, CTAS Support String B120B, Break Room B120C, HOST/ATOP Computer Room B134, Office B134C, Office B134D, and Stair No. 3.

Administration Wing: HOST Mechanical Room B119, Power Room B118, IFD Room B101, Boiler Room B116 and adjacent areaway, Chiller Room B115, and Machine Shop B112.

Miscellaneous: Engine Generator Room, Pump House, Chemical Treatment Building, Cooling Tower Plant/Yard.

Hazardous materials abatement work includes mudded fittings and elbows, and provisions for spot abatement of lead based paints.

The work includes new and/or extended mechanical, controls, plumbing, fire protection, and electrical distribution systems and components in the Control Wing Basement. New mechanical equipment includes chillers, boiler, cooling towers, pumps, filtration systems, electric water cooler, sanitary sump pump, air handlers, and associated piping, ductwork and controls, as well as provisions for a temporary cooling tower plant to maintain conditions within the facility during construction. New VFD's will be provided for the cooling towers. New BACnet System mechanical controls system, by Schneider will be provided for the new equipment in this project.

Electrical power panels and a transformer will be replaced in the Control Wing Basement project area and at the Cooling Tower Yard.

Fire Sprinkler system will be extended to provide full coverage within the Control Wing Basement project area, and Fire Alarm will be adjusted as required to accommodate the demolition and new work. Air compressors for the Viking Firecycle systems will be replaced.

The roof on the Chemical Treatment Building will be replaced. Access floor and wall-mounted sound absorbing panel systems in the HOST Mechanical Room will be replaced and miscellaneous louvers, doors and hardware will be replaced. Walls in Electronic Equipment Room (North and South) B120 will be furred-out to align with existing wall-mounted equipment on the walls. Provisions for foundations for temporary cooling tower plant and stairs and access/maintenance platforms for the new permanent cooling towers are also required.

The elevated walkway and stairs at the cooling tower plant will be demolished and two new sets of walkways and stairs will be constructed between the two pairs of new cooling towers.

All areas of the facility will remain occupied and functional throughout the project.

This summary does not cover all aspects of the work. See other specification sections and the drawings for more detailed information.

1.3 DEDUCT ALTERNATE

A. This Project's Base Bid and Work includes replacement of the existing 12-inch underground condenser water mains and associated excavation and site restoration from the cooling tower yard to inside the main building's Chiller Room. As an initial on site activity, the Contractor is to excavate a limited area on site as shown on the drawings for ultrasonic testing of the underground water main piping by a consultant testing firm provided by the FAA. The Contractor is to provide a 30-day prior notice to the COR before beginning the excavation and testing work. If the test results indicate the 12-inch underground condenser water mains need be replaced, the Base Work to do so will proceed.

B. If the ultrasonic test results indicate the 12-inch underground condenser water mains need not be replaced, the FAA will direct the Contractor within no more than 30 days after the FAA's receipt of the test results to restore the excavated area and initiate the Deduct Alternate.

C. The Deduct Alternate Bid and Work consists of:

a. Not replacing the existing 12-inch underground condenser water mains; and

b. Not implementing full excavation and site restoration associated with to-be-deleted 12-inch underground condenser water mains replacement.

1.4 SUBMITTALS

A. Serial Letter Log

1.4 INTENT OF CONTRACT DOCUMENTS

A. These Contract Documents (specifications and drawings) indicate the work to be performed for the project. All material, labor, equipment, tools, layout, and supervision must be furnished by the Contractor to complete the work and provide complete operating systems. The Contractor is responsible for the supervision, health and safety, inspection, and quality control of its own work, workers, work areas, and lower tiered subcontractors. Work shall be performed to ICC, NFPA, and FAA codes and standards, and manufacturers' recommendations. All work performed and all materials and equipment used will be subject to approval by the Contracting Officer. This must include, but not be limited to, construction, testing, inspection, scheduling, reporting, and submittals.

B. Titles: Titles to divisions and sections of the specifications and notes and titles on drawings referring to subcontractors, division of work by trade, or type of work are used for convenience and do not imply any separate contractual arrangements of work assignments. Such separations into titles, divisions, sections, or notes should not be construed to establish limits between the Contractor and its subcontractors.

C. Reference to known standards within the Contract Documents means the latest edition in effect on the date of solicitation, unless specified otherwise.

D. Where Contract Documents refer to "Related Work in Other Sections" or "Related Requirements", the Contractor should not consider the list of specification divisions/sections to be all-inclusive. These lists are provided as a convenience for cross-reference and coordination.

E. Order of Preference: Generally, the written word takes precedence over the drawings. Figures marked on drawings should be followed in preference to scale measurements. Large scale drawings should govern small scale drawings. The Contractor should not use dimensions scaled from the drawings. All dimensions shown on the drawings must be verified by the Contractor by actual measurements in the field. Any discrepancy between the drawings and specifications and the existing conditions must be referred to the Contracting Officer for resolution before any work affected is performed. The Contractor must compare all drawings and verify the figures before laying out the work and will be responsible for any errors which might have avoided thereby.

1.5 CONTRACT DOCUMENTS

A. Copies of Specifications and Drawings: Two (2) hard copy sets and one (1) electronic set of the Contract Documents will be furnished to the Contractor without charge, with the exception of applicable publications incorporated into the technical specifications by reference.

B. Specification and Drawing Review: The Contractor is responsible for complete knowledge and understanding of the Contract Documents throughout the life of the Contract. The Contractor must check the Contract Documents immediately upon their receipt and promptly notify the Contracting Officer of any discrepancies.

C. Contracting Officer: The Contracting Officer (CO) is the person designated to act on behalf of the Government in the performance of this contract. The Contracting Officer's Representative (COR) is the Contracting Officer's authorized representative. The COR is the point of contact for all work on site between the Contractor and Government. The Contractor will coordinate all work through the COR, or will keep the COR informed when dealing directly with the Contracting Officer, and the Government will coordinate through the COR to the Contractor, except in case of urgency or emergency.

1.6 MEASUREMENT AND PAYMENT

A. The contract price constitutes full compensation for furnishing all plant, labor, materials, appurtenances, and incidentals, and performing all operations necessary to construct and complete the items in accordance with these Contract Documents performed by the Contractor. Payment for each item will be considered as full compensation, notwithstanding that all features may not be mentioned herein. No separate payment will be made for the work, services, or operations required by the Contractor, as specified in Division 1 General Requirements, to complete the project in accordance with these specifications; all costs thereof will be considered as incidental to the work.

1.7 CORRESPONDENCE: All correspondence must be addressed and delivered electronically to the Contracting Officer and the COR, and must be serially numbered commencing with number one (1), with no numbers missing or duplicated. All files/documents must be legible. Enclosures attached or transmitted with the correspondence must also be furnished electronically with copy to the COR. Each serial correspondence must include the contract number and project name and must have only one subject. The Contractor must create and maintain a serial letter log that shows the serial letter number, date, topic, and disposition if applicable. The Contractor must submit the updated serial letter log monthly.

PARTS 2 – PRODUCTS (Not used)

PARTS 3 – EXECUTION (Not used)

*** END OF SECTION ***

SECTION 01 14 00 – WORK RESTRICTIONS

PART 1 - CONDUCT OF WORK

1.1 COORDINATION AND ACCESS TO SITE

A. The work is at a critical facility which 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 security shall not be compromised.

B. General Area Requirements: The Contractor must confine operations, activities, storage of materials, and employee parking within the project boundaries and the approved staging and loading/unloading areas. Any additional space the Contractor deems necessary must be submitted to the COR for review and approval, or be obtained off site, at no additional cost to the Government.

C. Security Requirements: This project is on a restricted entry site and no compromise of the security system in any nature or of any duration may be made without prior approval of the Contracting Officer. Generally, such compromises, when approved, will be less than 24 hours in duration.

D. Facility Access Badges: Contractor personnel shall be subject to a security investigation by the FAA and shall obtain FAA Identification Media Badge prior to start of on-site work. Contractor shall return all badges to the FAA prior to final acceptance.

1. After award the Contractor shall provide the Contracting Officer with a list of contractor personnel who shall request FAA Identification Media Badge. The list shall be kept current during the entire duration of the project. The Contractor shall designate a representative to be the POC for inputting employee information into the Vendor Applicant Process (VAP). The Contractor shall request from the Contracting Officer all necessary forms, including FD 258 Fingerprint Card, 1681 Application, OF 306, and I-9. The Contracting Officer shall provide instruction for submitting forms.

2. Security Badge Process: Badging is a two stage process. The initial phase includes VAP entry and background check conducted by FAA security. Notification shall be provided by FAA Security of "Interim Suitability". At that time, contractor employees will be notified to make an appointment at a FAA PIV Center. A FAA PIV Center is located on the grounds of the Oakland Air Route Traffic Control Center. Alternate locations for PIV Centers can be provided upon request. The badging process takes approximately 30 days to complete. The timeframe varies based on filling out the forms timely and correctly, and scheduling appointments at the PIV Center promptly, etc.

3. Types of FAA Identification Media Badge. FAA Identification Media consist of a Contractor PIV Badge and Contractor Yellow Badge. Contractor PIV Badge allows the contractor access to the grounds and work site and escort authorized visitors at the work site. Contractor Yellow Badge allows the individual employee access to the grounds and work site. The FAA reserves the right to limit the number of PIV Badges issued.

4. Visitor Access: A visitor is defined as any employee who does not have a FAA Identification Media Badge. A minimum of 2 work day notification to the COR is required for admittance to the FAA facility. Contractor personnel with a "PIV badge" shall escort the visitor at all times while on site. FAA employees will not escort contractor employees except when it is coordinated and approved by the COR. Visitor access for the employee shall be renewed daily by the contractor. Visitor access is limited to single visit short duration employees.

E. Some areas in the facility are classified as controlled areas that require government escort of Contractor's personnel. Contractor's personnel must not violate any security regulations pertaining to the facility. The Contracting Officer has the authority to remove anyone from the site, including anyone who is determined to be a security risk. This authority extends to the entire complex, not just the buildings.

F. Facility Security Requirements:

1. Current procedures at FAA facilities include the "right to search". Access to the site constitutes consent to search. If in the judgement of the FAA Security Guard a cause to search a vehicle or the person of personnel exists, such search will be made.

2. Contractor's personnel shall not violate any security regulations pertaining to the ARTCC facility. Violators may be removed from the premises with the right to re-enter revocable.

3. All persons entering or delivering to this federal facility must have valid government issued identification.

Valid issued government identification is:

a) ID issued by the federal, state, county, or city government or by the military.
b) Must have the person's legal name.
c) Must have a unique ID number.
d) Must have an expiration date.
e) Must have a picture of the individual.
f) Must have the name of the agency issuing it.
(examples: state issued driver's license or IDs, passports, or military ID.)

4. Persons entering on to federal property (including visitor parking lot) are prohibited from having on their person or in their vehicle:

a) Guns
b) Knives with blades over 3 inches except for valid tools.
c) Projection devices, bow and arrows, paint ball weapons, blow guns, etc…
d) Clubs, batons, collapsible batons, or saps.
e) Stun guns or tazers.
f) Chemical agents, mace, or pepper sprays.
g) Martial arts weapons of any kind.
h) Weapons of any kind.
i) Alcohol
j) Illegal drugs

k) Animals with the exception of a verified service animal
l) Family members, friends, children, minors, anyone not authorized on the FAA visitor list.

G. Contractor Deliveries: The Contractor must provide an individual, submitted to and approved by the COR, who will be responsible for arranging site access for periodic or unscheduled Contractor deliveries. This individual must coordinate with the COR and facility security personnel, prior to the delivery, for site access of the delivery vehicle. Facility security personnel must be provided, at a minimum, with the name of the vendor, the driver's name, and the purpose for site access. Delivery vehicles arriving at the gate without prior notice and acceptance will be denied access. Delivery vehicles shall only contain items being delivered to FAA; if vehicles contain deliveries for recipients other than FAA at ZID, the vehicle will not be allowed on site. The Contractor assumes complete liability for the actions of delivery personnel and vehicles while on site.

H. Work hours: Normal work hours are 7:30 a.m. to 4:00 p.m., Monday through Friday. No work will be performed outside these hours without prior approval of the COR. If the Contractor intends to work other than normal work hours, the Contractor must notify the COR at least 24 hours in advance, or 48 hours prior to night, weekend, or holiday work. The Contractor shall notify the FAA if personnel will not report to the job site on a normal work day so that the COR and FAA staff can plan accordingly.

I. FAA Maintenance Moratoriums: Unless allowed otherwise by the FAA, no work shall be scheduled or take place during the week of and weekends preceding and following the Thanksgiving, Christmas, and New Year's holidays. Only emergency work to restore critical services to the Facility will be considered and a moratorium waiver must be submitted and approved. The moratorium period will not be counted against the contract construction duration of the project. Verify exact dates with COR and include moratorium dates in Contractor's Construction Schedule (refer to Section 01 32 00).

J. The Contractor's foreman or superintendent, or another responsible individual temporarily assigned to act as the foreman or superintendent, must be present on site at all times whenever work is being done, even if the only work being performed is by a subcontractor or is a delivery.

K. Contractor's use of premises: The Contractor must allow the Government complete access to all portions of the work site at any time.

L. Staging and parking: No parking or material storage will be allowed within 20 feet of any exterior fence. The Contractor's staging area is limited to the area designated by the COR. This will be reviewed and agreed on prior to site mobilization. The Contractor is responsible for providing temporary security fencing of their staging area if desired. See Section 01 50 00, "Temporary Facilities and Controls."

M. Vehicle engines of parked vehicles must not be left idling near air intakes for longer than ten minutes for gasoline engines or two minutes for diesel engines.

N. Special Tool Restrictions: Powder-driven fasteners, tools, and devices are not allowed on facility property. Not including vehicle engines, fuel (including natural gas, propane, gasoline, or diesel) powered tools and devices are only allowed with prior approval and scheduling with the COR. At least 48-hours' notice must be given prior to any proposed use of fuel-powered tools or devices. This restriction includes fuel-powered pumps, generators, welders, and air compressors, including those mounted on vehicles but with their own engines.

O. Outages: The Contractor must request in writing and coordinate any mechanical, water, sewer, or electrical outage at least three working days in advance with the COR. Outages must be kept to a minimum. Outages could require the Contractor to work during other than normal hours at no additional cost to the Government.

Only the FAA will turn off, lock out, and tag out systems, not the Contractor, including to facility equipment, valves, and breakers. The FAA will lock out and tag out systems, and the Contractor may add their lock out and tag out on top of the FAA's. The Contractor shall positively verify de-energization before working on individual systems.

P. The Contractor must provide safety cones, barricades, and flag off exclusion areas, such as overhead work or around openings. Refer to Sections 01 35 29 Health, Safety and Emergency Response Procedures, and 01 45 00 Quality Control.

Q. Testing: The Contractor must notify the COR in writing at least three working days in advance of any testing.

R. In addition, any work involving jackhammering, cutting, sanding, sawing, grinding, drilling, and/or general demolition of concrete or masonry material will generate dust that may contain silica which is harmful when inhaled. These types of activities should be performed wet, when possible, with a localized water misting system, or with the use of local exhaust ventilation (LEV). Ventilation can be achieved with either a portable local exhaust unit, or with tools fitted with a vacuum dust collection (VDC) system. The use of fans for circulation of general room air should be avoided as well as the use of compressed air to clean clothing, tools, or work material. Appropriate eye and respiratory protection should also be considered to prevent exposure.

1.2 SUPPLEMENTARY REQUIREMENTS

A. Damage to the Site: Damage caused by the Contractor's activities to existing facility paving, lawns, curbs, sidewalks, utilities, or buildings must be repaired or replaced by the Contractor. After the Notice to Proceed and prior to the start of construction, the Contractor and COR must conduct joint inspections of the existing areas affected by the construction. Existing site damage/defects in these areas must be noted by the Contractor in writing and photographed and will be used as the basis for determination of any damages caused by the Contractor's operations.

B. Photography Permit: Photography is allowed on site only by permit from the facility, as obtained by the COR. Photographs are generally restricted to documenting the work and progress and should not show any FAA employees or employees' automobile/vehicle license plates. Photographs from the facility are for official Government use only and cannot be used on Contractor promotional material or without the expressed written consent from the FAA.

C. The following items are strictly prohibited on the faculty:

1. Any unsafe act.
2. Explosives.
3. Guns or weapons.
4. Pets or animals.
5. Blocking facility driveways or entrances (see drawings).
6. Allowing fumes or odors from the work to enter the facility (see Article 1.2.F. below).
7. Working on energized electrical circuits.
8. Fires or burning.
9. Use of forklifts, manlifts, loaders or other self-propelled equipment unless equipped with a fire extinguisher.
10. Dripping or leaking vehicles or equipment.
11. Refueling of vehicles or equipment while hot.
12. Bringing any material of health, safety or environmental concern on site without Material Safety Data Sheets (MSDSs) being readily available on the work site, and without spill containment materials in place and ready to catch spills, including while fueling or servicing vehicles or equipment.
13. Open flame, torching, or other welding without a fire watch, fire extinguisher, and daily hot-work permit from the COR.
14. Performing any work on site without properly providing warning signs, safety cones, barricades and flagging off exclusion areas, such as for overhead work or around openings.
15. Performing any work on site without proper personal protective clothing and equipment, such as hard hats, safety glasses, hearing protection, high visibility vests, gloves, protective boots, et cetera.
16. Performing any work on electrical or mechanical systems before positively verifying that the facility has de-energized and locked it out.

17. Use of any tools or equipment without proper inspection before use, including at least daily inspections of equipment.

18. Use of any tools, equipment, or vehicles unless trained, experienced, and certified (if applicable), and authorized by the Contractor, including to operate manlifts or forklifts.

19. Use of any electrical equipment or extension cords in wet conditions or if not in good condition, properly maintained, grounded, and with ground fault circuit interruption (GFCI) protection.

20. Working in an area unless there is at least one 2-A:20-B:C minimum portable fire extinguisher in plain sight and within 50 feet of the work.

21. Working in an area if there is a risk of fire blocking the exit unless a second means of escape is provided in case of emergency.

22. Smoking except in designated areas that have safe receptacles for smoking materials, and that are located more than 50 feet from building entrances.

D. Prevention of Transference of Construction Noise, Dust and Odors: All areas outside the project work areas in the facility will remain occupied and operational (24 hours a day 7 days a week) throughout the entire period of performance of construction. The Contractor is to establish, to the satisfaction of the COR, and maintain provisions to prevent the transference of construction noise, dust and odors from construction areas and activities to the occupied areas of the facility. Such provisions ought to include sealing of existing and new openings in walls, floors and ceilings within the work areas, negative air system, et cetera. The Contractor is to submit to the COR for FAA review and approval proposed methodology for preventing transference.

E. Contractor's Responsibility for Testing: All testing identified in these documents and/or otherwise required for implementation and completion of the project is the responsibility of the Contractor at no additional cost to the Government.

F. HPSB: Applicable portions of the FAA's *High Performance Standards for Buildings (HPSB) Criteria* have been incorporated into the project's design and documents. These include specifications of certain products based on compliance with local availability and/or recycled content, special procedures for collecting and disposing of construction waste (refer to Section 01 74 19), et cetera.

G. Controls: Contractor shall subcontract with Oakland-local vendor of FAA's national controls contractor, Schneider, or Schneider themselves for controls on this project.

H. Security Systems and Components: Contractor shall subcontract with FAA's national Security Systems Design and Integration (SSDI) Contractor Honeywell for all security system and component work, including temporary relocation or removal of existing security components required to complete the work.

I. Salvage Items: Existing fire protection system air compressors, existing I/Net Controllers, and other items designated on the drawings to be removed and not incorporated back into the work are to be protected and turned over to the COR.

1.3 SUBMITTALS

A. Contractor employee list for facility access.

B. Existing site damage/defects report.

C. Methodology for preventing construction noise, dust and odors from transferring for work areas to occupied areas of the facility.

PART 2 - PRODUCTS (Not used)

PART 3 - EXECUTION (Not used)

*** END OF SECTION ***

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SECTION 01 25 00 – SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Contractor's option in selection of products

B. Request for substitution of products

1.2 OPTIONS

A. Products specified by reference standards or by description only: Any product meeting those standards as approved by the COR.

B. Products specified by naming one or more manufacturers with a provision for substitutions: Provide submittal for substitute material as outlined in this Section.

C. Submittals Format: Unless noted otherwise, all submittals are to be provided to the FAA in electronic format. Five (5) hard copies of submittals where colors choices are being submitted for selection or validated are to also be provided along with the electronic copy. Also, hard copies of O&M manuals are to be provided; see Section 01 78 23, "Operation and Maintenance Data."

PART 2 - PRODUCTS

2.1 PRODUCTS

A. In general, manufacturer's names, brand names, or model numbers may be specified for items as a basis of design a schedule, detail or in a list of approved products. This is not meant to be proprietary and the words "or equal" are implied if not expressly stated after every manufacturer's name, brand name, or model number stated in the Specifications. Where manufacturer's names, brand names, or model numbers are specified for items, they set a standard for quality, function, and performance. Products of other manufacturers are not automatically precluded provided they are:

1. Equal or superior in construction, efficiency, utility, or function to the product(s) specified.

2. Of a similar profile, shape, size, style, and configuration and can be incorporated into the Work in the space allocated in a reasonable manner reflective of good design and engineering practices.

3. Accepted by the Architect/Engineer of Record, Contracting Officer (CO) and Contracting Officer's Representative (COR), in writing, as meeting the specified criteria and fit (both physical and functional) within the project. Certain product's manufacturer warranties may also require other related products be produced by the same manufacturer, or by a manufacturer approved by the product's manufacturer.

4. Submitted for approval as a substitution.

B. The Contractor's submittal for approval of material or products of higher quality than that specified will not obligate the Government to pay any additional costs that may be associated with furnishing and installing the substitute material. The Contractor must, in such transmittals, state that there will be no additional costs borne by the Government as a result of the substitution.

C. The Contractor, when submitting for approval of materials which are other than that cited in the Contract Documents, must submit the necessary scale drawings, product data, and performance and test data of both the materials specified and the proposed substitution materials, so that a proper evaluation of the substitution request may be made, including illustrating how the proposed substitution fits within the allocated space in a reasonable manner reflective of good design and engineering practices.

D. The contractor bears all responsibility for the adjustment of affected drawings as a result of any FAA-approved material or equipment 'as equal' substitutions by the contractor and the costs to execute incidental work arising from the substitution to complete FAA design intent. This will include any necessary adjustments of connections, piping or wiring, equipment pad resizing, finishing of exposed areas as a result of the substitution, the need to coordinate with the function and compatibility of other equipment for the full intended function of all individual pieces towards the desired design functional goal, and any other newly required incidental work or changes to the provided design in accordance with this Section 01 25 00, "Substitution Procedures."

PART 3 - EXECUTION (Not used)

*** END OF SECTION ***

SECTION 01 31 00 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 SUMMARY

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

1. General project coordination procedures.
2. Conservation.
3. Submittals and Coordination Drawings.
4. Schedule of Values.
5. Administrative and supervisory personnel.
6. Project meetings.

1.2 COORDINATION

A. Coordination: Coordinate construction operations included in various 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 with other contractors to ensure maximum accessibility for required maintenance, service, and repair.
3. Make adequate provisions to accommodate items scheduled for later installation.

B. If necessary, 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 Contracting Officer's Representative (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 and activities of other contractors 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. Preinstallation conferences.
7. Project closeout activities.

D. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials.

1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work.
2. Comply with Section 01 74 19 with regard to construction waste management and disposal.

1.3 SUBMITTALS

A. Coordination Drawings: Prepare and submit for review and approval by the COR Coordination Drawings to illustrate maximum utilization of space for efficient installation of different components or where coordination is required for installation of products and materials fabricated by separate entities.

1. Indicate relationship of components shown on separate Shop Drawings.
2. Indicate required installation sequences.
3. Refer to the following Sections for specific Coordination and/or Shop Drawing requirements:
   a. Section 21 13 13 "Fire Suppression System"
   b. Section 23 05 00 "Common Work Results for HVAC"
   c. Section 23 21 13 "Hydronic Piping"
   d. Section 23 30 00 "Air Duct Accessories"
   e. Section 23 34 23 "HVAC Power Ventilators"
   f. Section 23 73 13 "Modular Indoor Central Station Air Handling Units"
   g. Section 23 82 39 "Cabinet Unit Heaters"
   h. Section 23 84 13 "Humidifiers"
   i. Section 26 05 00 "Common Work Results for Electrical"

B. Staff Names: Within 15 days of starting construction operations, submit a list of principal staff assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home and office telephone numbers. 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 by each temporary telephone.

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. Schedule of Values (SOV): The Contractor must submit a draft Schedule of Values (SOV) within two weeks after the award, and upon receipt of comments, make revisions and submit a final SOV prior to the Pre-Construction Conference. The purpose of the Schedule of Values is to subdivide the contract amount into line items that can be readily estimated and tracked for monthly progress payment. The SOV must be linked to the Construction Schedule and be

separated into hierarchical groupings using the divisions and sections listed in these specifications.

1. The SOV must have a summary showing the whole project totals, each separate division's subtotals, and then each section within each division's subtotals. The SOV summary must have columns listing the amount of payments received, current payment requested, and amount still remaining on the contract for each hierarchical subdivision.

2. Large dollar amount sections must be further subdivided into activities within the section, as determined by the Contractor. Line items should be of roughly similar value to the extent possible.

3. The SOV must be updated and re-submitted with each pay request and when changes are proposed and have been made to the contract price. Progress SOVs must be agreed to by the COR in advance of pay requests.

1.4 ADMINISTRATIVE AND SUPERVISORY PERSONNEL

A. General: In addition to Project superintendent, provide other administrative and supervisory personnel as required for proper performance of the Work.

1. Include special personnel required for coordination of operations with other contractors.

B. Safety and Health Officer: Provide a safety and health officer whose duties shall consist of developing and implementing safety and health programs specified in Section 01 35 29 "Health, Safety and Emergency Response Procedures."

1.5 ON-SITE PERSONNEL

A. Whenever work is performed on site, the Contractor must have a company-designated superintendent or foreman, Site Safety and Health Officer (SSHO), Quality Control (QC) Officer, at least one worker with current CPR and First Aid certifications, and at least one Contractor telephone for emergency use. For this job, the SSHO and QC Officer positions could be held by one or more qualified workers other than the superintendent or foreman, as designated by the Contractor's management. Each position should have a designated alternate in case the primary person is not available.

The superintendent or foreman, SSHO, and QC Officer must have at least three years of experience in the type of work being performed and each must be designated by the Contractor's management as being a qualified, competent person in their assignment. The site safety and health officer must also meet the qualifications required in Section 01 35 29, "Health, Safety and Emergency Response Procedures".

B. All workers, including subcontractors, except for brief occasional visitors, such as delivery drivers who shall be escorted by the Contractor, must read, understand, and sign-off on the Contractor's Safety Plan before working on site.

C. Site Safety and Health Officer (SSHO). In addition to assuring implementation and monitoring of the Contractor's Safety Plan and project safety requirements in accordance with Section 01 35 29, "Health, Safety, and Emergency Response Procedures," the Contractor's SSHO will:

1. Conduct initial safety briefings to all workers before they start work on site, except for brief occasional visitors, such as delivery drivers who must be escorted by the Contractor.

2. Conduct at least weekly safety briefings on site when work is being performed. Notes about the weekly safety briefing, including topics and issues covered, will be attached to the daily report for that day, along with the signature list of attendees.

3. Maintain lists of workers who have read and signed-off on the safety plan, attended an initial safety briefing, and attended weekly on-site safety briefings.

1.6 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.
2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
3. Minutes: Record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including COR even if he/she did not attend the meeting, within 3 days of the meeting.

B. Preconstruction Conference. Attend a preconstruction conference before starting construction, at a time convenient to Contracting Officer and Contractor but no later than 10 days prior to the start of construction. The conference will be held at Project site or another convenient location. The Contracting Officer will conduct the meeting to review responsibilities and personnel assignments.

1. Attendees: Authorized representatives of FAA, Contractor, and its superintendent; major subcontractors and other concerned parties shall attend the conference. The Contractor will submit their list of attendees, including subcontractors, five days before the meeting in accordance with Section 01 14 00 – 1.1.D.2. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
2. Agenda: The Contracting Officer will distribute the agenda and discuss items of significance that could affect progress, including the following:

   a. Tentative construction schedule.
   b. Safety and Health Checklist items (Obtain proper form from COR for Reporting).
   c. Phasing.
   d. Critical work sequencing.
   e. Designation of responsible personnel.
   f. Procedures for processing field decisions and Change Orders.
   g. Procedures for processing Applications for Payment.
   h. Distribution of the Contract Documents.
   i. Submittal procedures.
   j. Preparation of Record Documents.
   k. Use of the premises.

l. Badging and access.
m. Responsibility for temporary facilities and controls.
n. Parking availability.
o. Office, work, and storage areas.
p. Equipment deliveries and priorities.
q. First aid.
r. Security.
s. Progress cleaning.
t. Working hours.
u. FAA Asbestos Work Permit

C. Preinstallation Conferences: Conduct a Preinstallation Conference at Project site before each construction activity that requires coordination with other construction.

1. Attendees: Installer and representatives of manufacturers (if determined necessary) 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 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 Change Orders.
d. Purchases.
e. Deliveries.
f. Submittals.
g. Review of mockups.
h. Possible conflicts.
i. Compatibility problems.
j. Time schedules.
k. Weather limitations.
l. Manufacturer's written recommendations.
m. Warranty requirements.
n. Compatibility of materials.
o. Acceptability of substrates.
p. Temporary facilities and controls.
q. Space and access limitations.
r. Regulations of authorities having jurisdiction.
s. Testing and inspecting requirements.
t. Required performance results.
u. Protection of construction and personnel.

3. Record significant conference discussions, agreements, and disagreements.
4. 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. Progress and Coordination Meetings: Conduct Progress and Coordination Meetings at weekly intervals. Coordinate dates of meetings with preparation of payment requests. Weekly Progress and Coordination Meetings are in addition to specific meetings held for other purposes such as Preinstallation Meetings.

1. Attendees: In addition to representatives of the FAA and the 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 conference 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 coordinate the work.

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

        1) Interface requirements.
        2) Two-Week Look-Ahead Schedule
        3) Sequence of operations.
        4) Status of submittals.
        5) Deliveries.
        6) Off-site fabrication.
        7) Access.
        8) Site utilization.
        9) Temporary facilities and controls.
        10) Work hours.
        11) Activity Hazards Analysis Forms (Obtain forms from COR).
        12) Progress cleaning.
        13) Quality and work standards.
        14) Change Orders.
        15) Documentation of information for payment requests.

3. Reporting: Distribute minutes of the meeting to the COR, each party present, and other interested parties as determined by the Contractor. Include a brief summary, in narrative form, of progress since the previous meeting and report.

    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 meeting.

E. Safety Meetings: A daily work place safety meeting shall be held prior to commencing work each morning.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 GENERAL COORDINATION PROVISIONS

A. Inspection of Conditions: Prior to installations, require the installer of each major component to inspect both the substrate and conditions under which work is to be performed.

1. Do not proceed until unsatisfactory conditions have been corrected in an acceptable manner.
2. Coordinate temporary enclosures with required inspections and tests to minimize the necessity of uncovering completed construction for that purpose.

B. Construction in Progress: Keep construction in progress, and adjoining materials in place, clean during handling and installation. Apply protective coverings where required for protection from damage or deterioration.

C. Completed Construction: Clean completed construction, and provide maintenance, as frequently as necessary to prevent damage or soiling or other deterioration through the remainder of the construction period. Adjust and lubricate operable components as necessary to assure operability without damage.

D. Limiting Exposures: Supervise construction operations to prevent exposure of any part of construction, completed or in progress, to harmful, dangerous, damaging or otherwise deleterious conditions during the construction period. Such conditions including but not limited to the following:

1. Excessive static or dynamic loading.
2. Excessive internal or external pressures.
3. Excessively high or low temperatures.
4. Thermal shock.
5. Excessively high or low humidity.
6. Pollution and air contamination.
7. Water or ice.
8. Chemicals and solvents.
9. Light.
10. Radiation.
11. Puncture.
12. Abrasion.
13. Heavy traffic.
14. Soiling, staining, and corrosion.
15. Bacteria.
16. Rodent and insect infestation.
17. Combustion.
18. Electrical current.
19. High-speed operation.

20. Improper lubrication.
21. Unusual wear or other misuse.
22. Contact between incompatible materials.
23. Destructive testing.
24. Misalignment.
25. Excessive weathering.
26. Unprotected storage.
27. Improper shipping or handling.
28. Theft or vandalism.

END OF SECTION 01 31 00

SECTION 01 32 00 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

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

1. Preliminary Construction Schedule.
2. Contractor's Construction Schedule.
3. Submittals Schedule.
4. Daily construction reports.
5. Material location reports.
6. Field condition reports.
7. Special reports.
8. Construction photographs.

1.2 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 activities are activities on the critical path. They must start and finish on the planned early start and finish times.
2. Predecessor activity is an activity that must be completed before a given activity can be started.

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 the project.

C. Critical Path: The longest continuous chain of 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 FAA 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 following activity.
3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned project completion date.

F. Fragnet: A partial or fragmentary network that breaks down activities into smaller activities for greater detail.

G. Major Area: A story of construction, a separate building, or a similar significant construction element.

H. Milestone: A key or critical point in time for reference or measurement.

I. Network Diagram: A graphic diagram of a network schedule, showing activities and activity relationships.

1.3 SUBMITTALS

A. Submittals Format: Unless noted otherwise, all submittals are to be provided to the FAA in electronic format. Five (5) hard copies of submittals where colors choices are being submitted for selection or validated are to also be provided along with the electronic copy. Also, hard copies of O&M manuals are to be provided; see Section 01 78 23, "Operation and Maintenance Data."

B. Qualification Data: For firms and persons specified in "Quality Assurance" Article and in-house scheduling personnel to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

C. Submittals Schedule: Arrange the following information in a tabular format:

1. Scheduled date for first submittal.
2. Specification Section number and title.
3. Submittal category (action or informational).
4. Name of subcontractor.
5. Description of the Work covered.
6. Scheduled date for Contracting Officer's Representative's (COR) final release or approval.

D. Preliminary Construction Schedule.

E. Preliminary Network Diagram: Show entire network for entire construction period.

FAA Maintenance Moratoriums: Unless allowed otherwise by the FAA, no work shall be scheduled or take place during the week of and weekends preceding and following the Thanksgiving, Christmas, and New Year's holidays. Only emergency work to restore critical services to the Facility will be considered and a moratorium waiver must be submitted and approved. The moratorium period will not be counted against the contract construction duration of the project. Verify exact dates with COR and include moratorium dates in Contractor's Construction Schedule.

1. Submit an electronic copy of schedule, using software indicated, in a format acceptable by FAA.

F. CPM Updates: Submit update of construction schedule monthly. 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.

G. Daily Construction Reports: Submit at monthly intervals.

H. Field Condition Reports: Submit at time of discovery of differing conditions.

I. Special Reports: Submit at time of unusual event.

1.4 COORDINATION

A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors.

B. Coordinate Contractor's Construction Schedule with the Schedule of Values (SOV), list of subcontracts, Submittals Schedule, progress reports, payment requests, and other required schedules and reports.

1. Secure time commitments for performing critical elements of the Work from parties involved.
2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 - PRODUCTS

2.1 CONSTRUCTION SCHEDULE

The Contractor must submit a draft Construction Schedule within seven (7) days of the award, and upon receipt of comments, make revisions and issue a final Construction Schedule prior to the Pre-construction Conference. The Construction Schedule must be separated into logical tasks within the divisions listed in these specifications, and linked to the scopes of work used in the SOV. The Construction Schedule must include dates anticipated for testing and inspections.

The format of the Construction Schedule must be a Gant-style bar chart on 11x17 landscape paper or PDF, with a task list on the left side column and a row of dates on the top. The dates should be clearly subdivided into months and weeks (a week being Monday through Sunday). If the Construction Schedule is printed on multiple pages, the task list column must be on every sheet in the same location to allow easy reading.

The Construction Schedule must be updated and re-submitted monthly, and when changes are proposed and have been made to the contract schedule. During construction, the Contractor must submit three-week look-ahead schedules every week starting at mobilization.

2.2 SUBMITTALS SCHEDULE

A. Preparation: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, resubmittal, ordering, manufacturing, fabrication, and delivery when establishing dates.

1. Coordinate Submittals Schedule with list of subcontracts, the Schedule of Values, and Contractor's Construction Schedule.
2. Initial Submittal: Submit concurrently with preliminary network diagram. Include submittals required during the first 60 days of construction. List those required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.

    a. At Contractor's option, show submittals on the Preliminary Construction Schedule, instead of tabulating them separately.

3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's Construction Schedule.

2.3 REPORTS

A. Daily (Field) Construction Reports: Prepare a daily (field) construction report and submit by 9:00 am next day to the COR. For that day, the daily report is to record the following information concerning events at Project site:

1. Project name.
2. Date.
3. List of subcontractors and their staff at Project site and hours worked.
4. List of separate contractors and their staff at Project site and hours worked.
5. High and low temperatures and general weather conditions.
6. Safety Concerns, incidents, accidents, injuries, and corrective actions..
7. Meetings and significant decisions
8. Upcoming events, issues, or concern.
9. List of equipment on site and hours used.
10. List of major materials received and quantities.
11 Quality control observations, inspections, tests, issues, deficiencies, and corrective actions.
12. Unusual events (refer to special reports).
13. Stoppages, delays, shortages, and losses.
14. Meter readings and similar recordings.
15. Emergency procedures.
16. Orders and requests of authorities having jurisdiction.
17. Change Orders received and implemented.
18. Construction Change Directives received.
19. Services connected and disconnected.
20. Equipment or system tests and startups.
21. Partial Completions and occupancies.
22. Substantial Completions authorized.
23. Activities (by number and description) worked on with brief description of daily progress.

B. Field Condition Reports: Immediately on discovery of a difference between field conditions and the Contract Documents, prepare 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.

2.4 SPECIAL REPORTS

A. General: Submit special reports directly to FAA within one day of an occurrence. Distribute copies of report to parties affected by the occurrence. All incidents including employee injuries, damage to FAA property, water or solvent leakage from the abatement containment and near misses will be reported to the FAA Resident Engineer immediately after the incident occurs. The contractor will complete an incident report with emphasis on occurrence mitigation no later than the following work shift.

B. Reporting Unusual Events: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise FAA in advance when these events are known or predictable.

PART 3 - EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. Scheduling: Provide a detailed construction schedule using CPM scheduling.

B. Contractor's Construction Schedule Updating: On the first day of the month, submit an updated schedule to reflect actual construction progress and activities.

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 Actual Completion percentage for each activity.

C. Distribution: Distribute copies of approved schedule to 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.

END OF SECTION 01 32 00

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SECTION 01 33 00 – SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 GENERAL

A. 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 ENG Form 4288 submittal register.

B. Submittals Format: Unless noted otherwise herein or in other referenced sections, all submittals are to be provided to the FAA in electronic format. Five (5) hard copies of submittals where material samples or color choices are being submitted for selection or validated are to also be provided along with the electronic copy. Also, hard copies of O&M manuals are to be provided; see paragraph 1.7 below and Section 01 78 23, "Operation and Maintenance Data" for O&M manual detailed requirements.

1.2 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 timetable: A tabulated list using the Submittal Register, showing the date when the Contractor intends to submit each item. Coordinate with Submittals Schedule Section 01 32 00 – 2.2.

C. 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.

1.3 SUBMITTAL REGISTER

A. The Contractor must provide an ENG Form 4288 (not 4288-R) submittal register as follows.

1. Project Title and Location, Date, Contractor Name, and Contract Number: Fill in.

2. Specification Section: List each specification section that requires a submittal on its own line (row) in numerical order. List them as "Section -" and the specification section number and title, such as "Section 26 51 00 – Interior Lighting". Do not include specification sections that do not require submittals.

3. Activity Number: Not used.

4. Transmittal Number column: Leave blank for the initial submittal register. Fill in the transmittal numbers on later progress updates as possible.

5. Item Numbers: Under each specification section, list each submittal on its own line (row) in the order that the items appears in the specification. Number the items consecutively starting with "1" in each specification section. A separate item number must be given to each distinct major submittal item, or product, etc., as follows:

   a. When more than one submittal is required on an individual article, such as product data and a certificate of compliance, one item number must be used. Each such submittal must be listed on a separate line and identified as a sub-item by decimal identification.

   b. When a system is required to be submitted as a complete package, or when an item consists of multiple drawings, such as shop drawings, the package must be given one item number. Components of the package can be listed as decimal sub-items on separate lines of the submittal register, or the Contractor may furnish a supplementary list of the components in the submittal.

6. Specification Paragraph Number: List the paragraph that describes the technical requirements for the item. For submittals developed from the contract drawings, also list the drawing and detail numbers.

7. Description of Submittal: Identify each item by the name of article, such as item "1", specification paragraph "26 51 00-1.4.A", description "Product Data – Interior Lighting."

8. Type of Submittal: List the type of submittal as one of the following: data, drawings, instructions, schedules, statements, reports, certificates, samples, records, or operations and maintenance manuals.

9. Classification: Check "Government Approval" for all. All submittals for this work require Government review and approval.

10. Reviewer: Not used.

11. Contractor Scheduled Dates: Fill in when the item must be submitted, when Governmental approval is needed, and when the item is needed as required by the project schedule.

Adequate lead time for product ordering and shipping must be provided, as well as adequate Government review time as specified in Section 1.4 below.

12. Contractor and Government Action columns: Leave blank on the initial submittal register. Fill in the codes and dates on later progress updates as possible. Codes are described in the instructions for submittal transmittal ENG Form 4025

B. The Contractor must 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.

1.4 CONTRACT SUBMITTALS

A. The Contractor is responsible for the adequacy of submittals for compliance with the Contract.

B. The Contractor must thoroughly review in detail, approve, and certify that each submittal is in strict conformance with contract specifications and drawings, except as may be otherwise explicitly stated, before submitting it to the Government for review and approval.

C. Submittals must be in sufficient detail when first submitted to enable ready determination of the acceptability of the equipment or material. The submittal must be complete, as applicable, with all required working drawings, schedules, diagrams, charts, certificates, samples, test specimens, manufacturer's qualifications, descriptive literature, and performance curves as applicable. Every characteristic of the item specified in the specification must be positively identified in the submittal. The location or use of each unit of equipment or material must be identified in the submittal. The Contractor must make all annotations required to finish any incomplete submittals originating from subcontractors or suppliers. If a submittal is disapproved by the Contracting Officer, or if the Contracting Officer's Representative (COR) determines that the submittal is not adequate to justify the Contractor's approval, the Contractor must make corrections and resubmit the same number of copies as for an original submittal.

D. Failure by the Contractor to make a required submittal for any item of work prior to construction will result in withholding of progress payments for that item.

E. 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.

F. Submittals must be delivered to the COR a minimum of 3 weeks prior to the date the Contractor requires return of the approved submittals with exceptions as otherwise specified. The Contractor is cautioned that this time period does not include any allowance for resubmittal in cases where the Contracting Officer determines that the Contractor's approval and certification are not adequately justified.

G. Delays caused by inadequacies in the Contractor's review process will be the responsibility of the Contractor, and will not be made the subject of a claim for extension of time or for excess costs or damages by the Contractor.

H. 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. This provision applies to deficiencies resulting from erroneous Contractor approvals or work performed prior to the Contracting Officer's approval.

I. 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. Approval must not be construed as authorizing any deviations from the contract specifications and drawings, unless the deviation itself is explicitly designated as the subject of the approval. If a proposed deviation from the original Contract requirements is approved, the new contract requirements will be established as provided in the Contract Clause: "Specifications, Drawings, and Material Submittals".

J. Submittals must include an ENG Form 4025 transmittal. Follow the instructions on the back of the form except as noted below.

1. An electronic copy of a signed original version must be furnished to the COR as part of each submittal. When hard copies of a submittal are required, a copy of the signed original transmittal shall be the first page of each submittal copy.

2. The prime Contractor will be fully responsible for this form and the adequacy of all submittals containing information prepared by its subcontractors.

3. The transmittal number, Item 2 at the top of the form, consists of the specification section number and then numbered sequentially starting with the number "1" for that specification section, such as "26 51 00 – 01" for the first Interior Lighting submittal. Note that the transmittal number is different than the item number. For example, the first transmittal in a specification section could be for the third item number, and the second transmittal could be for the first item number in the specification section. A resubmittal will have a different transmittal number from the original, so reference the original transmittal in Item 9 remarks on the form.

4. In Section 1, Item 2 "From", the submittal is from the Contractor, regardless if a vendor or subcontractor first submitted the item to the Contractor for its review and approval before the Contractor submits it to the Government for review and approval. Include the Contractor's name, mailing address, contact name and telephone number.

5. In Section 1, Item 7, check Box b. All submittals for this work are for Government review and approval.

6. Each transmittal should cover only one section of the specifications or drawings. However, if an item applies to more than one section, a single submittal is acceptable provided the paragraphs of each applicable section are indicated in Column D and all applicable item numbers are listed in Column A on the form.

7. Section 1, Column e Action Code is for use by the Contractor, and Column g is for use by the Government.

8. In Section 1, Item 9 Remarks, if additional space is needed, the Contractor may write "See Attached", and attach a supplemental sheet.

9. Leave Section II of the form blank, which is for the Contracting Officer's action.

K. Deviations: For submittals that do not meet the specifications and drawings, the Contractor may propose a deviation (variation) and the Variation Column on the form must be checked. The Contractor must set forth in writing the justification and all the reasons for any deviations and annotate such deviations on the submittal. The variance must be correlated to the specific specification section and paragraph. Normally, variances are not approved unless there is an advantage to the Government. The Government reserves the right to rescind inadvertent approval of submittals containing unnoted deviations.

L. Drawings: Submittal drawings must be complete and have a title block in lower right hand corner that includes the project name and location, contract number, title for the description of item(s), Contractor's and subcontractor's or fabricator's name(s) and contract numbers, signature and date of the drawing, and drawing revision number. Maximum size of drawings is 24" x 36".

1.5 WARRANTIES/GUARANTIES MANUAL

A. The Contractor must assemble warranties/guarantees executed by each of the respective manufacturers, suppliers, and subcontractors into a combined certified product data, O&M, and warranty book, (see paragraph 1.7) including the Contractor's one-year construction warranty.

B. Each individual warranty must be signed by the provider. This is a requirement for warranties provided by the Contractor and by equipment manufacturers. The Contractor must provide complete information for each item.

1. Product or work item.

2. Firm, with name of principal, address, and telephone number.

3. Scope.

4. Warranty duration.

5. Beginning and ending warranty dates.

6. Provide the following information for the Government.

   a. The proper procedure to evoke the warranty.

   b. Instances that might affect the validity of warranty.

7. Contractor, name of responsible principal, address, and telephone number.

C. Warranties and guaranties in the manual must include any specific warranties and guaranties required by other sections of the technical specifications and other warranties normally provided with the particular piece of equipment or system. Extended warranties normally

provided by manufacturers that are beyond the warranty of construction must be specifically noted.

D. Warranties/Guarantees will not begin until the facility is accepted by the Contracting Officer.

E. Equipment warranty tag: The Contractor must furnish and install equipment warranty tags on all Contractor furnished and installed equipment. Lettering must be Arial bold, upper case, and easily readable. Tags must be durable and state the following.

1. The title "Equipment Warranty".

2. The Contractor's name and contract number.

3. The month-day-year (mm-dd-yy) that the warranty expires.

4. The manufacturer's name, make and model number, point of contact name, and telephone number.

1.6 SUBMITTALS

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. Progress Submittal Registers: Provide updated submittal registers immediately before or with each monthly pay request.

C. Certified Product Data, O&M, and Warranty Manual.

1.7 CERTIFIED PRODUCT DATA RECORD, O&M, AND WARRANTIES MANUAL

A. Certified product data record submittals are required and are to be submitted in a single manual containing the following:

1. Certified Product Data Sheets.

2. Operations and Maintenance (O&M) Information/Data.

3. Warranties.

B. Provide three (3) hard copies of the Certified Product Data, O&M, and Warranties Manual and an electronic copy of the Manual.

C. The Manual must meet the following requirements.

1. Bind in commercial quality three-ring binders with cleanable plastic covers.

2. Label the cover of each binder with typed or printed title "Certified Product Data, O&M, and Warranties and Guarantees", with the title of project, Contract Number, Contractor name, address and telephone number, and the name of the responsible principal.

3. Neatly type the table of contents in the sequence of the table of contents of the specifications with each item identified with the number and title of the specification section and the name of the product or work item.

4. Separate each item with index tab sheets keyed to the table of contents listing. List the subcontractor's, supplier's, and manufacturer's name, address, telephone number, and name of the responsible principal.

PARTS 2 - PRODUCTS (Not used)

PARTS 3 - EXECUTION (Not used)

*** END OF SECTION ***

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SECTION 01 35 13 - SPECIAL PROJECT PROCEDURES

PART 1 – GENERAL

1.1 FACILITY

a. The project is on a restricted entry site and no compromise of the security system in any nature or of any duration may be made without prior approval of the facility and Contracting Officer. The Contractor must allow the Government complete access to any portion of the work on site at any time. See Specification Section 01 14 00, "Work Restrictions," Article 1.1 for requirements for coordination, access the site, and for temporary badging.

b. The work is at a critical facility. The Contractor must not interfere with or disrupt air traffic operations. The work must not discharge static electricity, damage, or interfere with other equipment or operations at the facility.

c. The Contractor must confine operations, activities, storage of materials, and parking within the project boundaries and the approved staging and loading/unloading areas. Any additional space the Contractor deems necessary must be submitted to the Contracting Officer's Representative (COR) for review and approval, or be obtained off site, at no additional cost to the Government. Also see Specification Section 01 50 00, "Temporary Facilities and Controls."

d. In addition, any work involving jackhammering, cutting, sanding, sawing, grinding, drilling, and/or general demolition of concrete or masonry material will generate dust that may contain silica which is harmful when inhaled. These types of activities should be performed wet, when possible, with a localized water misting system, or with the use of local exhaust ventilation (LEV). Ventilation can be achieved with either a portable local exhaust unit, or with tools fitted with a vacuum dust collection (VDC) system. The use of fans for circulation of general room air should be avoided as well as the use of compressed air to clean clothing, tools, or work material. Appropriate eye and respiratory protection should also be considered to prevent exposure.

1.2 SUBMITTALS

a. Contractor's One-Year Construction Warranty

1.3 INTENT OF CONTRACT DOCUMENTS

a. The Contract Documents (drawings and specifications) indicate the work to be performed for the project. All material, labor, equipment, tools, layout, and supervision must be furnished by the Contractor to complete the work and provide complete operating systems of good commercial grade and workmanship to industry standard. Contractor workmanship shall conform to all of the trades involved, and shall include all items of fabrication, construction, or installation regularly furnished or required for completion and for successful operation as intended. All Contractor work shall be performed by individuals skilled in their respective lines of work. The Contractor is responsible for the supervision, health and safety, inspection, and quality control of its own work, workers, work areas, and lower tiered subcontractors. Work shall be performed to ICC, NFPA, and FAA codes and standards, and manufacturers'

recommendations. All work performed and all materials and equipment used will be subject to approval by the Contracting Officer. This includes, but is not be limited to, scheduling, submittals, construction, inspection, testing, and reporting.

b. Titles. Titles to divisions and sections of the specifications and notes and titles on the drawings referring to subcontractors, division of work by trade, or type of work are used for convenience and do not imply any separate contractual arrangements of work assignments. Such separations into titles, divisions, sections, or notes should not be construed to establish limits between the Contractor and its subcontractors.

c. Standards. Reference to known standards in the Contract Documents means the latest edition in effect on the date of the solicitation unless specified otherwise.

d. Where Contract Documents refer to related work in other sections or related requirements, the Contractor should not consider these to be all-inclusive. These are provided as a convenience for cross-reference and coordination.

1.4 SITE MAINTENANCE

a. The Contractor must maintain the job site in a neat and orderly condition, at least as follows. Also see Section 01 74 23, "Final Cleaning,":

1. Daily clean-up of all rubbish and waste, including removal of tools, equipment, and materials not required for the work in progress.

2. Final inspection cleaning.

3. Final cleaning at the completion of work.

b. The Contractor must provide and maintain cleaning supplies and equipment, such as rags, brooms, buckets, mops, and vacuums, throughout the duration of the project, including for immediate cleanup of spills.

c. The Contractor must provide and maintain containers on site for the collection of waste materials, debris, and rubbish. Use of the Government's existing trash containers on site for the work is prohibited.

d. The Contractor must store volatile materials and waste in covered metal containers for fire protection in an approved location, as coordinated with the COR.

e. The Contractor must haul all project waste off site for proper disposal. Burning or burying waste on site is prohibited. Disposal of volatile, harmful, or dangerous materials on the ground or in storm or sanitary sewer systems or drainages is prohibited.

1.5 WARRANTIES

a. The Contractor must provide the Contractor's one-year construction warranty on company letterhead and signed by a company principle. The Contractor' one-year construction warranty will begin on the date of acceptance by the Contracting Officer. The Contractor's warranty shall be provided in the combined Certified Product Data, O&M, and Warranties Manual (see 01 33 00 -1.5. and 1.7).

PART 2 – PRODUCTS (Not used)

PART 3 – EXECUTION (Not used)

*** END OF SECTION ***

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SECTION 01 35 29 – HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. References: In addition to publications referenced in the Construction Contract Clauses, the following Code of Federal Regulations (CFR) publications designate and define hazardous materials and conditions, and establish procedures for handling these materials and conditions.

1. 29 CFR, Part 1910: Occupational Safety and Health Administration (OSHA) General Industry and Health Standards.
2. 29 CFR, Part 1926: OSHA Construction Industry Standards.
3. 40 CFR, Part 61: National Emission Standards for Hazardous Air Pollutants.
4. 40 CFR, Part 261: Environmental Protection Agency (EPA) Characteristics of Hazardous Waste.
5. 40 CFR, Part 761, EPA Polychlorinated Biphenyls (PCBs), Manufacturing, Processing, Distribution in Commerce and Use Prohibitions.
6. 40 CFR, Part 763: EPA Asbestos.

B. Hazardous Materials: Some hazardous and toxic materials and substances are included in 29 CFR Part 1910, subparts H and Z, and in 29 CFR Part 1926. Commonly encountered hazardous materials include but are not limited to asbestos, PCBs, explosives and radioactive material.

1. Asbestos may be found in spray-on fireproofing, insulation, pipe fittings and coverings, lath and plaster, floor tile and base and mastic, and other materials.
2. PCBs may be contained in transformers, capacitors, voltage regulators, oil switches, mechanical insulation and other materials.
3. Lead-based paint or coatings.

C. Acquisition of Publications: Referenced CFR publications may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

1.2 SAFETY REQUIREMENTS

A. Safety Plan: The Contractor will be responsible for initiating and maintaining a Safety Plan. Prior to commencement of work at the job site, the Contractor must submit a Safety Plan for the project for review. Unless the Contractor has a safety plan template, the Safety Plan must utilize an abbreviated version of the U.S. Army Corps of Engineers' Healthy and Safety Manual. The Safety Plan must include sections on accident and fire prevention and fall protection. The Safety Plan must include a requirement that at least on Contractor employee with current CPR and First Aid certifications be on site whenever work is being performed. All workers, including subcontractors, except for brief occasional visitors, such as delivery drivers who shall be escorted by the Contractor, must read, understand, and sign-off on the Safety Plan before working on site. Unless specifically authorized by the Contracting Officer, no work at the project site will be started until the Contractor's Safety Plan is reviewed.

B. Safety and Health Officer: The Contractor must have a designated Site Safety and Health Officer (SSHO) on site whenever work is being performed, to assure implementation and monitoring of the Safety Plan. There must also be at least one designated alternate to fill-in when the primary SSHO is not available. The positions require qualification letters be submitted showing that the individuals each have at least three years relevant experience and are designated by the Contractor as company certified safety officers. These individuals need not be full-time dedicated SSHOs and may be tasked with performing other work, such as the foreman or superintendent if also qualified as SSHOs. Also see Section 01 31 00, "Project Management and Coordination," Article 1.5.C.

1.3 SAFETY MEETING

A. Prior to commencing construction, representatives of the Contractor, including the principal on-site project representative and one or more safety representatives, shall meet with designated representatives of the Contracting Officer's Representative (COR) for the purpose of reviewing the Contract's safety and health requirements.

B. The Contractor's safety and health program shall be reviewed, and implementation of safety and health provisions pertinent to the Work shall be discussed. A short, daily safety meeting shall be held each morning prior to commencing work.

1.4 COMPLIANCE WITH REGULATIONS

A. The Work, including contact with or handling of hazardous materials, disturbance or dismantling of structures containing hazardous materials, and disposal of hazardous materials, shall comply with the applicable requirements of 29 CFR Parts 1910 and 1926, and 40 CFR Parts 61, 261, 761 and 763.

1. Work involving disturbance or dismantling of asbestos or asbestos containing materials, demolition of structures containing asbestos and removal of asbestos, shall comply with 40 CFR Part 61, Subparts A and M, and 40 CFR Part 763, as applicable
2. Work shall additionally comply with applicable state and local safety and health regulations.
3. In case of a conflict between applicable regulations, the more stringent requirements shall apply.

B. Contractor Responsibility: The Contractor shall assume full responsibility and liability for compliance with all applicable codes, standards and regulations pertaining to the health and safety of personnel during execution of the Work, and shall hold the FAA harmless for any action on the Contractor's part, or that of the Contractor's employees or subcontractors, that results in illness, injury or death.

1. The Contractor shall have written safety and health programs in compliance with 29 CFR Parts 1910 and 1926.

1.5 OCCUPATIONAL SAFETY AND HEALTH – ARTICLE 53

A. Information in this Article is required by the FAA to maintain the health and safety of their Employees at facilities during construction operations.

B. The information in this Article is taken from the Agreement between the National Air Traffic Controllers Association (NATCA), AFL/CIO and the Federal Aviation Administration Department of Transportation Agreement (known as "Agreement") for the protection of union workers covered under the "Agreement". "Employer" in Article 53 refers to the FAA; however, construction activities at FAA facilities, and the safety of FAA employees during the construction activities, shall be monitored by the COR. The information in this Article is required to become part of the Contractor's written Safety and Health plan for this Project. Only those "sections" of Article 53 applicable to Contractor's Safety Plan are included in the following paragraphs.

C. Section 1: The Employer shall abide by P.L. 91-596 and Executive Order 12196, concerning occupational safety and health, and regulations of the Assistant Secretary of Labor for occupational Safety and health and such other regulations as may be promulgated by appropriate authority.

D. Section 2: The Employer shall make every reasonable effort to provide and maintain safe and healthful working conditions. Factors to be considered include, but are not limited to, proper heating, air conditioning, ventilation, air quality, lighting and water quality.

E. Sections 4 through 6: (Not included – Not applicable.)

F. Section 8: (Not included – Not applicable.)

G. Section 9: In the event of construction or remodeling within a facility, the Employer shall insure that proper safeguards are maintained to prevent injury to bargaining unit employees.

H. Section 10: If the Employer initiates or permits the use or storage of chemicals, pesticides, or herbicides at any facility, Material Safety Data Sheets (MSDS) for each chemical, pesticide or herbicide shall be provided to the Union prior to use/storage. Any pregnant/nursing employees or personnel with medical conditions which could be aggravated by the use of the chemicals, pesticides or herbicides shall be reasonably accommodated in a manner so as to prevent exposure. All chemicals, pesticides and herbicides shall be used in accordance with applicable law and the manufacturer's guidelines and precautions.

I. Sections 11 and 12: (Not included – Not applicable.)

1.6 OCCUPATIONAL SAFETY AND HEALTH – ARTICLE 77

A. Information in this Article is required by the FAA to maintain the health and safety of their Employees at facilities during construction operations at locations where asbestos abatement is anticipated.

B. The information in this Article is taken from the Agreement between the National Air Traffic Controllers Association (NATCA), AFL/CIO and the Federal Aviation Administration Department of Transportation Agreement (known as "Agreement") for the protection of union workers covered under the "Agreement". "Agency" in Article 77 refers to the FAA; however, construction activities at FAA facilities, and the safety of FAA employees during the construction activities, shall be monitored by the COR. The information in this Article is required to become part of the Contractor's written Safety and Health Plan for this Project, by reference.

C. Section 2. In the event that a facility is planning a construction project which may cause the release of airborne asbestos fibers in areas frequented by bargaining unit employees, the Principal Facility Representative or designee shall be given a pre and post briefing on the construction project and be permitted to participate in all abatement project meetings that may impact bargaining unit employees. Additionally, the Principal Facility Representative will be permitted to attend any management briefings at the facility concerning air sampling and monitoring information. If, during the construction project, there is a release of airborne asbestos fibers, the Principal Facility Representative or designee shall be immediately notified, will receive periodic progress reviews as appropriate, and will be provided copies of all documents concerning the release. Upon request, the Principal Facility Representative shall be given an explanation of these reports. In addition, the Union may appoint a representative on each shift to receive copies of all air monitoring reports as soon as they can be made available. Upon request, the Union's Hygienist shall be permitted to attend meetings under this Section.

D. Section 3. The objectives of air monitoring by the Agency in connection with construction projects are as follows:

1. to establish baseline fiber levels in affected occupied space;
2. to determine if fiber levels are above established baseline levels are present in these occupied spaces; and
3. to determine if correlations exist between routine activities and any increase above baseline. Baseline fiber levels at each facility shall be established by the Agency in consultation with the Union's Certified Industrial Hygienist.

E. Section 5. Any evidence of visible release or airborne asbestos contamination, in excess of FAA/OSHA safety limits, shall result in immediate control steps by the Agency to abate the hazard caused by the asbestos. The Agency shall retain an asbestos abatement contractor as soon as possible.

F. Section 6. The Agency and all abatement contractors hired must comply with all applicable OSHA, EPA, FAA, local, and state regulations regarding asbestos. Contractors directly involved in the abatement process must be certified by their local and state governments.

G. Section 7. If protection measures will not provide adequate protection of occupants, the Agency will relocate bargaining unit employees outside of the affected work area while asbestos removal or renovation work is being done. This includes any work where asbestos may be disturbed due to construction activity.

H. Section 8. In the event that relocation is not required/possible, the abatement contractor will seal off the abatement area, when required, with a negative pressure enclosure. When negative enclosures are used, the contractor will ensure and maintain negative pressure at all times.

I. Section 9. Decontamination facilities will be provided for all abatement workers and strict decontamination procedures will be enforced to insure that workers cannot bring asbestos outside of the enclosure.

J. Section 11. The contractor will be required by the Agency to take continuous air samples by Phase Contrast Microscopy (PCM) both inside and outside the containment. Sample results will be posted the day they are received. All data and reports from the laboratory will be shared with the Union as soon as they are received. Representative personal monitoring shall also be conducted in accordance with the model contingency plan on at least one (1) employee in areas occupied by bargaining unit employees. Due to the potential noise level of the monitor and its associated distractions, any bargaining unit member who volunteers to wear the monitor shall, if staffing and workload permits, be assigned to a non-control position for the period in which such monitoring occurs.

K. Section 12. The abatement area cannot be reoccupied until it has passed a visual inspection and met a clearance air sampling criteria (e.g. by PCM or Transmission Electron Microscopy (TEM)) in accordance with applicable regulations.

L. Section 13. The Union, at its own expense, may designate an Industrial Hygienist to observe the work of the abatement contractor. Upon request, the Union will be given the air sampling slides for validation by an accredited laboratory, either on- or off-site. These materials will be returned to the Agency with a written chain-of-custody record covering the period during which they were outside the possession of the Agency. Upon request, the Union's Hygienist will be given the opportunity to validate, through an accredited laboratory, any air samples collected by the Agency. The Union's Hygienist will be allowed to perform side-by-side TEM air monitoring on a random basis, on days and times to be determined by the Union, at the Union's expense. The Parties will exchange copies of all reports, records, memoranda, notes and other documents prepared by the Agency, the Agency's contractor, the Union, the Union's Hygienist and the Union's accredited laboratory. The Union will give the Agency advance notice of visits by its Hygienist.

M. Section 14. Bargaining unit employees who have been exposed to levels equal to or greater than OSHA permissible exposure limits shall be eligible for medical surveillance programs paid for by the Agency, in accordance with OSHA standards/FAA directives.

N. Section 15. The Agency recognizes its obligation to comply with the requirements of 29 CFR in connection with all facets of asbestos abatement operations. Asbestos abatement will comply with OSHA Standards 1910 and 1926, FAA Order 3900.19, the Agency's O&M Plan, and the appropriate facility Model Asbestos Abatement Contingency Plans.

1.7 SUBMITTALS

A. Safety and Health Programs: The Contractor shall submit, for approval, copies of the project Safety And Health Programs and Safety Plan (see Article 1.2) , as applicable to the work scope, or required as a result of the safety meeting, including but not necessarily limited to the following:

1. Occupational Noise Exposure.
2. Fall Protection.
3. Personnel Protective Equipment.
4. Control of Hazardous Energy.
5. Electrical Safety Related Work Practices.
6. Lead.
7. Asbestos.
8. Respirator Protection.
9. Confined spaces.

B. Permits: If hazardous materials are disposed of off-site, submit copies of shipping manifests and permits from applicable federal, state or local authorities and disposal facilities, and submit certificates that the material has been disposed of in accordance with regulations.

C. Accident Reporting: Submit a copy of each accident report that the Contractor or Subcontractors submits to their insurance carriers, within seven calendar days after the date of the accident.

D. Contractor must submit information on the type and location of on-site fire extinguishers and first-aid equipment and supplies.

E. Hard Hat Signs: The Contractor must submit to the Contracting Officer's Representative (COR) the proposed locations and an example for approval of the "Hard Hat Area" signs at each entry to the project site or work area. A minimum of two signs will be required.

1.9 SAFETY SHEETS

A. Hard copies of product safety sheets for all products and materials incorporated into the work are to be maintained in the Contractor's field office on site and made available to FAA personnel for review upon request.

PART 2 - PRODUCTS

2.1 PERSONNEL PROTECTIVE EQUIPMENT

A. Special facilities, devices, equipment and similar items used by the Contractor in execution of the Work shall comply with 29 CFR Part 1910, Subpart I and other applicable regulations.

2.2 HAZARDOUS MATERIALS

A. The Contractor shall bring to the attention of the COR any material encountered during execution of the Work that the Contractor suspects is hazardous.

B. The COR shall determine whether the Contractor shall perform tests to determine if the material is hazardous.

C. If the COR directs the Contractor to perform tests and the material is found to be hazardous, or if the material is found to be hazardous without Contractor testing, a change to the Contract price may be provided, subject to the applicable provisions of the Contract.

PART 3 - EXECUTION

3.1 EMERGENCY SUSPENSION OF WORK

A. When the Contractor is notified by the COR of non-compliance with the safety or health provisions of the Contract, the Contractor shall immediately, unless otherwise instructed, correct the unsafe or unhealthy condition.

1. If the Contractor fails to comply promptly, all or part of the Work will be stopped by notice from the COR.
2. When, in the opinion of and by notice given by the COR satisfactory corrective action has been taken by the Contractor, work shall resume.
3. The Contractor shall not be allowed any extension of time or compensation for damages in connection with a work stoppage for an unsafe or unhealthy condition.

3.2 PROTECTION OF PERSONNEL

A. The Contractor shall take all necessary precautions to prevent injury to the public, occupants, or damage to property of others. The public and occupants includes all persons not employed by the Contractor or a subcontractor.

B. Wherever practical, the work area shall be fenced, barricaded or otherwise blocked off from the public or occupants to prevent unauthorized entry into the work area.

1. Provide traffic barricades and traffic control signage where construction activities occur in vehicular areas.
2. Corridors, aisles, stairways, doors and exitways shall not be obstructed or used in a manner to encroach upon routes of ingress or egress utilized by the public or occupants, or to present an unsafe or unhealthy condition to the public or occupants.
3. Store, position and use equipment, tools, materials, scraps and trash in a manner that does not present a hazard to the public or occupants by accidental shiftings, ignition or other hazardous activity.
4. Store and transport refuse and debris in a manner to prevent unsafe and unhealthy conditions for the public and occupants. Cover refuse containers, and remove refuse on a frequent regular basis acceptable to the COR. Use tarpaulins or other means to prevent loose transported materials from dropping from trucks.

3.3 ENVIRONMENTAL PROTECTION

A. Dispose of solid, liquid and gaseous contaminants in accordance with local codes, laws, ordinances and regulations.

B. Comply with applicable federal, state and local noise control laws, ordinances and regulations, including but not limited to 29 CFR 1910.95 and 29 CFR 1926.52.

END OF SECTION 01 35 29

SECTION 01 35 53 - SECURITY PROCEDURES

PART 1 - GENERAL

1.1 SECURITY REQUIREMENTS

A. Bidding Clearances: Bidders will be required to comply with security regulations imposed by the occupying agency including any necessary clearances. Access to the project site will be limited to specific times established by the FAA. Call the Contracting Officer's Representative (COR) for instructions.

B. Construction Clearances: After award of the Contract, all Contractor employees shall be required to furnish information for security clearances and shall comply with security regulations as imposed by the occupying agency. All persons receiving access to FAA site shall be citizens of the United States of America.

1. Procedures for acquiring facility access badges are identified in Section 01 14 00 Work Restrictions.

1.2 SECURITY REGULATIONS

A. Agency Security Regulations: All persons employed within the boundaries of the property or restricted-access areas therein, and all persons permitted to enter such property and areas shall comply with the security regulations that have been established for this Contract.

1. The Contractor agrees on behalf of himself and all subcontractors that the following security regulations will be observed by Contractor and subcontractor personnel on the property. The Contractor shall make it a specific provision of his subcontracts that these regulations be accepted.

2. At the commencement of the work under this contract, the following security procedures shall apply to the Contractor and all subcontractors.

a. Do not enter the building without building passes or park without parking permits. Vehicle authorization requests shall be required for any vehicle entering the site, and shall be submitted 24 hours before the date and time of access. Access shall be restricted to picking up and dropping off materials and supplies, and, with a permit issued by the FAA, to parking in designated areas.
b. Comply with the security regulations of the building.
c. In the case of any questions as to the eligibility of an individual to obtain a pass, notify the COR, who will obtain a determination whether the individual can obtain a pass.
d. Cameras are not permitted without written permission from the Occupant Agency and the COR. If approved, permission will be granted in writing and will provide additional guidelines.

e. Personnel may be subject to inspection of their personal effects when entering and leaving the facility. In addition, unscheduled inspections of personnel may be made while on site.
f. If any work is canceled, notify the COR.

3. The Occupant Agency reserves the right to close down the job site and order Contractor personnel off the premises in the event of a national emergency or a shut-down, for as long as security problems persist. The Contractor may only return to the site with verbal approval from the FAA and the COR.
4. The FAA reserves the right to exclude or remove from the site or building any employee of the Contractor or a subcontractor whom the FAA deems incompetent, careless, insubordinate or otherwise objectionable, or whose continued employment on the work is deemed by the FAA to be contrary to the public interests. The FAA further reserves the right to complete processing of the security documentation for personnel assigned to work within restricted access areas prior to access to such areas by the personnel.
5. No interviews shall be conducted within the secured area. Applicants for employment and other persons not entitled to access to the secured area shall be required to contact the Contractor or subcontractor at some other location.
6. The Contractor shall notify the COR in writing at least three working days in advance of any work planned on the facility outside of the Contractor's normal work area.

PART 2 - PRODUCTS (Not used)

PART 3 - EXECUTION (Not used)

END OF SECTION 01 35 53

SECTION 01 45 00 – QUALITY CONTROL

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. General Quality Control

B. Workmanship

C. Manufacturer's Instructions

D. Manufacturer's Certificates

E. Manufacturer's Field Services

1.2 RELATED SECTIONS:

A. Section 01 33 00, "Submittal Procedures"

1.3 GENERAL QUALITY CONTROL: Maintain quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of specified quality.

1.4 QUALITY CONTROL OFFICER: The Quality Control (QC) Officer must have at least three years of experience in the type of work being performed and each must be designated by the Contractor's management as being a qualified, competent person in their assignment.

1.5 WORKMANSHIP

A. Comply with industry standards except when more restrictive tolerances or specified requirements indicate more rigid standards or more precise workmanship.

B. Perform work by persons qualified to produce workmanship of specified quality.

C. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, and racking.

1.6 MANUFACTURER'S INSTRUCTIONS: Comply with instructions in full detail, including each step in sequence. Request clarification from the Contracting Officer before proceeding if instructions conflict with Contract Documents,

1.7 MANUFACTURER'S CERTIFICATES: When required by individual specification sections, submit manufacturer's certificates, in duplicate, that products meet or exceed specified requirements.

1.8 MANUFACTURER'S FIELD SERVICES

A. When specified by individual specification sections, require suppliers and/or manufacturers to provide qualified personnel to observe field conditions, conditions of surfaces and installation, quality of workmanship, testing, and to make appropriate recommendations.

1.9 TESTING NOTIFICATION: The Contractor must notify the COR in writing at least three working days in advance of any testing.

1.10 INSPECTION SCHEDULE

A. Coordinate with requirements of Section 01 77 00 "Closeout Procedures." The Contractor must provide one week written notice to the COR for the following items of work that require inspection:

1. Completion of Demolition
2. Pre-Substantial Completion: When the Contractor considers the work substantially complete and ready for inspection, the Contractor must request a pre-substantial completion inspection. After the pre-substantial completion inspection, the COR will develop an initial punch list of work remaining to be completed by the Contractor.
3. Substantial Completion
   a. Prior to the substantial completion inspection, the Contractor must:
      1) Complete all initial punch list items.
      2) Remove all tools, equipment, and excess materials from in and around the building to the staging area.
      3) Restore its work areas in and around the building, including repair of lawns, curbs, and sidewalks as needed.
      4) Clean up its work areas in and around the building.
      5) Provide all required operation and maintenance manuals, red-lined as-built drawings, and training.
   b. After completion of the above, as inspected and approved by the COR, the Contractor must request a substantial completion inspection. The COR will arrange the substantial completion inspection with the Contractor and with facility operations and maintenance personnel. During the substantial completion inspection, the Contractor must demonstrate complete testing, operation, and maintenance of all work by skilled technicians. After the substantial completion inspection, the COR will develop a final punch list of work to be completed by the Contractor.
4. Final Completion
   a. Prior to the final completion inspection, the Contractor must:
      1) Complete all final punch list items.
      2) Provide any remaining required documentation.
      3) Remove all office trailers, storage and waste containers, equipment, tools, and excess materials from the staging area and facility.
      4) Restore its work areas in the staging area and facility, including repair of lawns, pavement, curbs, and sidewalks as needed.
      5) Clean up its work areas in the staging area and facility.
      6) Submit a Completion Certification.
   b. Completion Certification: The Contractor must submit a written Completion Certification to the Contracting Officer that certifies:
      1) Contract documents have been reviewed.
      2) The work has been inspected for compliance with contract documents.

3) Equipment and systems have been tested in the presence of the COR and facility operations and maintenance personnel, and are fully operational.
4) The required operation and maintenance manuals with maintenance schedules and parts list as applicable have been submitted.
5) The required project records and as-built documentation have been submitted.
6) The required instruction and training of facility operations and maintenance personnel have been performed.
7) The work is complete, premises cleaned, and are ready for acceptance.

c. Final Completion Inspection: After completion Item 5.a above, as inspected and approved by the COR, the Contractor must request a final completion inspection. After the final completion inspection, the COR will notify the Contractor of any remaining work to be completed.

1.11 DUST

A. Where dust would impact or impair execution of the Work, dust control measures such as broom-cleaning or HEPA vacuums are to be used

PART 2 - PRODUCTS (Not used)

PART 3 - EXECUTION (Not used)

*** END OF SECTION ***

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SECTION 01 50 00 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Furnish, install and maintain temporary facilities required for construction.

1.2 RELATED SECTIONS

A. Section 01 14 00, "Work Restrictions."
B. Section 01 35 29, "Health, Safety, and Emergency Response Procedures."

1.3 AVAILABILITY OF UTILITY SERVICES

A. The Government will provide reasonable amounts of utilities including water and electricity for the use of the Contractor as may be necessary for Contractor related work based on COR approval. Such utility connections will be via existing hose bibs and receptacles only and may not overload any aspect of the facility's systems. Contractor will be responsible for repairing any damage to facility systems resulting from mis-use or over-use of utilities.

B. Communications: The Contractor will be responsible for providing its own telephone.

C. Sanitary Facilities: The Contractor will furnish portable sanitary facilities for Contractor and Subcontractor personnel. The location of the facilities will be determined in coordination with COR, however at the minimum one should be located in the area of work and one near the field office (if the Contractor provides a field office).

1.4 TEMPORARY POWER: The Contractor must provide construction power facilities in accordance with the safety requirements of the National Electric Code (NEC) and the Safety Hazard Risk Management (SHRM). The Contractor must enforce the electrical extension safety requirements for all the project work. Skilled electrical tradesmen must accomplish electrical work.

1.5 FIRE PROTECTION: The Contractor must provide fire extinguishers in accordance with the safety requirements of the SHRM.

1.6 SECURITY

A. 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.

B. 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. The Contractor shall provide the COR two copies of the staging area's gate lock's key or combination, one for the COR and the other for FAA security personnel.

C. The Contractor should not leave materials, tools, or equipment unsecured on the project site.

1.7 FIELD OFFICE

A. Contractor is responsible for providing a field office and meeting space trailer(s) if desired. The FAA will not provide interior office space or facilities for Contractor's use. The field office may be accommodated in the provided staging area, where there will be access to an electrical connection. No water, sewer, or communication connections will be provided.

1.8 STAGING AREA

A. Also see Section 01 14 00, "Work Restrictions," Article 1.1.l.

B. The staging area size and location will be determined in coordination with COR prior to on-site mobilization.

C. The Contractor will be responsible for keeping the staging area clean. All loose debris and material subject to being blown by the wind must be picked up or secured at all times.

D. If the area is not maintained in a 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.

E. Subject to approval by the facility, the Contractor may provide temporary security fencing around their staging area, provided the fence posts do not penetrate or otherwise damage the ground, slab, or paving. The Contractor shall provide the COR two copies of the staging area's gate lock key or combination. One copy is for the COR and the other is for facility security personnel.

PART 2 – PRODUCTS (Not used)

PART 3 – EXECUTION (Not used)

*** END OF SECTION***

SECTION 01 61 00 – COMMON PRODUCT REQUIREMENTS

PART 1 - GENERAL

1. 1. REQUIREMENTS

A. Material and equipment incorporated into the work must conform to applicable specifications and standards and comply with size, type, and quality specified, unless a substitute is approved in writing by the Contracting Officer.

B. Materials shall be standard products from manufacturers regularly engaged in the manufacturing of such products that have been in satisfactory commercial or industrial use for at least three years. Materials shall be identifiable, bearing the manufacturer's name and model number. All material shall be new and of good commercial grade, unless noted otherwise as existing for reuse. Not all materials are shown or listed.

C. The Contractor must provide, install, maintain, and operate a complete and adequate facility for the handling, execution, disposal, and distribution of all material and equipment required for the proper and timely performance of all work connected with the Contract.

D. The Contractor workmanship must conform to all of the trade(s) involved, and must include all items of fabrication, construction, or installation regularly furnished or required for completion and for successful operation as intended. All Contractor work must be executed by individuals skilled in their respective lines of work.

E. The Contractor must store all materials in such manner as necessary to properly protect same from damage. Materials or equipment damaged by handling, or from any other cause, will not be accepted. The Contractor must store all materials so as to cause no obstructions: store off sidewalks, roadways, and underground services. The Contractor will be responsible for protecting all materials and equipment furnished under the Contract.

F. The Contractor must provide a Material Safety Data Sheet (MSDS) on all chemical products per the OSHA Construction Standards, 29CFR-1910.1200 and 29CFR-1926.59. This MSDS is required for all chemicals purchased and brought on site. This would apply to such things as, but not limited to, paint, thinners, roofing and carpet adhesives, etc.

G. Hazardous Materials: No known hazardous building materials or asbestos containing products are to be utilized or installed in this project.

H. Use low-odor/ low VOC adhesives, sealants, cleaners, mastics, and other materials. During the submittal process, notify the Contracting Officer's Representative (COR) when low-odor/ low-VOC alternatives are not available for any required products or uses.

1.2 RELATED SECTIONS

A. Section 01 33 00, "Submittal Procedures"
B. Section 01 45 00, "Quality Control"

1.3 SUBMITTALS

A. Material Safety Data Sheets required

1.4 CERTIFIED PRODUCT DATA RECORD SUBMITTALS

A. Certified product data record submittals are required and are to be submitted in a single manual containing the following:

1. Certified Product Data (Certified Product Data Sheets).

2. Operations and Maintenance (O&M) Information/Data.

3. Warranties.

B. Provide three (3) hard copies of the Certified Product Data Record Submittals Manual and an electronic copy of the Manual.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01 66 00 – PRODUCT STORAGE AND HANDLING REQUIREMENTS

PART 1 - GENERAL

1.1 REQUIREMENTS INCLUDE

A. Provide protection of work from weather, physical damage, improper use, and other adverse natural conditions.

B. Replace any damaged work including finishes, materials, and equipment.

C. Store products at job site in accordance with manufacturer's instructions with product seals and labels intact and legible.

1. Store products within temperature and humidity range recommended by manufacturer.

2. Cover and protect materials subject to damage by the elements.

1.2 EXTERIOR STORAGE

A. Store products above the ground, on blocking or skids to prevent soiling or staining. Cover products subject to moisture damage with impervious sheet coverings. Provide adequate ventilation to avoid condensation.

B. Distribute materials temporarily stored on the roof to avoid permanent deflection of deck and stay within the live load limits of the roof (20 psf). Remove unused material from the roof at the end of each day's work.

1.3 PROTECTION DURING INSTALLATION

A. Provide protection of temporary openings in the building to protect the contents and enable work.

B. Provide protection of base materials to receive finishes or other work from weather and physical damage.

1.4 PROTECTION AFTER INSTALLATION

A. Provide protection of installed products to prevent damage from subsequent operations. Remove when no longer needed, prior to completion of work.

B. Control traffic to prevent damage to equipment and surfaces.

C. Waterproofed Surfaces

1. Prohibit use of membrane surfaces for work traffic and for storage of any products.

2. When some activity must take place in order to carry out the Contract, obtain the recommendations of installer for protection of surfaces.

a. Install recommended protection and remove upon completion of that activity.

b. Restrict use of adjacent unprotected areas.

D. Lawns and Landscaping

1. Avoid storage on, or travelling across, planted lawn and landscaped areas. When unavoidable, provide protection in the form of plywood boards on turf area, etc.

2. Contractor to hire professional landscaping firm to replant or repair any damaged landscaped areas to same condition as originally found, subject to Owner's agreement and approval, at no cost to Owner. See Section 01 14 00 "Work Restrictions".

PART 2 - PRODUCTS (Not used)

PART 3 - EXECUTION (Not used)

*** END OF SECTION ***

SECTION 01 73 00 - EXECUTION

PART 1 - GENERAL

1.1 SUMMARY

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

1. General installation of products.
2. Coordination of FAA-installed products.
3. Progress cleaning.
4. Starting and adjusting.
5. Protection of installed construction.
6. Correction of the Work.

1.2 SUBMITTALS

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

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

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

1. Before construction, verify the location and points of connection of utility services.

B. Existing Utilities: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities and other construction affecting the Work.

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

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

   a. Description of the Work.
   b. List of detrimental conditions, including substrates.
   c. List of unacceptable installation tolerances.
   d. Recommended corrections.

2. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
3. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
4. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
5. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Existing Utility Information: Furnish information to local utility and FAA if it is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.

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

1. Notify Contracting Officer's Representative (COR) not less than two weeks in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without COR's written permission

C. 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.

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

E. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to COR. Include a

detailed description of problem encountered, together with recommendations for changing the Contract Documents.

3.3 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 8 feet in spaces without a suspended ceiling.

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. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.

F. Anchors and Fasteners: Provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of the Work.

1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by COR.
2. Allow for building movement, including thermal expansion and contraction.

G. 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.

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

3.4 FAA-INSTALLED PRODUCTS

A. Site Access: Provide access to Project site for FAA's or other contractor's construction forces.

B. Coordination: Coordinate construction and operations of the Work with work performed by FAA's construction forces.

1. Construction Schedule: Inform COR of Contractor's preferred construction schedule for FAA's portion of the Work. Adjust construction schedule based on a mutually agreeable

timetable. Notify FAA if changes to schedule are required due to differences in actual construction progress.

2. Preinstallation Conferences: Include FAA's construction forces at preinstallation conferences covering portions of the Work that are to receive FAA's work. Attend preinstallation conferences conducted by FAA's construction forces if portions of the Work depend on FAA's construction.

3.5 PROGRESS CLEANING

A. Site Maintenance: The Contractor must maintain the job site in a neat and orderly condition.
1. The Contractor must secure all their material from damage and being blown about by the wind.
2. The Contractor must contain dust in their immediate work areas in order to maintain a dust-free facility.
3. The Contractor must maintain their work areas at least as follows.
   a. Daily cleanup of all rubbish and waste, including removal of tools, equipment, and materials not required for the work in progress.
   b. Final inspection cleaning.
   c. Final cleaning at the completion of work.
4. The Contractor must provide and maintain cleaning supplies and equipment, such as rags, brooms, buckets, mops, and vacuums, throughout the duration of the project, including for immediate cleanup of spills.
5. The Contractor must provide and maintain containers on site for the collection of waste materials, debris, and rubbish. The Contractor must store volatile waste in an approved covered metal container for fire protection. Use of the Government's existing trash containers on site for the work is prohibited.
6. The Contractor must haul all project waste off site for proper disposal; refer to additional requirements in Section 01 74 19 Construction Waste Management. Burning or burying waste on site is prohibited. Disposal of volatile, harmful, or dangerous materials on the ground or in storm or sanitary sewer systems or drainages is prohibited.

B. General: Clean Project site and work areas daily, including common areas. Coordinate progress cleaning for joint-use areas where more than one installer has worked. Enforce requirements strictly. Dispose of materials lawfully.

1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
2. Do not hold materials more than 7 days during normal weather or 3 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 all regulations.

C. Site: Maintain Project site free of waste materials and debris.

D. 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.

E. 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.

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

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

H. Cutting and Patching: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.

1. Thoroughly clean piping, conduit, and similar features before applying paint or other finishing materials. Restore damaged pipe covering to its original condition.

I. Waste Disposal: Burying or burning waste materials on-site will not be permitted. Washing waste materials down sewers or into waterways will not be permitted.

J. 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.

K. 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.

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

3.6 STARTING AND ADJUSTING

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

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

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

D. Manufacturer's Field Service: If a factory-authorized service representative is required to inspect field-assembled components and equipment installation, comply with qualification requirements in Section 01 45 00 "Quality Control."

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

3.8 CORRECTION OF THE WORK

A. Repair or remove and replace defective construction. Restore damaged substrates and finishes. Comply with requirements in Section 01 73 29 "Cutting and Patching."

1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.

B. Restore permanent facilities used during construction to their specified condition.

C. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.

D. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.

E. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION 01 73 00

SECTION 01 73 29 - CUTTING AND PATCHING

PART 1 - GENERAL

1.1 REQUIREMENTS INCLUDED

A. The Contractor will be responsible for all cutting, fitting, and patching required to complete the work or to:

1. Make the parts fit together properly.
2. Remove and replace defective work.
3. Remove and replace work not conforming to requirements.
4. Remove samples of installed work as specified for testing.
5. Uncover portions of the work to provide for installation of items omitted during earlier portions of the construction.

1.2 SUBMITTALS

A. Submit a written request through the COR to the Contracting Officer five working days in advance of executing any cutting or alteration which affects:

1. The work of the Government or any separate Contractor.
2. The integrity of weather-exposed or moisture-resistant elements or systems.

B. The Contractor's request must include

1. Identification of the project.
2. Description of affected work.
3. The necessity for cutting or alteration.
4. Effect on work or other work, or on structural or weather-proof integrity of project.
5. Description of proposed work
   a. Scope of cutting, patching, or alteration.
   b. Trades who will execute the work.
   c. Products proposed to be used.
   d. Extent of refinishing to be done.
6. Alternatives to cutting and patching.
7. Cost proposal, when applicable.
8. Written concurrence of any separate contractor whose work will be affected.

C. If conditions of work or the schedule indicate a change of products from original installation, Contractor must submit request for substitution as specified in Section 01 25 00 and Section 01 33 00.

D. Submit written notice through the COR to the Contracting Officer designating the date and time the work will be uncovered.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Use materials and products that are similar or identical to existing materials unless otherwise called out on the drawings. If identical materials are not available or cannot be used where exposed surfaces are involved, use materials that match adjacent surfaces to the fullest extent possible with regard to visual effect such that the end result is indistinguishable from the original. If this not be possible, replace the complete system as directed by the Contracting Officer. Use materials whose installed performance will equal or surpass that of existing materials.

PART 3 - EXECUTION

3.1 INSPECTION

A. Inspect existing conditions of project, including elements subject to damage or to movement during execution of the work.

B. After uncovering work, inspect conditions affecting installation of products or performance of work.

C. Report unsatisfactory or questionable conditions to COR in writing. Do not proceed with work until COR has provided approval of the revised cutting and patching methods.

3.2 PREPARATION

A. Provide devices and methods to protect other portions of the project from damage.

B. Provide protection from the elements for that portion of the project that could be exposed by cutting and patching work and maintain them free from water.

3.3 PERFORMANCE

A. Execute cutting and demolition by methods that will prevent damage to other work, and will provide proper surfaces to receive installation of repairs.

B. Restore work that has been cut or removed. Install new products to provide complete work in accordance with requirements of the Contract Documents.

C. Fit work weather tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.

D. Patch with durable seams that are invisible in the final work. Comply with specified tolerances.

E. Where required by the COR, inspect and test patched areas to demonstrate integrity of the installation.

F. Execute fitting and adjustment of products to provide a finished installation which complies with specified products, functions, tolerance, and finishes.

*** END OF SECTION ***

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SECTION 01 74 19 – CONSTRUCTION WASTE MANAGEMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Special requirements for waste management during renovation, construction operations.
   a. Protect the environment, both on-site and off-site, during renovation, and construction operations.
   b. Prevent environmental pollution and damage.
   c. Maximize source reduction, reuse and recycling of solid waste.

1.2 DEFINITIONS

A. Definitions pertaining to sustainable development: As defined in ASTM E2114.

1.3 QUALITY ASSURANCE

A. Maximize use of source reduction and recycling procedures outlined in ASTM D5834.

B. Diversion Goals: A minimum 50 percent by weight of total project solid waste to be diverted from landfill.

1.4 PRECONSTRUCTION MEETING

A. After award of Contract and prior to the commencement of the Work, schedule and conduct meeting with Owner Representatives and COR to discuss the proposed Waste Management Plan and to develop mutual understanding relative to details of environmental protection.

1.5 SUBMITTALS (reference Clause 3.6.3-22)

A. Solid Waste Management Plan: Not less than 10 days before the Pre-Construction Meeting, prepare and submit a Solid Waste Management Plan including, but not limited to, the following:

1. List of the recycling facilities, reuse facilities, municipal solid waste landfills and other disposal area(s) to be used. Include:
   a. Name, location, and phone number.
   b. Copy of permit or license for each facility.
2. Identify materials that cannot be recycled or reused. Provide explanation or justification.
3. Revise and resubmit Plan as required by Owner.

a. Approval of Contractor's Plan will not relieve the Contractor of responsibility for compliance with applicable environmental regulations.

B. Progress Documentation: Document solid waste disposal and diversion. Include the quantity by weight of waste generated; waste diverted through sale, reuse, or recycling; and waste disposed by landfill or incineration. Identify landfills, recycling centers, waste processors, and other organizations that process or receive the solid waste.

1. Document on form in Appendix A of this Section, or similar form as approved by Owner.
2. With each Application for Payment, submit updated Documentation for solid waste disposal and diversion.
3. With each Application for Payment, submit manifests, weight tickets, receipts, and invoices specifically identifying the Project and waste material.

C. Record Submittals: With Record Submittals as specified in Section 01 78 39 "Project Record Documents," submit the following:

1. Summary of solid waste disposal and diversion. Submit on form in Appendix A of this Section, or similar form as approved by Owner.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.1 SOLID WASTE MANAGEMENT

A. Develop and implement a waste management program in accordance with ASTM E1609 and as specified herein.

B. Collection: Implement a recycling/reuse program that includes separate collection of waste materials of the following types as appropriate to the project waste and to the available recycling and reuse programs in the project area:

1. Land clearing debris.
2. Asphalt.
3. Concrete and Masonry.
4. Metal.
   a. Ferrous.
   b. Non-ferrous.
5. Wood, nails and staples allowed.
6. Debris.
7. Glass, colored glass allowed.
8. Paper.
   a. Bond.
   b. Newsprint.
   c. Cardboard and paper packaging materials.
10. Non-hazardous paint and paint cans.

11. Carpet.
12. Insulation.
13. Others as appropriate.

C. Recycling/Reuse: Maximize recycling and reuse of materials.

1. Recycling/Reuse on project site: Coordinate with COR.

D. Handling:

1. Clean materials that are contaminated prior to placing in collection containers. Deliver materials in accordance with recycling or reuse facility requirements (e.g., free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to recycling process).
2. Arrange for collection by or delivery to the appropriate recycling or reuse facility.
3. Hazardous Waste and Hazardous Materials: Handle in accordance with applicable regulations.

E. Composting: In accordance with State Extension Service recommendations and as follows:

1. Moisture content: Maintain between 35 percent and 60 percent.
2. Carbon to nitrogen (C/N) ratio: Maintain at approximately 30 to 1 by weight.
3. Do not compost meat or dairy products on site.
4. Where the proposed Waste Management Plan incorporates composting of plastics, assess the potential effect of each type of plastic to be included on the composting process in accordance with ASTM D5509 and ASTM D6002.

F. Collection and Sorting

Debris will be collected on-site in an area identified by the COIR, and removed off-site by the Contractor for sorting and disposal.

END OF SECTION

Appendix A

SUMMARY OF SOLID WASTE DISPOSAL AND DIVERSION

Project Name: _____ Project Number: _____

Contractor Name: _____ License Number: _____

Contractor Address: _____

Solid Waste Material	**Date Material Disposed/ Diverted**	**Amount Disposed/ Diverted** (ton or cubic yard)	**Municipal Solid Waste Facility** (name, address, & phone number)	**Recycling/ Reuse Facility** (name, address, & phone number)	**Comments** (if disposed, state why not diverted)
Appliances					
Asphalt					
Cardboard					
Carpet					
Concrete					
Gypsum Drywall					
Land Clearing/Soil					
Masonry					
Metals: Ferrous					
Metals: Non-ferrous					
Mixed/Co-mingled Waste					
Roofing: Asphalt-based					
Roofing: EPDM					
Salvaged/Surplus Materials for Reuse					
Wood: Landclearing Debris					
Wood: Scrap Lumber					
Other:					

Signature: _____ Date: _____

SECTION 01 74 23 – FINAL CLEANING

PART 1- GENERAL

1.1 SUMMARY

A. Just prior to occupancy of the building by the FAA, and prior to Final Completion Inspection, perform a thorough cleaning of the site, buildings, and other structures.

B. All vacuums and air filtering devices shall use HEPA filters and shall be cleaned or replaced prior to each use.

1.2 SUBMITTALS

A. Submit in accordance with Section 01 33 00 "Submittal Procedures" and include the following:

1. Record of Finishes
2. Maintenance Instructions

B. Provide a typewritten description of finish materials along with a list of the cleaning products recommended by the manufacturer. Place forms in the appropriate Section of the O & M Manual. Refer to Section 01 78 23 "Operations and Maintenance Data." Describe maintenance needed, including daily, weekly, and monthly maintenance instructions.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Furnish materials and equipment needed for cleaning and waxing purposes. Use cleaners and waxes recommended by the manufacturer for the individual material.

PART 3 – EXECUTION

3.1 SITE CLEANING

A. Maintain site in clean condition at all times. At the end of each workday, gather all loose trash and debris from around site and place in trash containers or remove from site. Do not stack trash or other construction debris on the ground or in the open. Place trash in closed containers. Arrange for periodic emptying of containers. Do not allow trash or debris to become airborne, blow around or blow off site.

3.2 ROUTINE CLEANING

A. Routinely clean buildings to remove all construction debris, packing crates, wrappings, packing materials, or other trash.

B. Maintain entire space of buildings in a clean condition at all times. Once partitions have been installed, maintain spaces in a "broom-clean" condition. Prior to installation of finishes and paint, thoroughly clean spaces of trash and debris, sweep floors clean and mop to remove dust.

3.3 FINAL CLEANING

A. 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.

B. Thoroughly clean the building where Work was accomplished and make ready for occupancy. Remove construction debris, boxes and trash. Clean entire site, removing all trash from the site. Remove construction storage sheds and field offices and restore grade to match surrounding conditions.

C. Clean floor and inspect for damage. Replace damaged flooring. Remove paint drippings and other spillage. Sweep floors clean, then mop repeatedly until thoroughly clean, including equipment rooms. Clean resilient flooring with an approved cleaner and give one coat application of liquid floor polish as recommended by the flooring manufacturer. Remove oil, grease and other contaminants from concrete floors, then mop repeatedly until thoroughly clean. Vacuum carpets with powered floor sweepers to remove dirt and dust. Remove glue or other substances from nap of carpet.

D. Clean wall surfaces to remove dirt or scuff marks. Remove excess adhesive along top edges of wall base. Remove adhesive from surfaces of vinyl wall coverings.

E. Inspect acoustical tile. Align tile to fit properly in grid. Replace cracked, dirty or damaged tiles with new tiles. Clean surface and grid system.

F. Inspect painted surfaces. Spot paint nicks and other damage. If spot-painting does not blend into the existing color and texture of the surrounding surfaces, repaint wall from inside corner to inside corner.

G. Clean 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.

H. Inspect all painted surfaces. Spot paint any damaged surfaces. Touch up damaged surfaces on factory finished equipment with special paint furnished by the equipment manufacturer.

I. Restore exterior areas to original condition, including replacement of sod and shrubs damaged during the course of construction. Clean and sweep affected parking areas.

J. Comply with safety standards for cleaning and with provisions of Section 01 74 19 "Construction Waste Management." Do not burn waste materials. Do not bury construction debris or excess construction materials on FAA property. Asbestos Containing Materials shall be disposed at a licensed disposal facility. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from Project site and dispose of lawfully.

END OF SECTION 01 74 23

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SECTION 01 77 00 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

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

1. Inspection procedures.
2. Project record document submittal.
3. Operation and maintenance manual submittal.
4. Final cleaning.

B. Closeout requirements for specific construction activities are included in the individual sections in Divisions 2 through 28.

1.2 COMPLETION

A. The Contractor must provide one (1) week's written notice to the COR for the following items that require inspection:

1. Pre-Substantial Completion.
2. Substantial Completion.
3. Final Completion.

B. Pre-Substantial Completion: When the Contractor considers the work substantially complete and ready for inspection, the Contractor must request a Pre-Substantial Completion Inspection and provide a Preliminary Punch List of work remaining to be completed by the Contractor. After the Pre-Substantial Completion Inspection, the COR will review the Preliminary Punch List and issue the Initial Punch List of work remaining to be completed by the Contractor.

C. Substantial Completion:

1. Prior to the Substantial Completion Inspection, the Contractor must:
   a. Complete all Initial Punch List items.
   b. Remove all tools, equipment, and excess materials from in and around the building to the staging area.
   c. Restore its work areas in and around the building, including repair of doors, walls, floors, ceilings, halls, lawns, curbs, sidewalks, etcetera as needed.
   d. Clean up its work areas in and around the building.
   e. Provide all required operation and maintenance manuals, warranties, and redlined as-built drawings.
2. After completion of the above, as inspected and approved by the COR, the Contractor must request a Substantial Completion Inspection. The COR will arrange the Substantial Completion Inspection with the Contractor and with facility operations and maintenance personnel. During the Substantial Completion Inspection, the Contractor must provide training by skilled technicians and demonstrate complete testing, operation, and

maintenance of all work. Coordinate with requirements of Section 01 79 00 "Demonstration and Training." After the Substantial Completion Inspection, the COR will develop a Final Punch List of work to be completed by the Contractor.

D. Final Completion:

1. Prior to the Final Completion Inspection, the Contractor must:
   a. Complete all Final Punch List items.
   b. Provide any remaining required documentation.
   c. Remove all office trailers, storage and waste containers, equipment, tools, excess materials, et cetera from the staging area and facility.
   d. Restore its work areas in the staging area and facility, including repair of lawns, pavement, curbs, sidewalks, et cetera as needed.
   e. Clean up its work areas in the staging area and facility.
   f. Submit Completion Certification.
2. Completion Certification: The Contractor must submit a written Completion Certification to the Contracting Officer (CO) in which the Contractor certifies that:
   a. Contract documents have been reviewed.
   b. The work has been inspected by the Contractor for compliance with contract documents.
   c. Equipment and systems have been fully tested and are fully operational.
   d. The required operation and maintenance manuals (see Section 01 78 23) with maintenance schedules, parts lists, and warranties as applicable have been submitted.
   e. The required project records and as-built drawings have been submitted (see Section 01 78 39).
   f. The required instruction and training of facility operations and maintenance personnel have been performed.
   g. Existing Administration Wing roof warranty from Firestone has not been impacted or voided.
   h. The work is complete, the premises cleaned, and the work is ready for acceptance.
3. Final Completion Inspection: After completion of the items above, as inspected and approved by the COR, the Contractor must request a Final Completion Inspection. After the Final Completion Inspection, the COR will notify the Contractor of any remaining work to be completed, if any.

1.3 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. Preparation: Submit three copies 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, starting with exterior areas first and proceeding from lowest floor to highest floor.
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 Architect/Engineer.
d. Name of Contractor.
e. Page number.

1.4 PROJECT RECORD DOCUMENT SUBMITTALS

A. Do not use record documents for construction purposes. Protect record documents from deterioration and loss in a secure, fire-resistant location. Provide access to record documents for the COR reference during normal working hours.

B. Refer to Section 01 78 39 "Project Record Documents" for procedures for processing and delivering Project Record Documents.

2.PRODUCTS (Not Applicable)

3.EXECUTION

3.1 FINAL CLEANING

A. Refer to Section 01 74 23 "Final Cleaning" for final cleaning procedures.

END OF SECTION 01 77 00

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SECTION 01 78 23 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes requirements for Operation and Maintenance (O&M) manuals for hard copy and electronic/record documents, including the following:

1. Prepare and submit operation and maintenance manuals for building operating systems and equipment.
2. Project record document submittal.
3. Provide O&M data to the FAA for Facility's O&M documents.

a) An inventory of each component and piece of equipment requiring operations and maintenance documentation identified in the Contract Documents shall be documented and provided to the COR in worksheet format. Provide electronic and paper copies. Use Attachment 1 to this section to identify systems and sub-systems. Use Attachment 2 to document O&M equipment inventory information.

B. Coordinate with requirements of Section 01 33 00, "Submittal Procedures," Article 1.7

1.2 REFERENCE STANDARDS

A. Federal Aviation Administration (FAA).

1. D-2494 Technical Instruction Book Manuscript: Electronic, Electrical, and Mechanical Equipment Requirement for Preparation of Manuscript and Production of Books, Appendix I (COTS).

1.3 QUALITY ASSURANCE

A. Maintenance Manual Preparation: In preparation of maintenance manuals, use competent/certified personnel thoroughly trained and experienced in operation and maintenance of equipment or systems involved.

1. Where Contract Documents require written instructions, use personnel skilled in technical writing where necessary for communication of essential data.
2. Where Contract Documents require drawings or diagrams, use personnel skilled in preparing drawings clearly in an understandable format.

1.4 SUBMITTAL SCHEDULE

A. Submittal Schedule: Before requesting inspection for Final Completion, comply with the following schedule for submitting operation and maintenance manuals:

1. Initial O&M Documentation for Individual Items. Prior to a request for Final Completion, provide initial O&M Data Manuals to FAA for review and comment. Submittals shall be

clear and legible manufacturer's publications. Two copies of the initial set with comments will be returned within 14 days of receipt by the FAA.

2. Prior to Substantial Completion Inspection, submit 2 corrected copies of each manual to the COR. Include a complete index or table of contents for each manual. O&M submittals shall be manufacturer's original publications, or clear and clean photocopies. Manuals shall be organized by system, as specified in "O&M Manual Sections By Building System".
3. After Substantial Completion Inspection, make corrections or modifications to comply with the COR's comments. Submit the specified number of copies of each approved manual to the COR within 15 days of receipt of the COR's comments.
5. Electronic imaging. Provide either scanned images or electronic files of O&M documentation in addition to the paper copies specified. Index scanned images and/or electronic files to facilitate organizing the electronic information in the same format as the final approved paper copies. Provide electronic information on CD-ROM.

B. Form of Submittal: Coordinate with Section 01 33 00, "Submittal Procedures," Article 1.7. Prepare operation and maintenance manuals in the form of an instructional manual for use by the Government's operating personnel. Organize into sets in sizes as specified. Organize O&M information by system as described in Schedule at end of Part 3 of this Section.

1. Binders: For each manual, provide heavy-duty, commercial-quality, 3-ring, vinyl-covered, loose-leaf binders, maximum of 3 inches thick, sized to receive 8-1/2-by-11- inch paper. Provide a clear plastic sleeve on the spine and front cover to hold labels describing contents. Provide 3-hole punched, heavy-duty sheet protectors to hold folded oversized documents. Do not fill binders to more than 1/2 capacity.

    a. Where multiple binders are necessary to accommodate data, correlate data in each binder into related groupings according to the Project Manual Table of Contents. Cross-reference other binders where necessary to provide essential information for proper operation or maintenance of the piece of equipment or system.
    b. Identify each binder on front and spine, with the printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter covered. Indicate volume number for multiple volume sets of manuals.

2. Dividers: Provide heavy paper dividers with clear celluloid-covered tabs for each separate Section. Mark each tab to indicate contents. Provide a description of the Product and major parts of equipment included in the Section on each divider.
3. Text Material: Provide the manufacturer's standard printed material. If manufacturer's standard printed material is not available, provide specially prepared data, computer generated, on 8-1/2-by-11 inch, 20-lb/sq. ft. white bond paper.
4. Drawings: Provide reinforced, punched binder tabs on drawings and bind with text. Where oversize drawings are necessary, fold drawings to the same size as text pages, and inserted in a 3-hole-punched, heavy-duty plastic sheet protector.
5. Photos: Provide required photographs in digital and paper format. Photos shall be adequately labeled, printed on photographic quality paper and placed in 3-hole punch plastic protector sheets. Provide photos in electronic format on CD-ROM.
6. Software: Provide 3-hole punch plastic protector sheets for labeled software media, such as electronic photographs, text and equipment inventory worksheets.

C. Submit 3 copies of each manual, in final form, on equipment and systems to the COR for distribution. Include information for each unit of equipment, each operating system, and each electric and electronic system.

D. Payment Processing: No payment will be made for materials delivered on site for which O&M Documentation for individual items has not been approved.

E. 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 will utilize services from others to obtain the required O&M information. The Contractor's price will be reduced by an amount commensurate with the cost to the FAA to obtain the required information by alternate means.

1.5 MANUAL CONTENT

A. Include information required by the Contract Documents in the form of Data Packages. Develop data packages for each building component, piece of equipment and system based on level of complexity and as specified. Provide data packages in accordance with Schedule at end of Part 3 of this Section. Applicability of data packages is as follows:

1. Data Package 1: General building materials and components such as sealants, light fixtures, door hardware, etc.
2. Data Package 2: Simple operating components such as valves, hatches, louvers, plumbing fixtures
3. Data Package 3: Minor equipment such as small pumps and fans
4. Data Package 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. Provide Data Package information as follows:

1. Data Package 1:
   a. Manufacturer's product information
   b. Supplier information
   c. Warranty information

2. Data Package 2: Data Package 1 information plus:
   a. Safety precautions
   b. Maintenance & repair procedures
   c. Replacement parts identification & installation

3. Data Package 3: Data Package 2 information plus:
   a. Normal operating instructions
   b. Lubrication data
   c. Preventive maintenance plan/schedule
   d. Alignment, adjusting and checking information
   e. Removal and replacement instructions

f. Parts identification
g. Wiring diagrams

4. Data Package 4:Data Package 3 information plus:
   a. Equipment or System Description including:
      1) Equipment or System Function
      2) Operating characteristics
      3) Safety precautions
      4) Environmental and limiting conditions
      5) Performance curves
      6) Engineering data and tests and TAB reports.
      7) Complete nomenclature and number of replacement parts
      8) Supplier and vendor information
   b. Manufacturer's Information including:
      1) Assembly drawings and diagrams required for maintenance
      2) List of items recommended to be stocked as spare parts
      3) Wiring and control diagrams
   c. Maintenance Procedures detailing essential maintenance procedures including:
      1) Printed operation and maintenance instructions
      2) Routine operations
      3) Troubleshooting guide & diagnostic techniques
      4) Disassembly, repair and reassemble
      5) Alignment, adjusting and checking
      6) Lubrication data
      7) Consumable information such as belts and filters
      8) Testing equipment & special tool information

   d. Operating Procedures including:
      1) Start up and shut down procedures
      2) Equipment or system break-in
      3) Routine and normal operating instructions
      4) Regulation and control procedures
      5) Emergency procedures
      6) Summer and winter operating instructions
      7) Required sequences for electric or electronic systems
      8) Special operating instructions
      9) Operator service requirements

C. Software: Specified program listings, interface control documents, source code listing, and copies of the operating programs on media appropriate to use as backup for the system software. Include instructions for loading the operating software onto the system.

D. Additional requirements:

1. For each system, general system or equipment description. Include size, weight, power consumption, power requirements, and outline drawings.
2. Copies of applicable Shop Drawings, Product Data, Drawings, and Schematics for the equipment systems.

3. Theory of Operation: Description of technical operating characteristics of the system and individual equipment using standard phraseology; descriptions of interface requirements including operating protocols; equipment displays and screens; make reference to installation drawings, schematics and equipment displays as required for technical understanding.

E. Identification Legends:

1. Piping and equipment: Provide a computer-generated legend to correspond with identification devices installed on piping and equipment. List the identifying device, its location, a brief description of the devices function, capacity and the I.D. number.
2. Panel boards and switchboards: Provide a computer-generated legend for each panel board and switchboard installed in the project. This information shall be a duplicate of the legend placed in the panel board.
3. Valve Tags and Schedule: Provide a computer-generated schedule of all valve tags. Include valve type, manufacturer, equipment location and size for all newly installed valves.

F. Organize the manual into separate Sections, by system as described in paragraph "O&M Manual Sections By Building System" of this Article, for each system or piece of related equipment.

1. Title Page: Provide a title page in a transparent, plastic envelope as the first sheet of each manual. Provide the following information:

   a. Subject matter covered by the manual
   b. Name and address of the Project
   c. Date of submittal
   d. Name, address, and telephone number of the D/B
   e. Cross-reference to related systems in other operation and maintenance manuals

2. Table of Contents: After the title page, include a computer-generated table of contents for each volume, arranged systematically according to the Project Manual format. Include a list of each product incorporated, identified by product name and other appropriate identifying symbol and indexed to the content of the volume. Each Data Package shall be tabbed and separately listed in the Table of Contents. Where multiple volumes are required to accommodate data, provide a comprehensive table of contents for all volumes in each volume of the set.
3. General Information: Provide a general information Section immediately following table of contents, listing each product included in the manual, identified by product name. Under each product, list the name, address, and telephone number of the subcontractor or installer and the maintenance contractor where applicable. Clearly delineate the extent of responsibility of each of these entities. Include a local source for replacement parts and equipment.
4. Product Data: Where the manuals include manufacturer's standard printed data, include only sheets that are pertinent to the part or product installed. Mark each sheet to identify each part or product included in the installation. Where the Project includes more than one item in a tabular format, identify each item, using appropriate references from the

Contract Documents. Identify data that is applicable to the installation, and delete references to information that is not applicable.

5. Written Text: Prepare written text to provide necessary information where manufacturer's standard printed data are not available, and the information is necessary for proper operation and maintenance of equipment or systems. Prepare written text where it is necessary to provide additional information or to supplement data included in the manual. Organize text in a consistent format under separate headings for different procedures. Where necessary, provide a logical sequence of instruction for each operation or maintenance procedure.
6. Drawings: Provide specially prepared drawings where necessary to supplement manufacturer's printed data to illustrate the relationship of component parts of equipment or systems or to provide control or flow diagrams. Coordinate these drawings with information contained in Project Record Drawings to ensure correct illustration of the completed installation.
7. Warranties, Bonds, and Service Contracts: Provide a copy of each warranty, bond, or service contract tabbed in a separate binder. Provide written data outlining procedures to follow in the event of product failure. List circumstances and conditions that would affect the validity of a warranty or bond.

G. O&M Manual Sections by Building System. This is the format to follow when preparing the Table of Contents.

SPEC SECTION NUMBER(S)	DESCRIPTION
	General Building Information
	Grounds & Pavements
	Exterior Closure
	Roofing
	Interior Construction
	Interior Finishes
	Conveying Systems
	Plumbing Systems
	HVAC Systems
	Life/Safety
	Electrical Systems
	Communication Systems
	Building Automation Systems
	Security Systems

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 SCHEDULE

A. Schedule of Operation and Maintenance Data Packages. The following is a minimum of information required for Operation and Maintenance Manuals for this project. Refer to individual technical Sections for additional information, which may be specified for O&M Manuals.

Schedule of Operation and Maintenance Data Packages					
SECTION	DESCRIPTION	DP 1	DP 2	DP 3	DP 4
07 84 13	Penetration firestopping	X			
07 92 00	Joint sealants	X			
08 11 13	Hollow metal doors/frames	X			
08 71 00	Door hardware	X			
09 29 84	Prefinished gypsum board	X			
09 51 13	Acoustical panel ceilings	X			
09 65 00	Resilient tile flooring/wall base	X			
09 69 00	Access flooring	X			
09 84 33.10	Acoustical wall panel units	X			
10 44 13	Fire extinguishers	X			
21 13 13	Fire suppression system			X	
23 05 19	Meters and gages for HVAC Piping		X		
23 05 93	TAB reports		X		
23 09 00	Instrumentation and controls for HVAC				X
23 21 23	Hydronic Pumps		X		
23 25 00	HVAC water treatment		X		
23 34 23	HVAC power ventilators		X		
23 37 13	Diffusers, registers and grilles		X		
23 41 13	Panel air filters		X		
23 65 00	Cooling Towers			X	
23 73 13	Modular indoor central station air handling units			X	
23 81 23	Computer room air conditioning units			X	
23 84 13	Humidifiers			X	
26 05 26	Grounding and bonding systems			X	
26 09 23	Lighting control devices			X	
26 29 23	Variable-frequency drive			X	
26 41 13	Lightning protection system			X	
26 51 00	Interior lighting		X		
26 56 00	Exterior lighting		X		
28 31 00	Fire detection and alarm system			X	
28 35 00	Refrigerant detection and alarm system			X	

Attachment 1: Format for O&M Inventory Information

Attachment 2: Format for O&M Inventory Information									
Equipment Identification	Description	Room	Manufacturer	Vendor	Model	Serial Number	System I.D.	Sub-System I.D.	Notes

END OF SECTION 01 78 23

SECTION 01 78 39 – PROJECT RECORD DOCUMENTS

PART I - GENERAL

1.1 SUBMITTALS

A. Submit in accordance with Section 01 33 00, "Submittal Procedures"

B. Redlined drawings, due at the completion of the work, five working days before final inspection.

PART 2 - PRODUCTS (Not used)

PART 3 - EXECUTION

3.1 AS-BUILT FIELD DATA

A. The Contractor must maintain a complete set of prints of the contract drawings at the job site.

B. At all times during performance of this contract, the Contractor must record on a set of construction drawings all field/construction changes, contract clarifications, modifications, and diagrams at variance with the original contract drawings.

C. The Contractor must keep a full set of these record drawings in its construction field office at all times. The Contractor shall update these record drawings daily, and they must be current as of the previous work day's changes.

D. In addition, on a weekly basis the Contractor must update a set of construction drawings within the Government's COR site office, noting any changes that have occurred from the previous week, and thus making both sets of record drawings identical at that point in time.

E. Mark the drawings with a red colored pencil.

F. The Contractor must make the record drawings available to the Contracting Officer at all times. 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 estimate.

3.2 REDLINED AS-BUILT DRAWINGS

A. The Contractor must maintain a complete full size set of prints of the contract drawings at the job site.

B. At all times during the performance of the contract, the Contractor must record on a full size set of construction drawings the locations and dimensions of all field/construction changes,

details and additional information, contract clarifications, modifications, and diagrams at variance with the original contract drawings.

C. The Contractor must keep a full set of these record drawings in its construction field office at all times. The Contractor shall update these record drawings daily, and they must be current as of the previous day's work.

D. In addition, on a weekly basis the Contractor must update a second set of construction drawings within the Government's COR site office, noting any changes that have occurred from the previous week, and thus making both sets of record drawings identical at that point in time.

E. The Contractor must use a red colored pencil to mark the drawings.

F. The Contractor must make the record drawings available to the Contracting Officer at all times. 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 estimate.

G. At the completion of construction and prior to the substantial completion inspection or final payment, the Contractor must deliver to the Contracting Officer two complete sets of redlined project record drawings.

*** END OF SECTION ***

SECTION 01 79 00 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes administrative and procedural requirements for instructing FAA personnel, including the following:

1. Demonstration of operation of systems, subsystems, and equipment.
2. Provide 16 hours (for example, total 4 sessions at 4 hours each session) training in operation and maintenance of systems, subsystems, and equipment. Coordinate schedule and times for training with the FAA/COR.
3. Written documentation of training and FAA personnel comprehension.

1.2 SUBMITTALS

A. Instruction Program: Within 90 days of final completion, submit ten (10) copies of instructional program outlines for demonstration and training, including a schedule of proposed dates, times, length of instruction time, instructors' names and instructors' qualifications for each training module. Include learning objective and outline for each training module. Instruction program shall be based upon and utilize the approved operation and maintenance manual data.

1. At completion of training, submit one complete training manual for the FAA's use.

B. Attendance Record: For each training module, submit list of participants and length of instruction time.

C. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test, and student evaluations of training.

D. Qualifications: Provide as specified in 1.3 Quality Assurance below.

1.3 QUALITY ASSURANCE

A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.

B. Instructor Qualifications: A factory-authorized service technician experienced in operation and maintenance procedures and training.

C. Pre-Instruction Conference: Conduct conference at Project site. 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 including classroom training and field training.
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.

1.4 COORDINATION

A. Coordinate instruction schedule with FAA operations. Adjust schedule as required to minimize disrupting Government operations.

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 operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved.

PART 2 - PRODUCTS

2.1 INSTRUCTION PROGRAM

A. Program Structure: Develop a comprehensive instruction program. Include individual training modules for each system and equipment not part of a system, as required by technical Specification Sections and the Schedule of Training in Part 3 of this Section.

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:

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. Operations manuals.
b. Maintenance manuals.
c. Project Record Documents.
d. Identification systems.
e. Warranties and bonds.
f. Maintenance service agreements and similar continuing commitments.

3. Emergencies: Include the following:

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:

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 system, subsystem, or equipment failure.
j. Seasonal and weekend operating instructions.
k. Required sequences for electric or electronic systems.
l. 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.

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/predictive 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.

PART 3 - EXECUTION

3.1 PREPARATION

A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a combined training manual.

B. Set up instructional equipment at instruction location.

3.2 INSTRUCTION

A. Qualified Facilitator shall prepare instruction program and training modules, to coordinate instructors, and coordinate between Contractor and Government for number of participants, instruction times, dates and location.

B. Qualified Instructors shall instruct FAA personnel to adjust, operate, and maintain equipment and systems.

1. The COR will furnish names and positions of participants.

C. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide instruction on actions necessary to prepare for and execute seasonal change over.

1. Schedule training through the COR with at least 30 days' advance notice.

D. Evaluation: At the conclusion of each training module, assess and document training.

1. Assess and document each participant's mastery of module by use of an oral performance-based test.
2. Obtain each participant's evaluation of the training via a pre-printed survey form approved by the COR.

E. Cleanup: Collect used and leftover educational materials. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

F. Record of Training to the COR. Provide a record of training. Record shall include list of attendees, student evaluation of training, evaluation of student comprehension at the end of training and recommendations for follow-on training.

END OF SECTION 01 79 00

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SECTION 01 91 13 – GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 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 the FAA'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 the FAA 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 30 00, "Submittal Procedures."
2. Section 01 78 23, "Operation and Maintenance Data."
3. Section 01 79 00, "Demonstration and Training."
4. Division 23 "Heating, Ventilation And Air Conditioning"

1.2 REFERENCES

ASHRAE

1. The Commissioning Process, Guideline 0-2005

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. Design Data Handbook, (DDH): A document that records the concepts, calculations, decisions, and product selections used to meet the design intent and the FAA's operational needs and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.

C. 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.

D. Commissioning: 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 FAA'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.

E. 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.

F. Commissioning Plan: A written plan of how the commissioning process will be accomplished. The plan describes how the Design Manager (DM), Resident Engineer (RE), CxA, General Contractor (GC) and Subcontractors will accomplish commissioning responsibilities.

G. 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.

H. Commissioning Team: The individuals, who through coordinated actions are responsible for implementing the commissioning process.

I. Pre-Functional Verification Checklist (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.

J. Construction Documents: These include a wide range of documents that will vary from project to project and with the 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.

K. Contract Documents: These include a wide range of documents that will vary from project to project with the 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.

L. 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.

M. 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.

N. Factory Testing: Testing of equipment at the factory or on-site by a factory representative with Design Manager, Resident Engineer or other FAA representative present.

O. Functional Performance Tests (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's and provide necessary test equipment to complete the tests. The CxA directs, witnesses, and documents the FPT's.

1. Functional performance testing shall not be performed until Pre-Functional Verification Checklists and Startups are completed, and verified.

P. General Contractor (GC): The contractor and subcontractor, suppliers and vendors who perform the construction activities and comply with the contract documents.

Q. Issues Log: A formal and ongoing vehicle to track commissioning issues concerns, deficiencies, their status and resolution of each item.

R. Occupancy and Operations Phase Cx: 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.

S. 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.

T. Owner's Witness: Owner authorized witness designated to sign completed Commissioning Test Data Forms to authenticate reported test data.

U. Simulated Condition: Condition created for purpose of testing response of system.

V. Startup: Initial starting or activating of dynamic equipment, including executing Pre-Functional Verification Checklists. Startup must be completed prior to Functional Performance Testing.

W. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

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. FAA Design Manager (DM)
2. FAA Resident Engineer (RE)
3. Commissioning Authority (CxA)
4. 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'S RESPONSIBILITIES

A. The Owner (FAA) defines the overall vision for the use of the area, establishes the Design Intent and Commissioning objectives, appoints the Resident Engineer, establishes the construction budget, and ultimately accepts and operates the finished facility.

B. The FAA appoints the Resident Engineer (RE) as the FAA's Contracting Officer's Representative (COR). The RE is the primary day-to-day FAA point of contact. The RE is responsible to ensure work is completed in accordance with the contract document requirements and that the FAA's design intent is met upon completion. The RE is the single point of contact for coordinating work with the FAA operations and accepting submittals, deliverables and completed work.

The RE 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's 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. Coordinates their review.
8. Participates at their discretion in Functional Performance Testing.
9. Coordinates training with the maintenance staff and the General Contractor and approves training plans.
10. Coordinates submission and review of the Operations and Maintenance documentation 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 O&M manuals. Ensure required O&M manuals, instructions and demonstrations are provided to the FAA's designated operating staff.
13. Review equipment warranties to ensure that the FAA's responsibilities are clearly defined.

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 the FAA'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 the FAA'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 the FAA, 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 Pre-Functional Verification Checklists (PFVCs) and Functional Performance Tests (FPTs) based on the Contract Documents, manufacturers O&M information, and accessibility requirements for O&M. Brings to the attention of the DM, GC, and RE identified deficiencies and coordination problems with HVAC systems/equipment to be commissioned.
6. Reviews completed PFVCs to ensure the results are documented properly as the checklists are completed and to evaluate any issues which are documented in the PFVCs.
7. Tracks testing non-conformance. Participates in re-testing as necessary until satisfactory performance is achieved as requested by the FAA.
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 the RE & 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 the FAA.
14. Maintain a master issues log and a separate record of Functional Performance Testing. Report all issues to the RE 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 FPTs, monitors control point-to-point checks performed by the controls contractor and ensures the results are documented as the checks are completed.
18. Reviews FPTs 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 the RE.
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 PFVCs, FPTs, deficiency lists, site visit reports, general findings and unresolved issues.

1.7 CONSTRUCTION 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 the RE 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 FAA. 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 the RE seven (7) 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 FPTs. Operate equipment and systems during FPTs 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 FPTs. 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 FAA personnel.
20. Complete Pre-Functional Verification Checklists (PFVCs) and submit them to RE. PFVCs shall be completed as the equipment delivery, installation and start up progresses. PFVCs 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 the FAA 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 RE.
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 the RE and CxA in accordance with requirements of Contract Documents to schedule Commissioning activities.
2. GC shall provide sufficient notice to the RE 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 the RE 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 provides Checklists to the commissioning team. Checklists will be developed utilizing the contract documents and approved submittals:

1. Pre-Functional Verification Checks (PFVC): Pre-Functional Verification Checklists cover the activities that must be performed for the proper storage, handling and installation of building components and equipment. PFVCs 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's and FPTs. The GC shall document by initialing the specific checks on each individual PFVC. The RE 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 the RE 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 the RE for incorporation into the process.
8. The GC executes the Pre-Functional Verification Checklists and completes according to the Commissioning Plan, and documents results. The RE will witness startup of selected and critical equipment, as identified by the FAA.
9. The CxA develops required specific equipment and system functional performance test procedures.
10. The CxA oversees the FPTs. 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. The RE reviews and verifies training plans developed and executed by the GC and Subcontractors.
13. The RE 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 the RE 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 the FAA.
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 RE 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 RE 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 through the FAA RE.

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 the RE 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 the RE.

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. The RE reviews and accepts Operation and Maintenance Manuals.

3.4 TRAINING OF FAA'S 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. The RE reviews training plans and schedules and verifies that demonstration and training has been completed.

END OF SECTION 01 91 13

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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. Removal of existing items to be reused.
3. Maintenance of operation of security components (card readers and security cameras).

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."

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.

1.5 ACTION SUBMITTALS

A. Hot Work Permit: Prepare and submit the FAA Hot Work Permit or Contractor's equivalent to the COR. The Contractor shall coordinate all project-related Hot Work with the COR.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For refrigerant recovery technician.

B. 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 Hot Work Plan. Include copy of permit if applicable.
5. Existing Roof Warranty: Provide correspondence from Firestone that Contractor's proposed methodology for work in this project on the Administration Wing roof will not validate existing roof warranty.
6. 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

C. 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 and of FAA's partial occupancy of completed Work.

D. Inventory: Submit a list of items to be removed and delivered to FAA prior to start of demolition.

E. Digital photographs, sufficiently detailed, of existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by selective demolition operations.

F. Record drawings at Project closeout.

1. Identify and accurately locate capped utilities and other subsurface structural, electrical, or mechanical conditions.

G. 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.

H. Warranties: Documentation indicating that existing Administration Wing roof warranty is still in effect after completion of selective demolition.

1.7 QUALITY ASSURANCE

A. Handle waste materials as specified in Section 01 74 19 – Construction Waste Management.

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. Protection and salvage of existing fire sprinkler and fire alarm components to be demolished and/or removed is not required.

1.9 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties. Notify warrantor and obtain approval before proceeding.

B. Administration Wing Roof Warranty: The roof on the Administration Wings is under warranty (manufacturer – Firestone). Contractor is to coordinate with Firestone to confirm proposed procedures for work in this project on the roof (for example, new penetrations, flashings, etc.) will not impact or void existing warranty.

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.

C. Erect and maintain dustproof partitions to limit dust and dirt migration and to separate areas from fumes and noise.

1. Construct dustproof partitions of not less than 3-5/8 inches metal studs, 3-1/2 inches sound attenuation blanket with fire-retardant 8 mil polyethylene sheet and gypsum wallboard or 1/2 inch fire retardant plywood, with joints taped to form dustproof barrier, as shown on the drawings or as directed by COR. COR shall determine final construction.
2. Seal joints and perimeter. Equip partitions with gasketed or weather-stripped doors and door sweeps to maintain dustproof conditions and to control noise.
3. Weather-strip openings.
4. Maintain equipment access for FAA personnel.
5. Where dustproof partitions are constructed on top of access floor system, assembly shall maintain access floor plenum air pressurization. Coordinate with COR air barrier and dust-proof construction.

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. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
7. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
8. 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.

1. Verify that no embedded utilities are within concrete. If discovered, notify COR and coordinate plan on how to proceed with the work.

B. Silica: In addition, any work involving jackhammering, cutting, sanding, sawing, grinding, drilling, and/or general demolition of concrete or masonry material will generate dust that may contain silica which is harmful when inhaled. These types of activities should be performed wet, when possible, with a localized water misting system, or with the use of local exhaust ventilation (LEV). Ventilation can be achieved with either a portable local exhaust unit, or with tools fitted with a vacuum dust collection (VDC) system. The use of fans for circulation of general room air should be avoided as well as the use of compressed air to clean clothing, tools, or work material. Appropriate eye and respiratory protection should also be considered to prevent exposure.

C. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.

D. 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.

E. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI's "Recommended Work Practices for the Removal of Resilient Floor Coverings." Do not use methods requiring solvent-based adhesive strippers.

F. PCB and Mercury: Refer to Hazardous Materials Abatement and Work Plan.

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 to the authorities having jurisdiction. 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 requirements and policies of Authorities Having Jurisdiction.

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 29 "Cutting and Patching."

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."

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.

C. Disposal: Transport demolished materials off FAA's property and legally dispose of them in compliance with Section 01 74 19.

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 74 23 "Final Cleaning."

END OF SECTION 02 41 19

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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.

The major mechanical project will include asbestos and lead paint abatement, and lead coated components demolition related to the control wing basement renovations, and chillers and cooling towers replacement of the main ARTCC building.

B. This Section includes the removal, control and disposal of asbestos (ACM) and lead coated components (LCC), which shall be encountered during the work at the Oakland ARTCC, Fremont, CA 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 ACM and LCC from the isolated work area, and the packaging and legal disposal of the removed ACM and 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), 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.

The following tables identify types and locations of hazardous ACM and Lead paint within the project area.

Asbestos Containing Materials

Room	Description	Material	Asbestos
B116 Boiler Room	Fire Door	PACM	
B119 Mechanical Room	Remnant floor tile mastic under raised floor	Residual tile mastic	18% Chrysotile
B119	Stanchion mastic (tan) under raised floor (Approx. 722 sq ft)	Mastic	2% Chrysotile
B120	Fire Door	PACM	
B120	Pipe Hanger Block (26 ea.)	hanger block	46% Amosite & Chrysotile
B120	Mudded TSI fittings (180 ea.)	TSI mud	35% Chrysotile
B120	Straight run pipe insulation –block (approx. 320 linear ft)	Block pipe insulation	45% Amosite & Chrysotile
B120	Tar pipe wrap (on various valves)	Pipe wrap	4%
B120	Pipe Hanger Block (approx. 132 ea)	Hanger block	46% Amosite & Chrysotile
B120	Fiberglass mud (on various fittings)	Insulation around fittings	27% Chrysotile
B120	Pipe wrap patches on piping systems (132 ea)	Pipe insulation wrap patch	35% Chrysotile
Stairway 3	Fire Door	PACM	
Utility Chase #1	Fire Door	PACM	
Utility Chase #1	Straight run pipe block insulation (approx. 75 linear ft)	Block insulation	45% Amosite/Chrysotile
Utility Chase #1	Mudded TSI Fittings (20 ea.)	TSI mud	35% Amosite/Chrysotile
Utility Chase #3	Baseboard mastic where baseboards are present	mastic	18% Chrysotile

Lead Paint and Coatings

Room	Description	Material	Lead
B115 Chiller Room	Chilled Water Supply Line	Blue Paint	<0.0098%
B116 Boiler Room	I-beam tank supports	Paint	4.7 mg/cm^2
B119	Ceiling	Paint	1.34%
B119	Columns	Paint	1.34%
B119	Handrail	Paint	5.7 mg/cm^2
B119	Walls	Paint	1.34%
B120	AHU 160	Yellow paint	1.8%
B120	Column	Pale yellow paint	1.3%
B120	Drywall Partition to B120A	Paint	1.04%
B120	Wall across from Break Rm.	Dark yellow paint	1.6%
B120	Wall across from Break Rm.	Bright yellow paint	1.4%
B134	Column	Mustard grey paint	<0.0099%
B120A	Column	Paint	1.04%
B120A	Door frame to B108B	paint	4.1 mg/cm^2
B120A	Ductwork	Paint	1.47%
B120A	Drywall partition on wall to B120	Paint	1.04%
B120A	Walls	Paint	1.47%
Utility Chase #1	Door Frames	Paint	4.6 mg/cm^2
Utility Chase #2	Door Frames	Paint	4.6 mg/cm^2
Utility Chase #3	Ceiling	Paint	1.47%
Utility Chase #3	Walls	Paint	1.47%

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.

E. The roof of the Chemical Treatment Building must be tested for potential ACM prior to demolition. Core samples analyzing each roof layer are required to verify the presence or absence of asbestos in the roofing material. Contractors shall arrange to have a representative number of samples collected by a CAL-OSHA Certified Asbestos Consultant (CAC). The sample number and locations to be determined by the CAC.

Samples shall be analyzed to a detection limit 0.1% as defined by California State requirements. Samples must be analyzed by a laboratory accredited by the American Industrial Hygiene Association (AIHA) for the analysis of asbestos.

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
Subpart F	Fire Protection and Prevention
1926.150	Fire Protection
1926.151	Fire Prevention
1926.154	Temporary Heating Devices
Subpart J	Welding and Cutting
1926.350	Gas Welding and Cutting
1926.352	Fire Prevention
1926.353	Ventilation and Protection in Welding, Cutting and Heating
Subpart L	Scaffolds
1926.450	Scope, Application, and Definitions Applicable to this Subpart
1926.451	General Requirements
1926.452	Additional Requirements Applicable to Specific Types of Scaffolds
1926.453	Aerial Lifts
1926.454	Training Requirements
Appendix A	Scaffold Specifications
Subpart M	Fall Protection
1926.500	Scope, Applicability, and Definitions Applicable to this Subpart
1926.501	Duty to Have Fall Protection
1926.502	Fall Protection Systems Criteria and Practices
1926.503	Training Requirements
Subpart N	Cranes, Derricks, Hoists, Elevators, & Conveyors
1926.552	Material Hoists, Personnel Hoists, and Elevators
Subpart Z	Toxic & Hazardous Substances
1926.1101	Asbestos

Appendix F	Work Practices and Engineering Controls for Major Asbestos Removal, Renovation, and Demolition Operations
Appendix I	Medical Surveillance Guidelines for Asbestos

40 CFR Part 61 Environmental Protection Agency

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

Article 77	Agreement between DOT/FAA and the National Air Traffic Controllers Association (NATCA)
Article 52	Agreement between DOT/FAA and the Professional Airways System Specialists (PASS)
Order 1050.20A	Airway Facilities Asbestos Control
Order 3900.19B	FAA Occupational Safety and Health Program
Local Order	Facility Asbestos Abatement Contingency Plan

California State Requirements

California Code of Regulations (CCR)

Tile 8 Subchapter 4 Construction Safety Orders (Section 1500-1938)
Tile 8 Subchapter 5 Electrical Safety Orders (Section 3000-3146)
Tile 8 Subchapter 7 General Industry Safety Orders (Section 3200-6148)

California Bay Area Air Quality Management District
Regulations 11, Hazardous Pollutants, Rule 2
Asbestos Demolition, Renovations, & Manufacturing

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 T8 CCR 1504 and for overseeing asbestos-related work as required by 29 CFR 1926.1101 and T 8CCR 1529. 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 and T8 CCR 1529.

1.4 PROVIDE THE FOLLOWING PRE-BID CONTRACTOR QUALIFICATION SELECTION SUBMITTALS

A. Contractor Identification: The Abatement Contractor shall be licensed by the State of California for the purpose of removal, encapsulation, enclosure, or demolition of asbestos containing material (ACM) and lead coated components (LCC).

1 Company name and address (street and mailing if different).
2 Name of individual supplying information.
3 Name of parent company, if any.
4 California State Business License
5 California Asbestos Abatement Contractors License.
6 California Lead Abatement Contractors License.
7 Project Manager Name.
8 Address of office responsible for this project.
9 Telephone number.

B. Insurance: Contractor shall have at a minimum the following insurance.

Commercial General Liability	$5 million per occurrence and aggregate with bodily injury and property damage coverages
Automobile Liability	$5 million per occurrence and aggregate with bodily injury coverage
Worker's Compensation	Consistent with state statutory requirements
Employer's Liability	$2 million per occurrence and each employee
Pollution Liability	$5 million per occurrence and aggregate

C. Staff:

1. Number of full-time company employees.
2. Names and resumes of local office Company Officers.
3. Names of local office full-time field supervisory personnel, and years of asbestos and lead removal experience, include resumes.

4. Names of local office part-time field supervisory personnel, and years of asbestos and lead removal experience, include resumes.
5. Number of local office full-time foreman and laborers.
6. Number of local office part-time foreman and laborers.
7. Name of employees' union(s), if any.
8. Usual ratio of supervisory to labor personnel used.

D. Experience:

1. Briefly describe company history.
2. Provide evidence verifying the company has a minimum of three (3) years of successful abatement experience working in the State of California.
3. Provide a representative list (at least three projects) of successful abatement projects working in occupied facilities. List project name, date, size, duration, removal cost, references and telephone numbers for each project.
4. State average yearly dollar volume of abatement removal work over the past two years.

E. Regulatory (Past 5 Years):

1. List and explain warnings or citations received from Federal, State or Local Regulatory Agencies related to asbestos and/or lead abatement activities. Include project name, date and resolution.
2. List assessed penalties, liquidated damages or schedule overruns and resolutions, which occurred. Include contract terminations.
3. List projects where the owner, architect or consultant halted project activities. State project name, date, reason for shutdown and resolutions.
4. List asbestos or lead related legal proceedings/claims in which the company (or employees scheduled to participate in this project) have participated or are currently involved. Include descriptions of role, issue and resolution to date.

F. Medical Requirements: Provide a copy of the company's Medical Surveillance Program.

G. Abatement Training: Provide a copy of the company's training program for supervisors and laborers. The program shall include, but is not limited to, how often training is conducted, who conducts the training, when it is conducted, what the duration of the program is and how documentation of training is accomplished for asbestos and lead. Provide copies of current California State licenses for abatement project supervisors and laborers.

H. Respiratory Protection: Provide a copy of the company's respiratory protection training program.

I. Health and Safety Program: Provide a copy of the company's health and safety program.

J. Submittal Notarization: Sign and date submittal by an officer of the company, indicating name and title of person signing.

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 Oakland 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 and Tile 8 CCR 5194. 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 as well as T8 CCR 1532.1 and T8 CCR1529 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. Miscellaneous: 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. Certified Industrial Hygienist: Provide the name, address, telephone number, and copies of the CIH's current ABIH and resume documenting at least two years of asbestos abatement experience.

H. 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.
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 Industrial Hygiene 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 T8 CCR 1529. Labels shall 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:

WEAR RESPIRATORY PROTECTION AND PROTECTIVE CLOTHING IN THIS AREA

(Prior to June 1, 2016, employers may use the following legend in lieu of that specified in paragraph above:

DANGER
ASBESTOS
CANCER AND LUNG DISEASE HAZARD
AUTHORIZED PERSONNEL ONLY

Additionally prior to June 1, 2016, employers may use the following legend in lieu of the wording above in areas where respirators are required:

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 (10) working 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 10 pm to 6 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 (MC).
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 and the corresponding California State regulations T8 CCR 5144, T8 CCR 1532.1, T8 CCR 1529

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 and the corresponding California State regulations T8 CCR 1532.1 and T8 CCR 1529.

L. Signs and Labels: Signs and labels shall be provided in accordance with 29 CFR 1926.62, 29 CFR 1926.1101 and the corresponding California State regulations T8 CCR 1532.1, T8 CCR 1529 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, CAL/OSHA T8 CCR 1529 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 and T8 CCR 1529, 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 and T8 CCR 1532.1, 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 the corresponding California State regulations T8 CCR 3340 & 3341, T8 CCR 1532.1, T8 CCR 1529 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 CAL/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 Jacobs 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 containment 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 containment 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 , and the corresponding California State regulations T8 CCR 5144, T8 CCR 1532.1, T8 CCR 1529

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 AT THE FAA FACILITY

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 and the corresponding California State regulations T8 CCR 1523 and Subchapter 4, article 3, 4 and 34 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 the corresponding California State regulations T8 CCR 1532.1 and T8 CCR 1529, 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, T8 CCR 2320.4, T8 CCR 2320.6 and the facility's lockout/tagout program.

B. Establishing Negative Pressure: Establish negative pressure in accordance with the recommendations of 29 CFR 1926.1101 Appendix F and the corresponding California State regulation T8 CCR 1529, Appendix F.

1. Maintain negative pressure for containments between negative 0.02 and negative 0.10 inches of water gauge. The intent of the design negative pressure is to prevent the contamination of non-abatement areas.

2. Air Filtration Devices shall exhaust to the buildings exterior a minimum distance of thirty feet from the buildings HVAC make-up air.

C. Pre-Abatement Inspection: Upon completion of the work area containment and the establishment of negative pressure, the Abatement Contractor shall receive notification from the FAA before removal work is initiated.

D. 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.

E. Maintenance of Enclosure System: The FAA shall be immediately notified of problems that have developed such as a puncture of the containment system, electrical power loss, GFCI failure, equipment failure, accidental discharge into occupied areas, and partial collapse of the critical barrier (plastic sheet fails to remain in place), etc.

3.5 DECONTAMINATION UNIT

A. Worker Decontamination Unit: No employee decontamination is required for this task.

3.7 ABATEMENT PROCEDURES

The sequence of operations to remove asbestos from the 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.

3.8 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

Oakland ARTCC (ZOA)
5125 Central Avenue
Fremont, CA 94536

(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 signed 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

Oakland ARTCC (ZOA)
5125 Central Avenue
Fremont, CA 94536 (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.

3.9 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 01 30 - MAINTENANCE OF CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Removal of deteriorated concrete and subsequent patching.
2. Epoxy crack injection.
3. Corrosion-inhibiting treatment.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: Cured Samples for each exposed product and for each color and texture specified.

1.4 INFORMATIONAL SUBMITTALS

A. Material certificates.

B. Product test reports.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Concrete-Maintenance Specialist Qualifications: Engage an experienced concrete-maintenance firm that employs installers and supervisors who are trained and approved by manufacturer to apply packaged patching-mortar, crack-injection adhesive and corrosion-inhibiting treatments to perform work of this Section. Firm shall have completed work similar in material, design, and extent to that indicated for this Project with a record of successful in-service performance. Experience in only installing or patching new concrete is insufficient experience for concrete-maintenance work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: For repair products, obtain each color, grade, finish, type, and variety of product from single source and from single manufacturer with resources to provide products of consistent quality in appearance and physical properties.

2.2 BONDING AGENTS

A. Epoxy-Modified, Cementitious Bonding and Anticorrosion Agent: Manufactured product that consists of water-insensitive epoxy adhesive, portland cement, and water-based solution of corrosion-inhibiting chemicals that forms a protective film on steel reinforcement.

B. Epoxy Bonding Agent: ASTM C 881/C 881M, bonding system Type V and free of VOCs.

C. Latex Bonding Agent, Redispersible: ASTM C 1059/C 1059M, Type I for use at nonstructural and interior locations unless otherwise indicated.

D. Latex Bonding Agent, Non-Redispersible: ASTM C 1059/C 1059M, Type II for use at structural and exterior locations and where indicated.

2.3 PATCHING MORTAR

A. Patching Mortar Requirements:

1. Only use patching mortars that are recommended by manufacturer for each applicable horizontal, vertical, or overhead use orientation.
2. Color and Aggregate Texture: Provide patching mortar and aggregates of colors and sizes necessary to produce patching mortar that matches existing, adjacent, exposed concrete. Blend several aggregates if necessary to achieve suitable matches.
3. Coarse Aggregate for Patching Mortar: ASTM C 33/C 33M, washed aggregate, Size No. 8, Class 5S. Add to patching-mortar mix only as permitted by patching-mortar manufacturer.

B. Cementitious Patching Mortar: Packaged, dry mix for repair of concrete.
1. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109/C 109M.

C. Rapid-Strengthening, Cementitious Patching Mortar: Packaged, dry mix, ASTM C 928/C 928M for repair of concrete.
1. Compressive Strength: Not less than 3000 psi within three hours when tested according to ASTM C 109/C 109M.

D. Polymer-Modified, Cementitious Patching Mortar: Packaged, dry mix for repair of concrete and that contains a non-redispersible latex additive as either a dry powder or a separate liquid that is added during mixing.

1. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109/C 109M.

E. Polymer-Modified, Silica-Fume-Enhanced, Cementitious Patching Mortar: Packaged, dry mix for repair of concrete and that contains silica fume complying with ASTM C 1240 and a non-redispersible latex additive as either a dry powder or a separate liquid that is added during mixing.
1. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109/C 109M.

2.4 EPOXY CRACK-INJECTION MATERIALS

A. Epoxy Crack-Injection Adhesive: ASTM C 881/C 881M, bonding system Type IV, at other locations; free of VOCs.
1. Capping Adhesive: Product manufactured for use with crack-injection adhesive by same manufacturer.

2.5 CORROSION-INHIBITING MATERIALS

A. Corrosion-Inhibiting Treatment: Waterborne solution of alkaline corrosion-inhibiting chemicals for concrete-surface application that penetrates concrete by diffusion and forms a protective film on steel reinforcement.

2.6 MISCELLANEOUS MATERIALS

A. Portland Cement: ASTM C 150/C 150M, Type I, II, or III unless otherwise indicated.

B. Water: Potable.

2.7 MIXES

A. General: Mix products, in clean containers, according to manufacturer's written instructions.

B. Dry-Pack Mortar: Mix required type(s) of patching-mortar dry ingredients with just enough liquid to form damp cohesive mixture that can be squeezed by hand into a ball but is not plastic.

PART 3 - EXECUTION

3.1 CONCRETE MAINTENANCE

A. Have concrete-maintenance work performed only by qualified concrete-maintenance specialist.

B. Comply with manufacturers' written instructions for surface preparation and product application.

3.2 EXAMINATION

A. Notify COTR seven days in advance of dates when areas of deteriorated or delaminated concrete and deteriorated reinforcing bars will be located.

B. Locate areas of deteriorated or delaminated concrete using hammer or chain-drag sounding and mark boundaries. Mark areas for removal by simplifying and squaring off boundaries. At columns and walls make boundaries level and plumb unless otherwise indicated.

C. Pachometer Testing: Locate at least three reinforcing bars using a pachometer, and drill test holes to determine depth of cover. Calibrate pachometer using depth of cover measurements, and verify depth of cover in removal areas using pachometer.

D. Perform surveys as the Work progresses to detect hazards resulting from concrete-maintenance work.

3.3 PREPARATION

A. Ensure that supervisory personnel are on-site and on duty when concrete maintenance work begins and during its progress.

B. Protect persons, motor vehicles, surrounding surfaces of building being repaired, building site, plants, and surrounding buildings from harm resulting from concrete maintenance work.

1. Comply with each product manufacturer's written instructions for protections and precautions.
2. Contain dust and debris generated by concrete maintenance work and prevent it from reaching the public or adjacent surfaces.
3. Protect floors and other surfaces along haul routes from damage, wear, and staining.
4. Provide supplemental sound-control treatment to isolate removal and dismantling work from other areas of the building.
5. Neutralize and collect alkaline and acid wastes for disposal off Owner's property.

C. Existing Drains: Prior to the start of work in an area, test drainage system to ensure that it is functioning properly. Notify COTR immediately of inadequate drainage or blockage. Do not begin work in an area until the drainage system is in working order.

1. Prevent solids such as aggregate or mortar residue from entering the drainage system. Clean out drains and drain lines that become sluggish or blocked by sand or other materials resulting from concrete maintenance work.
2. Protect drains from pollutants. Block drains or filter out sediments, allowing only clean water to pass.

D. Preparation for Concrete Removal: Make explorations, probes, and inquiries as necessary to determine condition of construction to be removed in the course of repair.

1. Verify that affected utilities have been disconnected and capped.
2. Provide and maintain shoring, bracing, and temporary structural supports as required to preserve stability and prevent unexpected or uncontrolled movement, settlement, or

collapse of construction being demolished and construction and finishes to remain. Strengthen or add new supports when required during progress of removal work.

E. Reinforcing-Bar Preparation: Remove loose and flaking rust from exposed reinforcing bars by needle scaling or wire brushing until only tightly adhered light rust remains.

1. Where section loss of reinforcing bar is more than 25 percent, or 20 percent in two or more adjacent bars, cut bars and remove and replace as indicated on Drawings.
2. Remove additional concrete as necessary to provide at least 3/4-inch clearance at existing and replacement bars.
3. Splice replacement bars to existing bars according to ACI 318 by lapping, welding, or using mechanical couplings.

3.4 CONCRETE REMOVAL

A. Do not overload structural elements with debris.

B. Saw-cut perimeter of areas indicated for removal to a depth of at least 1/2 inch. Make cuts perpendicular to concrete surfaces and no deeper than cover on reinforcement.

C. Remove deteriorated and delaminated concrete by breaking up and dislodging from reinforcement.

D. Remove additional concrete if necessary to provide a depth of removal of at least 1/2 inch over entire removal area.

E. Where half or more of the perimeter of reinforcing bar is exposed, bond between reinforcing bar and surrounding concrete is broken, or reinforcing bar is corroded, remove concrete from entire perimeter of bar and to provide at least 3/4-inch clearance around bar.

F. Test areas where concrete has been removed by tapping with hammer, and remove additional concrete until unsound and disbonded concrete is completely removed.

G. Provide surfaces with a fractured profile of at least 1/8 inch that are approximately perpendicular or parallel to original concrete surfaces. At columns and walls, make top and bottom surfaces level unless otherwise directed.

H. Thoroughly clean removal areas of loose concrete, dust, and debris.

3.5 BONDING AGENT APPLICATION

A. Epoxy-Modified, Cementitious Bonding and Anticorrosion Agent: Apply to reinforcing bars and concrete. Apply to reinforcing bars in two coats, allowing first coat to dry two to three hours before applying second coat. Allow to dry before placing patching mortar.

B. Epoxy Bonding Agent: Apply to reinforcing bars and concrete, leaving no pinholes or other uncoated areas. Apply to reinforcing bars in at least two coats, allowing first coat to dry before

applying second coat. Place patching mortar while epoxy is still tacky. If epoxy dries, recoat before placing patching mortar.

C. Latex Bonding Agent, Type I: Apply to concrete by brush roller or spray. Allow to dry before placing patching mortar.

D. Latex Bonding Agent, Type II: Mix with portland cement and scrub into concrete surface. Place patching mortar while bonding agent is still wet. If bonding agent dries, recoat before placing patching mortar.

E. Slurry Coat for Cementitious Patching Mortar: Wet substrate thoroughly and then remove standing water. Scrub a slurry of neat patching mortar mixed with latex bonding agent into substrate, filling pores and voids.

3.6 PATCHING MORTAR APPLICATION

A. Place patching mortar as specified in this article unless otherwise recommended in writing by manufacturer.

1. Provide forms where necessary to confine patch to required shape.
2. Wet substrate and forms thoroughly and then remove standing water.

B. Pretreatment: Apply specified bonding agent and slurry coat.

C. General Placement: Place patching mortar by troweling toward edges of patch to force intimate contact with edge surfaces. For large patches, fill edges first and then work toward center, always troweling toward edges of patch. At fully exposed reinforcing bars, force patching mortar to fill space behind bars by compacting with trowel from sides of bars.

D. Vertical Patching: Place material in lifts of not more than thickness recommended by manufacturer. Do not feather edge.

E. Overhead Patching: Place material in lifts of not more than thickness recommended by manufacturer. Do not feather edge.

F. Consolidation: After each lift is placed, consolidate material and screed surface.

G. Multiple Lifts: Where multiple lifts are used, score surface of lifts to provide a rough surface for placing subsequent lifts. Allow each lift to reach final set before placing subsequent lifts.

H. Finishing: Allow surfaces of lifts that are to remain exposed to become firm and then finish to a surface matching adjacent concrete.

I. Curing: Wet-cure cementitious patching materials, including polymer-modified cementitious patching materials, for not less than seven days by water-fog spray or water-saturated absorptive cover.

3.7 DRY-PACK-MORTAR APPLICATION

A. Use dry-pack mortar for deep cavities. Place as specified in this article unless otherwise recommended in writing by manufacturer.

1. Provide forms where necessary to confine patch to required shape.
2. Wet substrate and forms thoroughly and then remove standing water.

B. Pretreatment: Apply specified bonding agent and slurry coat.

C. Place dry-pack mortar into cavity by hand, and compact tightly into place. Do not place more material at a time than can be properly compacted. Continue placing and compacting until patch is approximately level with surrounding surface.

D. After cavity is filled and patch is compacted, trowel surface to match profile and finish of surrounding concrete.

E. Wet-cure patch for not less than seven days by water-fog spray or water-saturated absorptive cover.

3.8 EPOXY CRACK INJECTION

A. Clean cracks with oil-free compressed air or low-pressure water to remove loose particles.

B. Clean areas to receive capping adhesive of oil, dirt, and other substances that would interfere with bond.

C. Place injection ports as recommended by epoxy manufacturer, spacing no farther apart than thickness of member being injected. Seal injection ports in place with capping adhesive.

D. Seal cracks at exposed surfaces with a ribbon of capping adhesive at least 1/4 inch thick by 1 inch wider than crack.

E. Inject cracks wider than 0.003 inch to a depth of 8 inches.

F. Inject epoxy adhesive, beginning at widest part of crack and working toward narrower parts. Inject adhesive into ports to refusal, capping adjacent ports when they extrude epoxy. Cap injected ports and inject through adjacent ports until crack is filled.

G. After epoxy adhesive has set, remove injection ports and grind surfaces smooth.

3.9 CORROSION-INHIBITING-TREATMENT APPLICATION

A. Apply by brush, roller, or airless spray in two coats at manufacturer's recommended application rate. Remove film of excess treatment before patching treated concrete.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform the following tests and inspections:

1. Packaged, Cementitious Patching Mortar: Two randomly selected sets of samples for each type of mortar required, tested according to ASTM C 928/C 928M.
2. Joint Filler: Core-drilled samples to verify proper installation.

    a. Testing Frequency: One sample for each 100 feet of joint filled.
    b. Where samples are taken, refill holes with joint filler.

3. Epoxy Crack Injection: Core-drilled samples to verify proper installation.

    a. Testing Frequency: One sample for each 100 feet of crack injected.
    b. Where samples are taken, refill holes with epoxy mortar.

C. Product will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 03 01 30

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.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Design Mixtures: For each concrete mixture.

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 C or 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: 0.50.
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: 3-1/2 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.

C. Do not chamfer exterior corners and edges of permanently exposed concrete.

3.2 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.3 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

3.4 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items 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.

3.5 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.

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.

3.6 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.

3.7 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.

3.8 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 C, structural tubing.

E. Steel Pipe: ASTM A 501, Grade A.

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.

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

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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.

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 inches by 1-5/8 inches.
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: 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.

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.

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 plates.

2.9 FINISHES

A. General:

1. Comply with NAAMM AMP 500 "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Finish metal fabrications after assembly.
3. 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.

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.

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 05 52 13 - PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel pipe and tube railings for stairs, platforms, and walkways.
2. Railing gates at the level of exit discharge.

B. Related Requirements:

1. Refer to Section 09 69 00 "Access Flooring" for access flooring guard and handrail systems.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design railings, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:

1. Steel: 72 percent of minimum yield strength.

C. Structural Performance: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Handrails and Top Rails of Guards:

a. Uniform load of 50 lbf/ ft. applied in any direction.
b. Concentrated load of 200 lbf applied in any direction.
c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:

a. Concentrated load of 50 lbf applied horizontally on an area of 1 square foot.
b. Infill load and other loads need not be assumed to act concurrently.

D. 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.

E. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Manufacturer's product lines of mechanically connected railings.
2. Paint products.
3. Preparation instructions and recommendations.
4. Storage and handling requirements and recommendations.
5. Installation instructions.

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 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: Showing fabrication and installation of handrails and guardrails including plans, elevations, sections, details of components, anchor details, and attachment to adjoining units of work.

D. Samples: For each type of exposed finish required.

1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
2. Fittings and brackets.

E. 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 and testing agency.

B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of railing from single source from single manufacturer.

1.6 PROJECT CONDITIONS

A. Field Measurements: Field verification of existing conditions is particularly important for this Project. Verify actual locations of construction contiguous with metal fabrications by field measurements before fabrication.

B. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Materials to be delivered to the job site in good condition and adequately protected against damage as handrails are a finished product.

B. Store products in manufacturer's unopened packaging until ready for installation.

1.8 COORDINATION AND SCHEDULING

A. Coordinate fabrication and delivery schedule of handrails with construction progress and sequence to avoid delay of railing installation.

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. Steel Pipe and Tube Railings:

a. Kee Industrial Products, Inc.; Safety; KeeGuard System (Basis of Design).
b. Blum, Julius & Co., Inc.
c. Braun, J.G., Co.; div. of the Wagner Companies.
d. Pisor Industries, Inc.
e. Tubular Specialties Manufacturing, Inc.
f. Wagner, R&B, Inc.; div. of the Wagner Companies.

2.2 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

C. Recycled Content of Steel Products: Post-consumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.

2.3 STEEL AND IRON

A. Tubing: ASTM A 500 (cold formed) or ASTM A 513.

B. Pipe: ASTM A 53/A 53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.

1. Provide galvanized finish for exterior installations.

C. Plates, Shapes, and Bars: ASTM A 36/A 36M.

D. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

2.4 SYSTEMS

A. General: Provide pipe or tubing, fittings, and accessories as indicated or required to match design indicated on the Drawings.

1. Fittings: Cast iron.
2. Handrail Tubing, 12 gage, Size:

a. 1-1/2 inches - 1.90 inches outside diameter.
b. 1-1/4 inches - 1.66 inches outside diameter.

3. Handrail Pipe, Schedule 40, Size:

a. 1-1/2 inches - 1.90 inches outside diameter.
b. 1-1/4 inches - 1.66 inches outside diameter.

4. Infill Panels: As indicated. Refer to Drawings.

B. Custom Design: Provide pipe, fittings, and accessories as indicated or required by Drawings to match design indicated.

C. Railing Gates at Level of Exit Discharge: Form gates from tube of same material, size, and shape as top rails, with infill to match guards. Provide with self-closing type hinges for fastening to wall and overlapping stop with rubber bumper to prevent gate from opening in direction opposite egress.

2.5 MATERIALS

A. Pipe: Provide the following:

1. Steel Pipe: Steel, 1-1/2 inches Schedule 40, galvanized.

2. Tube: Galvanized tube, 12 gage, 1-1/2 inches, 1.90 inches outside diameter.

B. Fittings, Including Elbows, Crossovers, Wall flanges, Tees, Couplings:

1. Galvanized Malleable Cast Iron: Kee Klamp, or other special fitting by manufacturer, structural pipe fittings, ASTM A 447 with ASTM A 153 galvanizing.

C. Finish: Polyester factory applied spray coating.

D. Fasteners: Type 304 stainless steel.

2.6 FASTENERS

A. Provide Type 304 stainless steel fasteners comply with ASTM A 153/A 153M for hot-dip galvanized railings.

B. Fasteners for Interconnecting Railing Components:

1. Provide concealed fasteners for interconnecting railing components, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.
2. Provide square or hex socket flat-head machine screws for exposed fasteners unless otherwise indicated.

2.7 MISCELLANEOUS MATERIALS

A. Low-Emitting Materials: Paints and coatings, including touch-up paint supplied by railing manufacturer, shall comply with local regulations controlling use of volatile organic compounds (VOC's).

B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

C. Shop Primer for Galvanized Steel: Manufacturer's standard compatible with topcoat.

D. Intermediate Coats and Topcoats: Manufacturer's standard.

2.8 FABRICATION

A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and counterweighting, but not less than that required to support structural loads.

B. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

C. Upright tops shall be plugged with weather and light resistant material.

D. 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.

E. Form work true to line and level with accurate angles and surfaces.

F. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weepholes where water may accumulate.

G. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

H. Connections: Fabricate railings with non-welded connections unless otherwise indicated.

I. Non-Welded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.

J. Form changes in direction as follows:

1. As detailed.

K. Bend members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

L. Close exposed ends of railing members with prefabricated end fittings.

2.9 FINISHES

A. General:

1. Comply with NAAMM AMP 500 "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
3. 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.
4. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

B. Steel and Iron Finishes:

1. Galvanized Railings:

    a. Hot-dip galvanize steel and iron railings, including hardware, after fabrication.
    b. Comply with ASTM A 123/A 123M for hot-dip galvanized railings.
    c. Comply with ASTM A 153/A 153M for hot-dip galvanized hardware.
    d. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
    e. Fill vent and drain holes that will be exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

2. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.
3. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.
4. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
5. Shop-Painted Finish: Manufacturer's standard.

    a. Color: As indicated on the Drawings.

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. Fit exposed connections together to form tight, hairline joints. For all connections with manufacturer's special hardware and clamps, tighten each set screw to the recommended number of foot pounds of torque

B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

    1. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
    2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.

3.3 RAILING CONNECTIONS

A. Non-Welded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.

B. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches of post.

3.4 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean bolted connections and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0 mil dry film thickness.

3.5 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

END OF SECTION 05 52 13

SECTION 05 53 13 - BAR GRATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes metal bar gratings and metal frames and supports for gratings.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Clips and anchorage devices for gratings.
2. Paint products.

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: Include plans, sections, details, and attachments to other work.

D. Delegated Design Submittal: For gratings, including manufacturers' published load tables.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 45 00 "Quality Requirements," to design gratings.

B. Structural Performance: Gratings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Walkways and Elevated Platforms Used as Exits: Uniform load of 100 lbf/sq. ft.
2. Limit deflection to L/360 or 1/4 inch, whichever is less.

C. Seismic Performance: Gratings shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Component Importance Factor: 1.5.

D. Recycled Content of Steel Products: Post-consumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.

E. VOC Content: 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).

2.2 METAL BAR GRATINGS

A. Metal Bar Grating Standards: Comply with NAAMM MBG 531, "Metal Bar Grating Manual."

B. Welded Steel Grating: MBG-531:

1. Bearing Bar Spacing: 7/16 inch or 1/2 inch on center.
2. Bearing Bar Depth: As required to comply with structural performance requirements.
3. Bearing Bar Thickness: As required to comply with structural performance requirements.
4. Crossbar Spacing: 2 inches on center.
5. Traffic Surface: Serrated.
6. Steel Finish: Hot-dip galvanized with a coating weight of not less than 1.8 oz./sq. ft. of coated surface.

2.3 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Steel Bars for Bar Gratings: ASTM A 36/A 36M or steel strip, ASTM A 1011/A 1011M or ASTM A 1018/A 1018M.

C. Wire Rod for Bar Grating Crossbars: ASTM A 510.

D. Uncoated Steel Sheet: ASTM A 1011/A 1011M, structural steel, Grade 30.

E. Galvanized Steel Sheet: ASTM A 653/A 653M, structural quality, Grade 33, with G90 coating.

2.4 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.

2.5 FABRICATION

A. Cut, drill, and punch material 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.

B. Fit exposed connections accurately together to form hairline joints.

2.6 GRATING FRAMES AND SUPPORTS

A. Fabricate from metal shapes, plates, and bars of welded construction to sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.

B. Galvanize steel frames and supports as indicated on the Drawings and at exterior locations.

2.7 FINISHES

A. General: Comply with NAAMM'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.

1. Finish gratings, frames, and supports after assembly.

B. Steel Finishes:

1. Shop Primer for Ferrous Metal: Provide fast-curing, lead-free and chromate-free, universal modified alkyd primer complying with performance requirements of FS TT-P-664, selected for good resistance to normal atmospheric corrosion, compatibility with finish paint systems indicated, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.
2. 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.
3. Galvanizing Repair Paint: Provide high zinc dust content paint for regalvanizing welds in galvanized steel, with dry film containing not less than 94 percent zinc dust by weight, and complying with SSPC Paint 20.

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

A. General:

1. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
2. Fit exposed connections accurately together to form hairline joints.

    a. 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 the surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

3. Attach toe plates to gratings by welding at locations indicated.

B. Installing Metal Bar Gratings:

1. General: Install gratings to comply with recommendations of referenced metal bar grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.
2. Attach removable units to supporting members with type and size of clips and fasteners indicated or, if not indicated, as recommended by grating manufacturer for type of installation conditions shown.
3. Attach non-removable units to supporting members by welding where both materials are same; otherwise, fasten by bolting as indicated above.

3.3 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.

3.4 PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to the Installer, that shall ensure that the bar gratings shall be without damage at time of Substantial Completion.

END OF SECTION 05 53 13

SECTION 06 10 00- MISCELLANEOUS ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Framing with dimension lumber.
2. Wood grounds, nailers, and blocking.
3. Wood boards.
4. Plywood panels.

1.2 DEFINITIONS

A. Dimension Lumber: Lumber of 2 inches nominal or greater but less than 5 inches nominal in least dimension.

1.3 SUBMITTALS

A. Wood Treatment Data: Submit wood treatment data as follows, including chemical treatment manufacturer's instructions for handling, storing, installing, and finishing treated materials:

1. For each type of preservative-treated wood product, include certification by treating plant stating type of preservative solution and pressure process used, net amount of preservative retained, and compliance with applicable standards.
2. For waterborne-treated products, include statement that moisture content of treated materials was reduced to levels indicated before shipment to Project site.
3. For fire-retardant-treated wood products, include certification by treating plant that treated materials comply with specified standard and other requirements as well as data relative to bending strength, stiffness, and fastener-holding capacities of treated materials.

B. Material Test Reports: Submit material test reports from a qualified independent testing agency indicating and interpreting test results relative to compliance of fire-retardant-treated wood products with performance requirements indicated.

C. Warranty: Warranty of chemical treatment manufacturer for each type of treatment.

D. Product Data: Unless otherwise indicated, submit for each type of product provided under work of this Section:

E. High Performance Sustainable Building Submittals:

1. Letter of Certification(s) for Sustainable Forestry:

a. Forest Stewardship Council (FSC): Provide letter of certification signed by lumber supplier. Indicate compliance with FSC "Principles for Natural Forest Management" and identify certifying organization.

1) Submit FSC certification numbers; identify each certified product on a line item basis.
2) Submit copies of invoices bearing the FSC certification numbers.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Keep materials under cover and dry. Protect from weather and contact with damp or wet surfaces. Stack lumber. Provide for air circulation within and around stacks and under temporary coverings.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

B. Sustainably Harvested Wood: Certification Organizations shall be accredited by the Forest Stewardship Council.

1. For lumber pressure treated with waterborne chemicals, place spacers between each bundle to provide air circulation.

PART 2 - PRODUCTS

2.1 LUMBER, GENERAL

A. Certified Wood: Lumber and plywood shall be produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

B. Lumber Standards: Furnish lumber manufactured to comply with PS 20, "American Softwood Lumber Standard," and with applicable grading rules of inspection agencies certified by American Lumber Standards Committee's (ALSC) Board of Review.

C. Resource Management: Virgin lumber fabricated from old growth timber is not permitted. Provide sustainably harvested; certified or labeled in accordance with FSC guidelines.

D. Inspection Agencies: Inspection agencies, and the abbreviations used to reference them, include the following:

1. NELMA: Northeastern Lumber Manufacturers' Association.

2. NLGA: National Lumber Grades Authority.
3. SPIB: The Southern Pine Inspection Bureau.
4. WCLIB: West Coast Lumber Inspection Bureau.
5. WWPA: Western Wood Products Association.

E. Grade Stamps: Provide lumber with each piece factory marked with grade stamp of inspection agency evidencing compliance with grading rule requirements and identifying grading agency, grade, species, moisture content at time of surfacing, and mill.

1. For exposed lumber, furnish pieces with grade stamps applied to ends or back of each piece.

F. Sizes: Provide nominal sizes indicated, complying with PS 20 except where actual sizes are specifically noted as being required.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

A. General: Where lumber is indicated as preservative treated or is specified to be treated, comply with applicable requirements of AWPA C20 (lumber). Mark each treated item with the Quality Mark Requirements of an inspection agency approved by ALSC's Board of Review.

1. Do not use chemicals containing chromium or arsenic.
2. For exposed items indicated to receive stained finish, use chemical formulations that do not bleed through contain colorants, or otherwise adversely affect finishes.

B. Pressure treat aboveground items with waterborne preservatives to a minimum retention of 0.25 lb./cu. ft. After treatment, kiln-dry lumber and plywood to a maximum moisture content of 19 percent and 15 percent, respectively. Treat indicated items and the following:

1. Wood nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
2. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.

C. Pressure treat wood members in contact with ground with waterborne preservatives to a minimum retention of 0.40 lb./cu. ft.

2.3 FIRE-RETARDANT-TREATED MATERIALS

A. General: Where fire-retardant-treated wood is indicated, comply with applicable requirements of AWPA C20 (lumber). Identify fire-retardant-treated wood with appropriate classification marking of UL; U.S. Testing; Timber Products Inspection, Inc.; or another testing and inspecting agency acceptable to authorities having jurisdiction.

1. Treatment Types: Interior Type A for protected wood and Exterior for wood exposed to weather.

B. Inspect each piece of treated lumber after drying and discard damaged or defective pieces.

2.4 DIMENSION LUMBER FRAMING

A. Non-Load-Bearing Framing: Construction, Stud, or No. 3 grade of any species.

2.5 BOARDS

A. Exposed Boards: Where boards will be exposed in the finished work, provide the following:

1. Moisture Content: 19 percent maximum.
2. Species and Grade: Southern pine, C Finish per SPIB rules.

B. Concealed Boards: Where boards will be concealed by other work, provide lumber with 19 percent maximum moisture content and of following species and grade:

1. Species and Grade: Eastern softwoods, No. 3 Common per NELMA rules.

2.6 MISCELLANEOUS LUMBER

A. General: Provide lumber for support or attachment of other construction, including rooftop equipment curbs and support bases, cant strips, bucks, nailers, blocking, furring, grounds, stripping, and similar members.

B. Fabricate miscellaneous lumber from dimension lumber of sizes indicated and into shapes shown.

C. Moisture Content: 19 percent maximum for lumber items are not specified to receive wood preservative treatment.

D. Grade: For dimension lumber sizes, provide No. 3 or Standard grade lumber per ALSC's NGRs of any species. For board-size lumber, provide No. 3 Common grade per NELMA, NLGA, or WWPA; No. 2 grade per SPIB; or Standard grade per NLGA, WCLIB or WWPA of any species.

2.7 PLYWOOD PANELS

A. Plywood Panels: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant-treated or preservative-treated as indicated on the Drawings, in thickness indicated or, if not indicated, not less than 1/2 inch nominal thickness.

2.8 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.

1. Where miscellaneous carpentry is exposed to weather, in ground contact, or in area of high relative humidity, provide fasteners with a hot-dip zinc coating per ASTM A 153 or of Type 304 stainless steel.

B. Nails, Wire, Brads, and Staples: FS FF-N-105.

C. Power-Driven Fasteners: CABO NER-272.

D. Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers.

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. Discard units of material with defects that impair quality of miscellaneous carpentry and in sizes that would require an excessive number or poor arrangement of joints.

B. Cut and fit miscellaneous carpentry accurately. Install members plumb and true to line and level.

C. Coat cut edges of preservative-treated wood to comply with AWPA M4.

D. Countersink nail heads on exposed carpentry work and fill holes.

E. Install as indicated and in accordance with the National Association of Home Builders (NAHB) Advanced Framing Techniques: Optimum Value Engineering.

3.3 WOOD GROUNDS, NAILERS, AND BLOCKING

A. Install where shown and where required for screeding or attaching other work. Cut and shape to required size. Coordinate locations with other work involved.

B. Attach to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated.

3.4 PLYWOOD PANELS

A. Install plywood panels by fastening to studs. Coordinate locations with utilities requiring backing panels. Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.

3.5 PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to the Installer that shall ensure that the miscellaneous rough carpentry shall be without damage at time of Substantial Completion.

3.6 SITE ENVIRONMENTAL PROCEDURES

A. Waste Management: As specified in Section 01 74 19 "Construction Waste Management" and as follows:

1. Select lumber sizes to minimize waste; reuse scrap lumber to the greatest extent possible. Clearly separate scrap lumber for use on site as accessory components, including: shims, bracing, and blocking.
2. Do not leave any wood, shavings, sawdust, etc. on the ground or buried in fill. Prevent saw dust and wood shavings from entering the storm drainage system.
3. Do not burn scrap lumber that has been pressure treated.

    a. Do not send lumber treated with pentachlorophenol, CCA, or ACA to co-generation facilities or "waste-to-energy" facilities.

END OF SECTION 06 10 00

SECTION 06 16 00 - SHEATHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes roof sheathing.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood preservative treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Indicate type of preservative used and net amount of preservative retained.
2. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
3. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

B. High Performance Sustainable Building Submittals:

1. Certificates: Chain-of-custody certificates indicating that products specified to be made from certified wood comply with forest certification requirements. Include documentation that manufacturer is certified for chain of custody by an FSC-accredited certification body. Include statement indicating cost for each certified wood product.
2. Product Data: For composite wood products, documentation indicating that product contains no urea formaldehyde.

1.3 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For following products, from ICC-ES:

1. Preservative-treated plywood.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PANEL PRODUCTS

A. Certified Wood: For the following wood products, provide materials produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship":

1. Plywood.

B. Plywood: Either DOC PS 1 or DOC PS 2 unless otherwise indicated.

C. Thickness: As needed to comply with requirements specified, but not less than thickness indicated.

D. Factory mark panels to indicate compliance with applicable standard.

2.2 PRESERVATIVE-TREATED PLYWOOD

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC3b for exterior construction not in contact with the ground.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

B. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.

C. Application: Treat plywood in contact with masonry or concrete or used with roofing.

2.3 ROOF SHEATHING

A. Plywood Roof Sheathing: Exposure 1, Structural I sheathing.

1. Span Rating: As needed to comply with requirements specified.
2. Nominal Thickness: As needed to comply with requirements specified.

2.4 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. For roof sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.

B. Nails and Brads: ASTM F 1667.

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. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.

B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.

C. Securely attach to substrate by fastening as indicated, complying with the following:

1. Table 2304.9.1, "Fastening Schedule," in ICC's "International Building Code."

D. Use common wire nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections. Install fasteners without splitting wood.

E. Coordinate roof sheathing installation with flashing and joint sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.

F. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

G. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.3 WOOD STRUCTURAL PANEL INSTALLATION

A. General: Comply with applicable recommendations in APA Form No. E30, "Engineered Wood Construction Guide," for types of structural use panels and applications indicated.

B. Fastening Methods: Fasten panels as indicated below:

1. Roof Sheathing:

   a. Nail to wood framing.
   b. Space panels 1/8 inch apart at edges and ends.

3.4 PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to the Installer, that shall ensure that the sheathing shall be without damage at time of Substantial Completion.

END OF SECTION 06 16 00

SECTION 06 41 16 - PLASTIC-LAMINATE-FACED ARCHITECTURAL CABINETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plastic-laminate-faced architectural cabinets.
2. Laminate-clad countertops.
3. Wood blocking and shims for installing plastic-laminate-faced architectural cabinets unless concealed within other construction before cabinet installation.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product, including high-pressure decorative laminate, adhesive for bonding plastic laminate, fire-retardant-treated materials, and cabinet hardware and accessories.

1. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.

B. High Performance Sustainable Building Submittals:

1. Product Data:

a. 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.
b. For adhesives and composite wood products, documentation indicating that products contain no urea formaldehyde.

2. Product Certificates: For products and materials required to comply with requirements for regionally manufactured materials. Include statement indicating cost for each regionally manufactured material.
3. Certificates: Chain-of-custody certificates indicating that products specified to be made from certified wood comply with forest certification and chain-of-custody requirements. Include statement indicating cost for each certified wood product.

C. Shop Drawings: Show location of each item, dimensioned plans and elevations, large scale details, attachment devices, and other components.

1. Show details full size.
2. Show locations and sizes of blocking, including concealed blocking and reinforcement specified in other Sections.
3. Apply AWI Quality Certification Program label to Shop Drawings.

D. Samples:

1. Samples for Initial Selection:

a. Plastic laminates.
b. PVC edge material.
c. Thermoset decorative panels.

2. Samples for Verification:

a. Plastic laminates, 8 by 10 inches, for each type, color, pattern, and surface finish.
b. Thermoset decorative panels, 8 by 10 inches, for each color, pattern, and surface finish.
c. Exposed cabinet hardware and accessories, one unit for each type and finish.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and fabricator.

B. Product Certificates: For each type of product.

C. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

D. Evaluation Reports: For fire-retardant-treated materials, from ICC-ES.

1.4 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance. Shop is a certified participant in AWI's Quality Certification Program.

B. Installer Qualifications: May be fabricator of products. Installer shall be certified participant in AWI's Quality Certification Program.

C. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

D. Pre-Installation Conference: Conduct conference at Project site.

E. Coordination: Coordinate sizes and locations of blocking, reinforcements, and other related units of Work specified in other Sections to ensure that cabinets can be installed as indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver cabinets until painting and similar operations that could damage woodwork have been completed in installation areas. If cabinets must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install cabinets until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 PLASTIC-LAMINATE-FACED ARCHITECTURAL CABINETS

A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of architectural plastic laminate cabinets indicated for construction, finishes, installation, and other requirements.

1. Provide labels and certificates from AWI certification program indicating that woodwork, including installation, complies with requirements of grades specified.

B. Grade: Premium.

C. Regional Materials: Plastic laminate cabinets shall be manufactured within 500 miles of Project site.

D. Certified Wood: Plastic laminate cabinets shall be made from wood products certified as "FSC Pure" or "FSC Mixed Credit" according to FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship," and FSC STD-40-004, "FSC Standard for Chain of Custody Certification."

E. Type of Construction: Flush overlay.

F. Cabinet, Door, and Drawer Front Interface Style: As indicated.

G. High Pressure Decorative Laminate: NEMA LD 3, grades as indicated or if not indicated, as required by woodwork quality standard.

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. Abet Laminati, Inc.
b. Formica Corp.
c. Lamin-Art, Inc.

d. Panolam Industries International, Inc.
e. Wilsonart International; div. of Premark International, Inc.

H. Laminate Cladding for Exposed Surfaces:

1. Horizontal Surfaces: Grade HGS.
2. Post-Formed Surfaces: Grade HGP.
3. Vertical Surfaces: Grade HGS.
4. Edges: Grade HGS.
5. Pattern Direction: As indicated.

I. Materials for Semi-Exposed Surfaces:

1. Surfaces Other Than Drawer Bodies: Thermoset decorative panels.

a. Edges of Plastic Laminate Shelves: Grade HGS.

2. Drawer Sides and Backs: Thermoset decorative panels.
3. Drawer Bottoms: Thermoset decorative panels.

J. Dust Panels: 1/4 inch plywood or tempered hardboard above compartments and drawers unless located directly under tops.

K. Concealed Backs of Panels with Exposed Plastic Laminate Surfaces: High pressure decorative laminate, NEMA LD 3, Grade BKL.

L. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.

1. Join subfronts, backs, and sides with glued rabbeted joints supplemented by mechanical fasteners or glued dovetail joints.

M. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:

1. As indicated on the Drawings.

2.2 COUNTERTOPS

A. Quality Standard: Comply with AWI AWS, Section 400 requirements for countertops.

B. Grade: Premium grade.

C. Plastic Laminate Countertop: Provide high pressure plastic laminate.

1. Grade: HGS, 0.048 inch nominal thickness.
2. Colors, Patterns, and Finishes: As indicated on the Drawings.
3. Edge Treatment: Same as laminate cladding on horizontal surfaces.
4. Core Material: Particleboard or MDF.

2.3 WOOD MATERIALS

A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of woodwork and quality grade specified unless otherwise indicated.

B. Composite Wood and Agrifiber Products: Provide materials that comply with requirements of referenced quality standard for each type of woodwork and quality grade specified unless otherwise indicated.

1. Recycled Content of Medium Density Fiberboard and Particleboard: Post-consumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.
2. Medium Density Fiberboard: ANSI A208.2, Grade 130, made with binder containing no urea formaldehyde.
3. Particleboard: ANSI A208.1, Grade M-2, made with binder containing no urea formaldehyde.
4. Softwood Plywood: DOC PS 1, medium density overlay.
5. Thermoset Decorative Panels: Particleboard or medium density fiberboard finished with thermally fused, melamine-impregnated decorative paper and complying with requirements of NEMA LD 3, Grade VGL, for test methods 3.3, 3.4, 3.6, 3.8, and 3.10.

2.4 FIRE-RETARDANT-TREATED MATERIALS

A. Fire-Retardant-Treated Materials, General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

1. Use treated materials that comply with requirements of referenced woodworking standard. Do not use materials that are warped, discolored, or otherwise defective.
2. Use fire-retardant treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
3. Identify fire-retardant-treated materials with appropriate classification marking of qualified testing agency in the form of removable paper label or imprint on surfaces that will be concealed from view after installation.

B. Fire-Retardant-Treated Lumber and Plywood: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.

1. Kiln dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent, respectively.
2. Mill lumber after treatment within limits set for wood removal that do not affect listed fire-test-response characteristics, using a woodworking shop certified by testing and inspecting agency.
3. Mill lumber before treatment and implement special procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from

drying sticks or other causes, marring, and other defects affecting appearance of treated woodwork.

C. Fire-Retardant Particleboard: Panels complying with the following requirements, made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 25 or less per ASTM E 84.

1. For panels 3/4 inch thick and less, comply with ANSI A208.1 for Grade M-2 except for the following minimum properties: modulus of rupture, 1600 psi; modulus of elasticity, 300,000 psi; internal bond, 80 psi; and screw-holding capacity on face and edge, 250 and 225 lbf, respectively.
2. For panels 13/16 inch to 1-1/4 inches thick, comply with ANSI A208.1 for Grade M-1 except for the following minimum properties: modulus of rupture, 1300 psi; modulus of elasticity, 250,000 psi; linear expansion, 0.50 percent; and screw-holding capacity on face and edge, 250 lbf and 175 lbf, respectively.

D. Fire-Retardant Fiberboard: Medium density fiberboard panels complying with ANSI A208.2, made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 200 or less per ASTM E 84.

2.5 CABINET HARDWARE AND ACCESSORIES

A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets.

B. Butt Hinges: 2-3/4 inch, five-knuckle steel hinges made from 0.095 inch thick metal, and as follows:

1. Semi-Concealed Hinges for Flush Doors: BHMA A156.9, B01361.
2. Semi-Concealed Hinges for Overlay Doors: BHMA A156.9, B01521.

C. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, 135 degrees of opening.

D. Back-Mounted Pulls: BHMA A156.9, B02011.

E. Catches: Magnetic catches, BHMA A156.9, B03141.

F. Adjustable Shelf Standards and Supports: BHMA A156.9, B04071; with shelf rests, B04081.

G. Drawer Slides: BHMA A156.9.

H. Door and Drawer Silencers: BHMA A156.16, L03011.

I. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.

1. Satin Stainless Steel: BHMA 630.

J. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

2.6 MISCELLANEOUS MATERIALS

A. Blocking and Shims: Fire-retardant-treated softwood lumber, kiln dried to less than 15 percent moisture content.

B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use non-ferrous metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.

C. Adhesives: Do not use adhesives that contain urea formaldehyde.

2.7 FABRICATION

A. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.

B. Fabricate cabinets to dimensions, profiles, and details indicated.

C. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

1. Notify COR seven days in advance of the dates and times woodwork fabrication will be complete.
2. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements before disassembling for shipment.

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 PREPARATION

A. Before installation, condition cabinets to average prevailing humidity conditions in installation areas.

B. Before installing cabinets, examine shop-fabricated work for completion and complete work as required.

3.3 INSTALLATION

A. Grade: Install cabinets to comply with same grade as item to be installed.

B. Assemble cabinets and complete fabrication at Project site to the extent that it was not completed in the shop.

C. Install cabinets level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches.

D. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

E. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork.

1. Use filler matching finish of items being installed.

F. Cabinets: Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.

1. Install cabinets with no more than 1/8 inch in 96 inch sag, bow, or other variation from a straight line.

G. Countertops: Anchor securely to base units and other support systems as indicated. Install countertops with no more than 1/8 inch in 96 inches for sag, bow, or other variation from a straight line.

3.4 ADJUSTING AND CLEANING

A. Repair damaged and defective cabinets, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.

B. Clean, lubricate, and adjust hardware.

C. Clean cabinets on exposed and semi-exposed surfaces.

3.5 PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to the Installer that shall ensure that the plastic-laminate-faced architectural cabinets shall be without damage at time of Substantial Completion.

END OF SECTION 06 41 16

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SECTION 06 65 29 - PLASTIC FASCIAE AND SOFFITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes vinyl fasciae and soffits.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Samples:

1. Samples for Initial Selection: For vinyl fascia and soffit including related accessories.
2. Samples for Verification: For each type, color, texture, and pattern required.

    a. 12 inch long by actual width sample of each type of fascia.
    b. 12 inch long by actual width sample of each type of soffit.
    c. 12 inch long by actual width samples of trim and accessories

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For each type of vinyl fascia and soffit.

C. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of product, including related accessories, 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. Furnish full lengths of vinyl fascia and soffit including related accessories, in a quantity equal to 2 percent of amount installed.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who is approved by the manufacturer.

B. Pre-Installation Conference: Conduct conference at Project site.

C. Coordination: Coordinate installation with flashings and other adjoining construction to ensure proper sequencing.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with labels intact until time of use.

B. Store materials under cover.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace products that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including cracking, fading, and deforming.
b. Deterioration of materials beyond normal weathering.

2. Fading is defined as loss of color, after cleaning with product recommended by manufacturer, of more than 4 Hunter color difference units as measured according to ASTM D 2244.
3. Warranty Period: 25 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain products, including related accessories, from single source from single manufacturer.

2.2 VINYL FASCIAE AND SOFFITS

A. Vinyl Fasciae and Soffits: Integrally colored product complying with ASTM D 4477.

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. Alside.

b. CertainTeed Corp.
c. Exterior Portfolio by Crane.
d. Gentek Building Products, Inc.
e. Heartland Building Products; a ProVia company.
f. Kaycan Ltd.
g. Mastic Home Exteriors.
h. Mitten, Inc.
i. Norandex; Building Materials Distribution, Inc.
j. RMC Siding.
k. Royal Building Products.
l. Variform, Inc.

2. Pattern: As indicated on the Drawings.
3. Texture: Smooth.
4. Nominal Thickness: 0.044 inch.
5. Minimum Profile Depth: As indicated on the Drawings.
6. Color: As indicated on the Drawings.

2.3 ACCESSORIES

A. Vinyl Accessories: Integrally colored vinyl accessories complying with ASTM D 3679 except for wind load resistance.

1. Texture: Smooth.
2. Color: Match adjacent fascia and soffit.

B. Flashing: Provide flashing complying with manufacturer's requirements where indicated.

C. Sealant: Provide sealant complying with manufacturer's requirements.

D. Fasteners:

1. For fastening to wood, use nails or ribbed bugle-head screws of sufficient length to penetrate a minimum of 1 inch into substrate.
2. For fastening to metal, use ribbed bugle-head screws of sufficient length to penetrate a minimum of 1/4 inch, or three screw threads, into substrate.
3. For fastening vinyl, use hot-dip galvanized fasteners. Where fasteners are exposed to view, use prefinished fasteners in color to match item being fastened.

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 EXAMINATION

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of vinyl fascia and soffit and related accessories.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 PREPARATION

A. Clean substrates of projections and substances detrimental to application.

3.4 INSTALLATION

A. General: Comply with manufacturer's written installation instructions applicable to products and applications indicated unless more stringent requirements apply.

1. Center nails without binding fasciae or soffits to allow for thermal movement.

B. Install vinyl fascia and soffit and related accessories according to ASTM D 4756.

C. Install joint sealants to produce a weathertight installation.

3.5 ADJUSTING AND CLEANING

A. Remove damaged, improperly installed, or otherwise defective materials and replace with new materials complying with specified requirements.

B. Clean finished surfaces according to manufacturer's written instructions and maintain in a clean condition during construction.

3.6 PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to the Installer that shall ensure that the plastic fasciae and soffits shall be without damage at time of Substantial Completion.

END OF SECTION 06 65 29

SECTION 07 54 23 - THERMOPLASTIC POLYOLEFIN (TPO) ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Adhered thermoplastic polyolefin (TPO) roofing system.
2. Roof insulation.

B. Related Requirements:

1. Section 07 71 00 "Roof Accessories."

1.2 DEFINITIONS

A. Roofing Terminology: Definitions in ASTM D 1079 and glossary in NRCA's "The NRCA Roofing and Waterproofing Manual" apply to work of this Section.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. High Performance Sustainable Building Submittals:

1. Product Data:

a. For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirement.
b. For adhesives and sealants used inside the weatherproofing system, documentation including printed statement of VOC content.

C. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work, including:

1. Flashings and membrane terminations.
2. Roof plan showing orientation of roof deck and orientation of roofing.
3. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.

D. Samples for Verification: For the following products:

1. Sheet roofing, of color required.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and manufacturer.

B. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

1. Submit evidence of compliance with performance requirements.

C. Product Test Reports: For components of roofing system, tests performed by manufacturer and witnessed by a qualified testing agency.

D. Research/Evaluation Reports: For components of roofing system, from ICC-ES.

E. Field quality control reports.

F. Sample Warranties: For manufacturer's special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing system to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is UL listed and FM Global approved for roofing system identical to that used for this Project.

B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

C. Preliminary Roofing Conference: Before starting roof deck construction, conduct conference at Project site.

1. Meet with COR, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review deck substrate requirements for conditions and finishes.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.

8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

D. Pre-Installation Roofing Conference: Conduct conference at Project site.

1. Meet with COR, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.

1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

1.8 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.

1. Special warranty includes roofing, flashings, roof insulation, fasteners, roofing accessories, and other components of roofing system.
2. Warranty Period: 15 years from date of Substantial Completion.

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. Carlisle SynTec, Inc.
2. Cooley Engineered Membranes.
3. Custom Seal Roofing.
4. Firestone Building Products.
5. Flex Roofing Systems.
6. GAF Materials Corp.
7. GenFlex Roofing Systems.
8. Johns Manville.
9. Mule-Hide Products Co., Inc.
10. Versico, Inc.

B. Source Limitations: Obtain components including roof insulation, fasteners, etc., for roofing system from same manufacturer as membrane roofing or manufacturer approved by membrane roofing manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Installed roofing and flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roofing and flashings shall remain watertight.

1. Accelerated Weathering: Roofing system shall withstand 2000 hours of exposure when tested according to ASTM G 152, ASTM G 154, or ASTM G 155.

2. Impact Resistance: Roofing system shall resist impact damage when tested according to ASTM D 3746 or ASTM D 4272.

B. Material Compatibility: Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roofing manufacturer based on testing and field experience.

C. FM Global Listing: Roofing, flashings, and component materials shall comply with requirements in FM Global 4450 or FM Global 4470 as part of a roofing system, and shall be listed in FM Global's "RoofNav" for Class 1 or non-combustible construction, as applicable. Identify materials with FM Global markings.

1. Fire/Windstorm Classification: Class 1A-90.
2. Hail Resistance Rating: SH.

D. Solar Reflectance Index: Not less than 78 when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

E. Exterior Fire Test Exposure: ASTM E 108 or UL 790, Class A; for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

2.3 TPO ROOFING

A. Fabric-Reinforced TPO Sheet: ASTM D 6878, internally fabric-reinforced or scrim-reinforced, uniform, flexible TPO sheet.

1. Thickness: 60 mils, nominal.
2. Exposed Face Color: White.

2.4 AUXILIARY ROOFING MATERIALS

A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with roofing.

1. Liquid type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
2. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content:

a. Plastic Foam Adhesives: 50 g/L.
b. Multipurpose Construction Adhesives: 70 g/L.
c. Single Ply Roof Membrane Adhesives: 250 g/L.
d. Single Ply Roof Membrane Sealants: 450 g/L.
e. Non-Membrane Roof Sealants: 300 g/L.
f. Sealant Primers for Non-Porous Substrates: 250 g/L.
g. Sealant Primers for Porous Substrates: 775 g/L.
h. Other Adhesives and Sealants: 250 g/L.

B. Sheet Flashing: Manufacturer's standard unreinforced TPO sheet flashing, 55 mils thick, minimum, of same color as TPO sheet.

C. Bonding Adhesive: Manufacturer's standard, water based.

D. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately 1 inch by 1/8 inch thick; with anchors.

E. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion resistance provisions in FM Global 4470, designed for fastening roofing to substrate, and acceptable to roofing system manufacturer.

F. Miscellaneous Accessories: Provide pourable sealers, preformed sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, and other accessories.

2.5 ROOF INSULATION

A. General: Preformed roof insulation boards manufactured or approved by TPO roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Global-approved roof insulation.

B. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, felt or glass fiber mat facer on both major surfaces.

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. Atlas Roofing Corp.
b. Carlisle SynTec, Inc.
c. Dyplast Products.
d. Firestone Building Products.
e. GAF Materials Corp.
f. Hunter Panels.
g. Insulfoam, LLC; a Carlisle company.
h. Johns Manville.
i. Rmax, Inc.

C. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping. Fabricate to slopes indicated.

2.6 INSULATION ACCESSORIES

A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with roofing.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion resistance provisions in FM Global 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer.

C. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to another insulation layer.

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. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work:

   a. Verify that roof openings and penetrations are in place, and curbs are set and braced.
   b. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.

2. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.

3.3 ROOFING INSTALLATION, GENERAL

A. Install roofing system according to roofing system manufacturer's written instructions.

B. Complete terminations and flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

3.4 INSULATION INSTALLATION

A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.

B. Comply with roofing system and insulation manufacturer's written instructions for installing roof insulation.

C. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch with insulation.

1. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.

D. Mechanically Fastened Insulation: Install insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board type roof insulation to deck type.

1. Fasten insulation according to requirements in FM Global's "RoofNav" for specified Windstorm Resistance Classification.
2. Fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.

3.5 ADHERED ROOFING INSTALLATION

A. Adhere roofing over area to receive roofing according to roofing system manufacturer's written instructions. Unroll roofing and allow to relax before retaining.

B. Start installation of roofing in presence of roofing system manufacturer's technical personnel.

C. Accurately align roofing, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

D. Bonding Adhesive: Apply to substrate and underside of roofing at rate required by manufacturer, and allow to partially dry before installing roofing. Do not apply to splice area of roofing.

E. In addition to adhering, mechanically fasten roofing securely at terminations, penetrations, and perimeter of roofing.

F. Apply roofing with side laps shingled with slope of roof deck where possible.

G. Seams: Clean seam areas, overlap roofing, and hot-air weld side and end laps of roofing and sheet flashings according to manufacturer's written instructions, to ensure a watertight seam installation.

1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet.
2. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.
3. Repair tears, voids, and lapped seams in roofing that do not comply with requirements.

3.6 FLASHING INSTALLATION

A. Install sheet flashings and preformed flashing accessories, and adhere to substrates according to roofing system manufacturer's written instructions.

B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate, and allow to partially dry. Do not apply to seam area of flashing.

C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.

D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.

E. Terminate and seal top of sheet flashings.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components, and to furnish reports to COR.

1. Electric Field Vector Mapping (EFVM): Testing agency shall survey entire roof area for potential leaks using electric field vector mapping (EFVM).

B. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.

C. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.

D. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.8 ADJUSTING AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to COR.

B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.9 PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to the Installer that shall ensure that the thermoplastic polyolefin roofing shall be without damage at time of Substantial Completion.

END OF SECTION 07 54 23

SECTION 07 71 00 - ROOF SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Roof edge specialties.
2. Precast concrete splash block.

B. Related Requirements:

1. Section 07 54 23 "Thermoplastic Polyolefin (TPO) Roofing."

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. High Performance Sustainable Building Submittals:

1. Product Data: 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 roof specialties.

1. Include plans, elevations, keyed details, and attachments to other work. Distinguish between plant-assembled and field-assembled work.
2. Include details for expansion and contraction.
3. Indicate profile and pattern of seams and layout of fasteners, clips, and other attachments.
4. Detail termination points and assemblies, including fixed points.
5. Include details of special conditions.

D. Samples:

1. Samples for Initial Selection: For each type of roof specialty indicated with factory-applied color finishes.
2. Samples for Verification:

a. Include samples of each type of roof specialty to verify finish and color selection, in manufacturer's standard sizes.

b. Include roof edge specialties made from 12 inch lengths of full-size components in specified material, and including fasteners, cover joints, accessories, and attachments.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Product Certificates: For each type of roof specialty.

C. Product Test Reports: For roof edge specialties for tests performed by a qualified testing agency.

D. Sample Warranty: For manufacturer's special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing specialties to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer offering products meeting requirements that are FM Approvals listed for specified class and SPRI ES-1 tested to specified design pressure.

B. Source Limitations: Obtain roof specialties approved by manufacturer providing roofing system warranty specified in Section 07 54 23 "Thermoplastic Polyolefin (TPO) Roofing."

C. Pre-Installation Conference: Conduct conference at Project site.

1. Meet with COR, roofing system testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, Installer, structural support Installer, and installers whose work interfaces with or affects roof specialties, including installers of roofing materials and accessories.
2. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
3. Review special roof details and condition of other construction that will affect roof specialties.

D. Coordination: Coordinate roof specialties with flashing, trim, and construction of parapets, roof deck, roof and wall panels, and other adjoining work to provide a leakproof, secure, and non-corrosive installation.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not store roof specialties in contact with other materials that might cause staining, denting, or other surface damage. Store roof specialties away from uncured concrete and masonry.

B. Protect strippable protective covering on roof specialties from exposure to sunlight and high humidity, except to extent necessary for the period of roof specialty installation.

1.7 FIELD CONDITIONS

A. Field Measurements: Verify profiles and tolerances of roof specialty substrates by field measurements before fabrication, and indicate measurements on Shop Drawings.

1.8 WARRANTY

A. Roofing System Warranty: Roof specialties shall be included in warranty provisions in Section 07 54 23 "Thermoplastic Polyolefin (TPO) Roofing."

B. Special Warranty on Painted Finishes: Manufacturer agrees to repair finish or replace roof specialties that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Fluoropolymer 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.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Roof specialties shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

B. FM Approvals' Listing: Manufacture and install roof edge specialties that are listed in FM Approvals' "RoofNav" and approved for windstorm classification, Class 1-90. Identify materials with FM Approvals' markings.

C. SPRI Wind Design Standard: Manufacture and install roof edge specialties tested according to SPRI ES-1 and capable of resisting the following design pressures:

1. Design Pressure: As indicated on Drawings.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of thermal movements. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime sky heat loss.

1. Temperature Change (Range): 120 degrees F, ambient; 180 degrees F, material surfaces.

E. Recycled Content of Metal Products: Post-consumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.

2.2 ROOF EDGE SPECIALTIES

A. One-Piece Metal Drip Edge: Manufactured, one-piece, metal drip edge in section lengths not exceeding 12 feet, with a horizontal flange and vertical leg terminating in a drip edge, and concealed splice plates of same material, finish, and shape as drip edge. Provide matching corner units if applicable.

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. Architectural Products Co.
b. Castle Metal Products.
c. Cheney Flashing Co.
d. Hickman Co., W.P.
e. Metal-Era, Inc.
f. Metal-Fab Manufacturing, LLC.
g. Perimeter Systems; div. of Southern Aluminum Finishing Co., Inc.
h. Petersen Aluminum Corp.

2. Formed Aluminum Sheet Drip Edge: Aluminum sheet, thickness as required to meet performance requirements.

a. Surface: Smooth, flat finish.
b. Finish: Two-coat fluoropolymer.
c. Color: As indicated on the Drawings.

2.3 SPLASH BLOCKS

A. Precast Concrete Splash Blocks: Splash block shall be reinforced with manufacturer's standard mesh or deformed bars. Concrete shall be normal weight, minimum 4000 psi 28 day compressive strength. Size shall be as indicated. If not indicated, provide in size to accommodate flow of water onto block for even distribution onto surface.

2.4 MATERIALS

A. Aluminum Sheet: ASTM B 209, alloy as standard with manufacturer for finish required, with temper to suit forming operations and performance required.

2.5 UNDERLAYMENT MATERIALS

A. Self-Adhering Sheet: Minimum 30 to 40 mils thick, consisting of slip-resisting polyethylene film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.

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. Carlisle Coatings & Waterproofing.
b. Grace Construction Products, a unit of W.R. Grace & Co.
c. Henry Co.
d. Metal-Fab Manufacturing, LLC.
e. Owens Corning.

2.6 MISCELLANEOUS MATERIALS

A. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to meet performance requirements. Furnish the following unless otherwise indicated:

1. Exposed Penetrating Fasteners: Gasketed screws with hex washer heads matching color of sheet metal.
2. Fasteners for Aluminum: Aluminum or Series 300 stainless steel.

B. Elastomeric Sealant: ASTM C 920, elastomeric silicone polymer sealant of type, grade, class, and use classifications required by roofing specialty manufacturer for each application.

C. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked type joints with limited movement.

D. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

E. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.7 FINISHES

A. General:

1. Comply with NAAMM AMP 500 "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

2. Protect painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
3. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved samples and are assembled or installed to minimize contrast.

B. Aluminum Sheet Finishes:

1. High Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

   a. Two-Coat Fluoropolymer: AAMA 2605. 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.
   b. Concealed Surface Finish: Apply pretreatment and manufacturer's standard acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

1. Examine roof edges, etc., for suitable conditions for roof specialties.
2. Verify that substrate is sound, dry, smooth, clean, and securely anchored.

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 UNDERLAYMENT INSTALLATION

A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Roll laps with roller. Cover underlayment within 14 days.

1. Apply continuously under roof edge specialties.

3.3 INSTALLATION, GENERAL

A. General: Install roof specialties according to manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, protective coatings, separators, underlayments, sealants, and other miscellaneous items as required to complete roof specialty systems.

1. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
2. Provide uniform, neat seams with minimum exposure of sealant.
3. Install roof specialties to fit substrates and to result in weathertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
4. Torch cutting of roof specialties is not permitted.
5. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

1. Coat concealed side of uncoated aluminum roof specialties with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
2. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.

C. Expansion Provisions: Allow for thermal expansion of exposed roof specialties.

1. Space movement joints at a maximum of 12 feet with no joints within 18 inches of corners or intersections unless otherwise indicated on Drawings.
2. When ambient temperature at time of installation is between 40 and 70 degrees F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures.

D. Fastener Sizes: Use fasteners of sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.

E. Seal concealed joints with butyl sealant as required by roofing specialty manufacturer.

F. Seal joints as required for weathertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below 40 degrees F.

3.4 ROOF EDGE SPECIALITIES INSTALLATION

A. Install anchoring and attachment accessories and devices with concealed fasteners.

B. Anchor roof edgings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.

3.5 ADJUSTING AND CLEANING

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean off excess sealants.

C. Remove temporary protective coverings and strippable films as roof specialties are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain roof specialties in a clean condition during construction.

D. Replace roof specialties that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

3.6 PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to the Installer that shall ensure that the roof specialties shall be without damage at time of Substantial Completion.

END OF SECTION 07 71 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 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 penetration firestopping, and each kind of construction condition penetrated and kind of penetrating item. Include firestopping 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 penetration firestopping configuration for construction and penetrating items.

D. Product Schedule: For each penetration firestopping system. Include location and design designation of qualified testing and inspecting agency.

1. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.3 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.

1.4 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. Firm shall be experienced in installing penetration firestopping 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 penetration firestopping products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

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.

1.5 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 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.

C. Penetrations in Horizontal Assemblies: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01 inch wg.

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.

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 Non-Porous 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.

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.

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. 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.

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. 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. 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 Substantial Completion. 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. 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 fire-resistive joint system configuration for construction and penetrating items.

D. 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.

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. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the 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 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. 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 inside the weatherproofing system, 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, provide one of 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 indicated on the Drawings.

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, Inc.; Proglaze SG.
g. Tremco, Inc.; 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.

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, Inc.; 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. 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.

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. 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 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.

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 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.

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.

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: Full profile welded.

4. Exposed Finish: Prime.

2.4 EXTERIOR HOLLOW METAL DOORS AND FRAMES

A. Construct exterior doors and frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Extra Heavy Duty Doors and Frames: SDI A250.8, Level 3.

1. Physical Performance: Level A 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: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum A40 coating.
    d. Edge Construction: Model 2, seamless.
    e. Core: Manufacturer's standard kraft paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral board, or vertical steel stiffener core at manufacturer's discretion.

        1) Thermal-Rated Doors: Provide doors fabricated with thermal-resistance value (R-value) of not less than 2.1 deg F x h x sq. ft./Btu when tested according to ASTM C 1363.

3. Frames:

    a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum A40 coating.
    b. Construction: Full profile welded.

4. Exposed Finish: Prime.

2.5 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.

2.6 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. Power-Actuated Fasteners in Concrete: From corrosion-resistant materials.

G. Grout: ASTM C 476, except with a maximum slump of 4 inches, as measured according to ASTM C 143/C 143M.

H. Mineral Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing).

I. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15 mil dry film thickness per coat.

2.7 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 fiber 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.

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. Provide countersunk, flat-head 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. 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 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.

2.8 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 Co. (distributed by Technical Glass Products).
    b. Vetrotech Saint-Gobain; SGG Keralite FR-R.

2.9 FINISHES

A. Steel Finishes:

1. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.

    a. Shop Primer: SDI A250.10.

2.10 ACCESSORIES

A. Louvers: Provide heavy duty exterior grade louvers for exterior doors, where indicated, which comply with SDI 111C, with blades or baffles formed of clear anodized aluminum frame with flanges. Attachments shall match louver.

1. Sightproof Louver: Stationary louvers constructed with inverted-V or Z blades.

B. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.

C. Grout Guards: Formed from same material as frames, not less than 0.016 inch thick.

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.

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.

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. 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.

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 31 13 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes access doors and frames for walls and ceilings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, fire ratings, materials, individual components and profiles, and finishes.

B. Shop Drawings:

1. Include plans, dimensions, elevations, sections, details, and attachments to other work.
2. Detail fabrication and installation of access doors and frames for each type of substrate.

C. Product Schedule: Provide complete access door and frame schedule, including types, locations, sizes, latching or locking provisions, and other data pertinent to installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Access Doors and Frames: Units complying with NFPA 80 that are identical to access door and frame assemblies tested for fire test response characteristics according to the following test method and that are listed and labeled by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

1. NFPA 252 or UL 10C for fire-rated access door assemblies installed vertically.

2.2 ACCESS DOORS AND FRAMES FOR WALLS AND CEILINGS

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. Babcock-Davis.
2. J.L. Industries, Inc.; div. of Activar Construction Products Group.
3. Larsen's Manufacturing Co.

B. Source Limitations: Obtain each type of access door and frame from single source from single manufacturer.

C. Flush Access Doors with Concealed Flanges:

1. Assembly Description: Fabricate door to fit flush to frame. Provide frame with gypsum board beads for concealed flange installation.
2. Locations: Wall and ceiling.
3. Door Size: Refer to the Drawings
4. Metallic-Coated Steel Sheet for Door: Nominal 0.064 inch, 16 gage.

    a. Finish: Factory prime.

5. Frame Material: Same material and thickness as door.
6. Hinges: Manufacturer's standard.
7. Hardware: Latch.

D. Fire-Rated, Flush Access Doors with Concealed Flanges:

1. Assembly Description: Fabricate door to fit flush to frame, with a core of mineral fiber insulation enclosed in sheet metal. Provide self-latching door with automatic closer and interior latch release. Provide frame with gypsum board beads for concealed flange installation.
2. Locations: Wall.
3. Fire-Resistance Rating: Not less than 45 minutes.
4. Metallic-Coated Steel Sheet for Door: Nominal 0.040 inch, 20 gage.

    a. Finish: Factory prime.

5. Frame Material: Same material, thickness, and finish as door.
6. Hinges: Manufacturer's standard.
7. Hardware: Latch.

E. Hardware:

1. Latch: Cam latch.

2.3 MATERIALS

A. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A 879/A 879M, with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.

B. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 or A60 metallic coating.

C. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

2.4 FABRICATION

A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.

B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access doors to types of supports indicated.

1. For concealed flanges with drywall bead, provide edge trim for gypsum board securely attached to perimeter of frames.
2. Provide mounting holes in frames for attachment of units to metal framing.

D. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.

1. For cylinder locks, furnish two keys per lock and key all locks alike.

2.5 FINISHES

A. Comply with NAAMM AMP 500 "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Steel and Metallic-Coated Steel Finishes:

1. Factory Prime: Apply manufacturer's standard, fast-curing, lead-free and chromate-free, universal primer immediately after surface preparation and pretreatment.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the 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. Comply with manufacturer's written instructions for installing access doors and frames.

B. Install doors flush with adjacent finish surfaces or recessed to receive finish material.

3.3 ADJUSTING

A. Adjust doors and hardware, after installation, for proper operation.

B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

3.4 PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to the Installer that shall ensure that the access doors and frames shall be without damage at time of Substantial Completion.

END OF SECTION 08 31 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.

2. 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. Point of Contact: Ron Alshouse of Honeywell who is responsible for security system maintenance at the Oakland ARTCC. Mobile telephone number: 707-689-0177

1.2 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.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and Architectural Hardware Consultant (AHC).

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.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of door hardware to include in maintenance manuals. Include final hardware schedule.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and an AHC 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.

B. AHC 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 AHC who is also an Electrified Hardware Consultant (EHC).

C. 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.

D. 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.

E. 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.

F. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

G. 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.

H. 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.

I. 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.

J. 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, FAA furnishing and installing key cores, 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.

1.6 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. 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.

1.7 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.

1.8 MAINTENANCE SERVICE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions for the 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. Coordinate with FAA's SSDI Contractor retained for this contract.

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.

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 Stanley Works.

2.4 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 Stanley Works.

2.5 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.

2.6 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.

2.7 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.

2.8 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.

2.9 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.

2.10 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. After FAA installs permanent cores, FAA will return construction cores.

B. FAA is to key and install permanent cores, cylinders and keys. Coordinate with COR when permanent cores are to be installed,

C. FAA installed cylinders shall be: Best CoreMax Core with type X key: 1CX7XC11626.

2.11 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.

2.12 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.

2.13 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.

2.14 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.

2.15 STOPS AND HOLDERS

A. Mechanical Wall-Mounted 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 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.

2.16 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.

2.17 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.

2.18 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.

2.19 AUXILIARY DOOR HARDWARE

A. Auxiliary Hardware: BHMA A156.16.

1. Manufacturers:

a. Baldwin Hardware Corp.
b. Hager Companies.
c. Stanley Commercial Hardware; div. of Stanley Works.
d. Trimco.

2.20 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.

2.21 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 non-corrosive fasteners for exterior applications and elsewhere as indicated.

2.22 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 AHC: The COR will engage a qualified independent AHC to perform inspections and to prepare inspection reports.

1. Independent AHC 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 AHC 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

HDW-1

6	Half Mortise Hinges, A8211	Hager, BB1138, 4 1/2x4 1/2, 26D NRP
1	Power Door Loop	Von Duprin, 798-18
1 pair	Automatic Flush Bolts,	Hager, 292D, 26D
1	Electric Strike	Von Duprin, 6223 32D
1	Lockset, F07	Best, 45H7D16J626
2	Regular Closers, C02011	LCN 4011 DA, Alum
2	Armor Plate, J101	Hager, 194SxB4E, 36" h x 34"w, 26D UL Stamped
2	Floor Door Stops, L02161	Hager, 243F 26D
1	Smoke Gasketing	Hager, 721S
1	Metal Astragal	Coordinate with HM Door Fabricator
1	Coordinator	Hager, 298D, 26D
2	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-2

5	Hinges, A8111	Hager, BB1168, 4 1/2x4 1/2, 26D NRP
1	Electric Hinge, A8111	Hager, BB1168, 4 1/2x4 1/2, 26D E1S NRP
1 pair	Automatic Flush Bolts,	Hager, 292D, 26D
1	Dustproof Strike	Hager 280X, 26D
1	Lockset, F07	Best, 45H7D16J626
1	Electric Strike	Von Duprin, 6223 32D
2	Parallel Closers, C02021	LCN 4111 DA, Alum
2	Armor 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	Metal Astragal	Coordinate with HM Door Fabricator

1	Coordinator	Hager, 297D
2	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-3

5	Hinges, A8111	Hager, BB1168, 4 1/2x4 1/2, 26D NRP
1	Electric Hinge, A8111	Hager, BB1168, 4 1/2x4 1/2, 26D E1S NRP
1 pair	Automatic Flush Bolts,	Hager, 292D, 26D
1	Lockset, F07	Best, 45H7D16J626
1	Electric Strike	Von Duprin, 6223 32D
2	Parallel Closers, C02021	LCN 4111 DA, Alum
2	Kick Plates, J102	Hager, 194SxB4E, 8x34, 26D
2	Door Stops, L02101	Hager, 232W 26D
1	Smoke Gasketing	Hager, 721S
1	Metal Astragal	Coordinate with HM Door Fabricator
1	Coordinator	Hager, 297D
2	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-4

6	Hinges, A8111	Hager, BB1168, 4 1/2x4 1/2, 26D
1 pair	Manual Flush Bolts, L04251	Hager, 281D, 26D
1	Latchset, F01	Best, 45H0N16J626
2	Parallel Closer, C02021	LCN 4111-DA, SCUSH Alum
2	Kick Plate, J102	Hager, 194S B4E 26D 8"x2 LDW
1	Smoke Gasketing	Hager, 874S A
1	Coordinator	Hager, 297D

HDW-5

3	Hinges, A8111	Hager, BB1168, 4 1/2x4 1/2, 26D
1	Latchset, F01	Best, 45H0N16J626
1	Parallel Closer, C02021	LCN 4111-DA, Alum
1	Door Stop, L02101	Hager, 232W 26D
1	Kick Plate, J102	Hager, 194S B4E 26D 8"x2 LDW
1	Smoke Gasketing	Hager, 874S A

HDW-6

3	Hinges, A8111	Hager, BB1168, 4 1/2x4 1/2, 26D NRP
1	Electric Strike	Von Duprin, 6223 32D
1	Lockset, F07	Best, 45H7D16J626
1	Parallel Closer, C02021	LCN 4111-DA, Alum
1	Kick Plate, J102	Hager, 194S B4E 26D 8"x2 LDW
1	Floor Door Stops, L02161	Hager, 243F 26D
1	Latch Protection Plate	Hager, 340D
1	Smoke Gasketing	Hager, 721S
1	Door Position Switch	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.
5. Paint Latch Protection Plate same color as door.

Proposed Sequence of Operation

Door is normally closed and secured on Stair-3 side. Door is free egress from Room B120 to Stair-3.

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

3	Hinges, A8111	Hager, BB1168, 4 1/2x4 1/2, 26D
1	Lockset, F04	Best, 45H7A16J626
1	Parallel Closer, C02021	LCN 4111-DA, Alum
1	Kick Plate, J102	Hager, 194S B4E 26D 8"x2 LDW
1	Door Stop, L02101	Hager, 232W 26D
1	Smoke Gasketing	Hager, 721S
1	Coat Hook	Hager, 946P 26D

HDW-8 (Stair-3 Swing Gate)

1 pair	Spring Hinges	

Notes:

1. Reuse existing magnetic hold-open device.

HDW-9

6	Hinges, A8111	Hager, BB1168, 4 1/2x4 1/2, 26D
1 pair	Automatic Flush Bolts,	Hager, 292D, 26D
1	Dustproof Strike	Hager 280X, 26D
1	Latchset, F01	Best, 45H0N16J626
2	Parallel Closers, C02021	LCN 4111 DA, Alum
2	Kick Plate, J102	Hager, 194S B4E 26D 8"x2 LDW
2	Door Stops, L02101	Hager, 232W 26D
1	Magnetic Hold Open Device	LCN, SEM7830 – (24V or 120V) - Alum
1	Smoke Gasketing	Hager, 721S

2	Astragal	Hager, 872S X
1	Coordinator	Hager, 297D

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-10

3	Hinges, A8111	Hager, BB1168, 4 1/2x4 1/2, 26D
1	Lockset, F07	Best, 45H7D16J626
1	Parallel Closer, C02021	LCN 4111-DA, Alum
1	Kick Plate, J102	Hager, 194S B4E 26D 8"x2 LDW
1	Floor Door Stop, L02161	Hager, 243F 26D
1	Smoke Gasketing	Hager, 721S

HDW-11

6	Hinges, A5111	Hager, BB1168, 4 1/2x4 1/2, 32D NRP
1 pair	Manual Flush Bolts, L04251	Hager, 281D, 26D
1	Lockset, F07	Best, 45H7D16J626
2	Parallel Closer, C02021	LCN 4111-DA, SCUSH Alum
2	Kick Plate, J102	Hager, 194S B4E 26D 8"x2 LDW
1	Smoke Gasketing	Hager, 874S A
1	Coordinator	Hager, 297D
1	Metal Astragal	Coordinate with HM Door Fabricator
1	Door Position Switch	Reuse existing or SSDI to provide replacement
1	PIR	Reuse existing or SSDI to provide replacement

Notes:

1. Existing door frame to be reused. Coordinate hinge sizes and other door hardware with existing conditions.
2. Paint coordinator to match door frame.

HDW-12

6	Hinges, A8111	Hager, BB1168, 4 1/2x4 1/2, 26D
1 pair	Manual Flush Bolts, L04251	Hager, 281D, 26D
1	Latchset, F01	Best, 45H0N16J626
2	Hinge Side Closers, C00191	LCN 4040SE, SCUSH Alum
2	Kick Plate, J102	Hager, 194S B4E 26D 8"x2 LDW
1	Floor Door Stop, L02161	Hager, 243F 26D (Active door leaf)
1	Smoke Gasketing	Hager, 874S A
1 pair	Astragal	Hager, 872S X

1	Coordinator	Hager, 297D

Notes:

1. Existing door frame to be reused. Coordinate hinge sizes and other door hardware with existing conditions.
2. Paint coordinator to match door frame.
3. Connect door closer to existing refrigerant leak detection system. Coordinate voltage with existing system and COR.

HDW-13

6	Hinges, A8111	Hager, BB1168, 4 1/2x4 1/2, 26D
1 pair	Manual Flush Bolts, L04251	Hager, 281D, 26D
1	Latchset, F01	Best, 45H0N16J626
2	Hinge Side Closers, C00191	LCN 4040SE, Alum
2	Kick Plate, J102	Hager, 194S B4E 26D 8"x2 LDW
2	Floor Door Stop, L02161	Hager, 243F 26D
1	Smoke Gasketing	Hager, 874S A
1 pair	Astragal	Hager, 872S X
1	Coordinator	Hager, 297D

Notes:

1. Existing door frame to be reused. Coordinate hinge sizes and other door hardware with existing conditions.
2. Paint coordinator to match door frame.
3. Connect door closer to existing refrigerant leak detection system. Coordinate voltage with existing system and COR.

HDW-14

3	Hinges, A8111	Hager, BB1168, 4 1/2x4 1/2, 26D
1	Lockset, F05	Best, 45H7R16J626
1	Hinge Side Closer, C00191	LCN 4040SE, Alum
1	Kick Plate, J102	Hager, 194S B4E 26D 8"x2 LDW
1	Floor Door Stop, L02161	Hager, 243F 26D
1	Smoke Gasketing	Hager, 721S

Notes:

1. Existing door frame to be reused. Coordinate hinge sizes and other door hardware with existing conditions.
2. Connect door closer to existing refrigerant leak detection system. Coordinate voltage with existing system and COR.

HDW-15

3	Hinges, A8111	Hager, BB1168, 4 1/2x4 1/2, 26D
1	Lockset, F05	Best, 45H7R16J626

1	Parallel Closer, C02021	LCN 4111-DA, Alum
1	Kick Plate, J102	Hager, 194S B4E 26D 8"x2 LDW
1	Floor Door Stop, L02161	Hager, 243F 26D
1	Smoke Gasketing	Hager, 721S

HDW-16

6	Hinges, A5111	Hager, BB1168, 4 1/2x4 1/2, 32D NRP
1 pair	Automatic Flush Bolts,	Hager, 292D, 26D
1	Lockset, F07	Best, 45H7D16J626
2	Kick Plate, J102	Hager, 194S B4E 26D 8"x2 LDW
2	Exterior Door Stops	
2	Door Holder	Hager, 271D, 26D
1	Weather Gasketing	Hager, 874S A
1	Metal Astragal	Coordinate with HM Door Fabricator
1	Coordinator	Hager, 297D

Notes:

1. Existing door frame to be reused. Coordinate hinge sizes and other door hardware with existing conditions.
2. Paint coordinator to match door frame.

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SECTION 08 80 00 - GLAZING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Glass for interior borrowed lites.
2. Glazing sealants and accessories.

1.2 DEFINITIONS

A. Glass Manufacturers: Firms that produce primary glass 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.

1.3 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. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on the Drawings.

1.4 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.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer shall be a firm engaged in the manufacture of glazing of types and sizes required, and whose products 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 needed to make progress and avoid delays.
2. Review temporary protection requirements for glazing during and after installation.

D. Coordination: Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.6 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.

1.7 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.

1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below 40 degrees 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 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 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) or Class 2 (tinted) as indicated, 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 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. Field-applied sealants shall have a VOC content of not more than 250 g/L.
4. Colors of Exposed Glazing Sealants: Black.

B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 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 of 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.
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 gaskets are driven into one side of channel to pressurize sealant tape on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected

to movement. Square cut at corners and install gaskets in a manner recommended by gasket manufacturer 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. 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 ADJUSTING AND PROTECTION

A. Immediately after installation remove nonpermanent 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.

3.5 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 08 80 00

SECTION 08 91 19 - FIXED LOUVERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fixed, formed metal louvers.

1.2 DEFINITIONS

A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.

B. Horizontal Louver: Louver with horizontal blades (i.e., the axes of the blades are horizontal).

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

B. High Performance Sustainable Building Submittals:

1. Product Data: 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 louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.

D. Samples: For each type of metal finish required.

E. Delegated Design Submittal: For louvers indicated to comply with structural and seismic performance requirements, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: Based on evaluation of comprehensive tests performed according to AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

1.6 FIELD CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain louvers from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design louvers, including comprehensive engineering analysis by a qualified professional engineer, using structural and seismic performance requirements and design criteria indicated.

B. Structural Performance: Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.

1. Wind Loads: Determine loads based on pressures as indicated on Drawings.

C. Seismic Performance: Louvers, including attachments to other construction, shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Component Importance Factor: 1.5.

D. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change (Range): 120 degrees F, ambient; 180 degrees F, material surfaces.

F. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

G. Recycled Content of Metal Products: Post-consumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.

2.3 FIXED, FORMED METAL LOUVERS

A. Horizontal, Non-Drainable Blade Louver:

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. Air Balance, Inc.; a Mestek company.
   b. Air Flow Co., Inc.
   c. Airolite Co., LLC (The).
   d. All-Lite Architectural Products.
   e. American Warming and Ventilating; a Mestek company.
   f. Arrow United Industries; div. of Mestek, Inc.
   g. Cesco Products; div. of Mestek, Inc.
   h. Construction Specialties, Inc.
   i. Dowco Products Group; Safe Air of Illinois.
   j. Greenheck Fan Corp.
   k. Industrial Louvers, Inc.
   l. Metal Form Manufacturing, Inc.
   m. NCA Manufacturing, Inc.
   n. Pottorff.
   o. Ruskin Co.; Tomkins PLC.
   p. United Enertech.
   q. Vent Products Co., Inc.

2. Louver Depth: 4 inches.
3. Blade Profile: Plain blade without center baffle.
4. Frame and Blade Material and Nominal Thickness: Aluminum sheet, 0.040 inch, unless otherwise indicated.
5. Louver Performance Ratings:

   a. Free Area: Not less than 6.5 square feet for 48 inch wide by 48 inch high louver.

6. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.4 MATERIALS

A. Aluminum Extrusions: ASTM B 221/B 221M, Alloy 6063-T5, T-52, or T6.

B. Aluminum Sheet: ASTM B 209/B 209M, Alloy 3003 or Alloy 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.

C. Fasteners: Use types and sizes to suit unit installation conditions.

1. Use Phillips flat-head screws for exposed fasteners unless otherwise indicated.
2. For fastening aluminum, use aluminum or 300 series stainless steel fasteners.
3. For color-finished louvers, use fasteners with heads that match color of louvers.

D. Post-Installed Fasteners for Concrete: Torque-controlled expansion anchors, made from stainless steel components, with capability to sustain, without failure, a load equal to four times the loads imposed for concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.5 FABRICATION

A. Factory assemble louvers to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.

C. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

1. Frame Type: As indicated on the Drawings.

D. Include supports, anchorages, and accessories required for complete assembly.

E. Join frame members to each other and to fixed louver blades with fillet welds concealed from view , threaded fasteners, or both, as standard with louver manufacturer unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.6 FINISHES

A. General:

1. Comply with NAAMM AMP 500 "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Finish louvers after assembly.
3. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved samples and are assembled or installed to minimize contrast.

B. Aluminum Finishes:

1. High Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2605 and 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.

    a. Color and Gloss: As selected by the COR from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the 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 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces.

C. Form closely fitted joints with exposed connections accurately located and secured.

D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

E. Protect non-ferrous metal surfaces that are in contact with concrete or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or non-metallic flashing.

F. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses. Comply with Section 07 92 00 "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

A. Clean exposed louver surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.

B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

C. Restore louvers damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by the COR, remove damaged units and replace with new units.

1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

3.5 PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to the Installer that shall ensure that the fixed louvers shall be without damage at time of Substantial Completion.

END OF SECTION 08 91 19

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 for interior gypsum ceilings and soffits.

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.

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 Drawings.

2. Dimpled Steel Studs and Runners:

a. Minimum Base Metal Thickness: 0.0329 inch unless otherwise indicated.
b. Depth: As indicated on 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.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 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. 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.

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. 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. 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 10 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:

1. CertainTeed Corp.
2. Georgia-Pacific Gypsum, LLC.
3. National Gypsum Co.
4. USG Corp.

C. Gypsum Wallboard: ASTM C 1396.

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 10 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. 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.

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 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:

1. Select panel sizes and layout panels to minimize waste; reuse cutoffs to the greatest extent possible.

END OF SECTION 09 29 00

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SECTION 09 29 84 - PREFINISHED GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Vinyl-film-faced prefinished gypsum board (VGWB).
2. Prefinished gypsum wall board trim for exposed conditions and as where indicated.

1.2 SUBMITTALS

A. Product Data: Product data for each type of product specified.

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:

1. Submit samples for initial selection in the form of manufacturer's color charts consisting of actual units or sections of units showing the full range of colors, textures, and patterns available for each type of prefinished gypsum board and trim accessory indicated.
2. Submit samples for verification purposes.

D. Maintenance Data: Maintenance data for prefinished gypsum board, including instructions for panel cleaning and repair.

1.3 QUALITY ASSURANCE

A. Single Source Responsibility for Prefinished Gypsum Board: Obtain each color, grade, finish, type, and variety of prefinished gypsum board and related materials from one source and by a single manufacturer.

B. Fire Test Response Characteristics: Provide prefinished gypsum board with the fire test response characteristics indicated as determined by testing identical products according to test method indicated by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.

1. Surface-Burning Characteristics: Flame-spread rating of 25 or less and smoke-developed rating of 90 or less when tested according to ASTM E 84.
2. Fire-Resistance Ratings: Where prefinished gypsum board panels are indicated as part of fire-resistance-rated assemblies, provide panels and related materials identical to those tested in fire-resistance-rated assembly indicated according to ASTM E 119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.
3. Fire-Resistance Rating: As indicated by GA file numbers in GA-600 or design designations in UL "Fire Resistance Directory," or in listing of another testing and inspecting agency acceptable to authorities having jurisdiction.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.

B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes. Neatly stack prefinished gypsum board panels flat to prevent sagging.

1.5 PROJECT CONDITIONS

A. Environmental Conditions, General: Establish and maintain environmental conditions for applying prefinished gypsum board to comply with manufacturer's written instructions.

B. Room Temperatures: For non-adhesive attachment of prefinished gypsum board to framing, maintain not less than 50 degrees F for at least 48 hours before, during, and after installation.

1.6 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.

1. Prefinished Gypsum Board: Two full-size units.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design Manufacturer: Subject to compliance with requirements, provide Gold Bond Brand Durasan Prefinished Gypsum Board as manufactured by National Gypsum or by other manufacturer approved by the COR, including but not limited to:

1. Vinyl-Film-Faced Prefinished Gypsum Board (VGWB):

a. SHEETROCK Vinyl-Faced Gypsum Panels; United States Gypsum Co.

2. Fire-Rated Vinyl-Film-Faced Pre-Decorated Gypsum Board: (Fire-rated VGWB)

a. SHEETROCK Vinyl-Faced Gypsum Panels, FIRECODE Core; United States Gypsum Co.

2.2 PREFINISHED GYPSUM BOARD

A. Colors, Textures, and Patterns: Where manufacturer's standard products are indicated, provide prefinished gypsum board and related materials complying with the following requirements:

1. Refer to Interior Color Scheme Schedule in the Drawings for finish selected.

B. Vinyl-Film-Faced Prefinished Gypsum Board: ASTM C 1396, Class 3.

C. Fire-Rated Vinyl-Film-Faced Pre-Decorated Gypsum Board: ASTM C 1396, Type X, Class 3.

2.3 MISCELLANEOUS MATERIALS

A. Concealed Edge Clips: Manufacturer's standard concealed clip for mechanically fastening prefinished gypsum board to substrate.

B. Prefinished Trim Accessories: Manufacturer's standard trim, faced with material matching prefinished gypsum panels, and as follows:

1. Snap-On Trim: Manufacturer's standard retainer clips and snap-on prefinished molded plastic strips for exterior corner and flat (batten) trim.

C. Prefinished Fasteners: Manufacturer's standard color-coated steel nails (color pins) in colors that match prefinished gypsum board panels' facing.

D. Concealed Fasteners: Types and sizes recommended by prefinished gypsum board manufacturer, but not less than steel drill screws complying with ASTM C 1002 for applications over steel framing.

E. Adhesive: Typically do not use adhesives. Where adhesives are indicated, provide adhesive or joint compound recommended by the manufacturer for directly adhering 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).

F. Vinyl Foam Tape Adhesive: Compatible with prefinished gypsum board and recommended by manufacturer for supplemental attachment of panels to support.

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 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 PREPARATION

A. Plan layout and coordinate location of exposed joints between prefinished gypsum board panels to occur at building expansion and control joints, and other interruptions in panel surfaces.

1. Mark proposed joint locations on support system for examination by COR to indicate proposed layout.
2. Notify COR seven calendar days in advance of the dates and times proposed layout will be available for viewing.
3. Revise layout as directed by COR.
4. Do not proceed with installation until layout is approved by COR.

3.3 INSTALLATION

A. General: Install prefinished gypsum board panels to comply with manufacturer's written instructions, GA-224, and other requirements indicated.

B. Color match prefinished gypsum board panels before installing in each area. Stand panels against wall; invert alternate panels; and rearrange them to minimize color, pattern, and tone variations between adjacent panels.

1. Install prefinished gypsum board panels within each space from the same lot for each color, texture, and pattern indicated.

C. Isolate perimeter of prefinished gypsum board panels from adjacent construction with trim accessories of types indicated or, if not indicated, as recommended by manufacturer.

1. Where edges of prefinished gypsum board panels abut concrete or masonry, provide 1/8 inch minimum clearance between edges of panels and these materials to prevent wicking of moisture.

D. Apply prefinished gypsum board panels to walls and partitions vertically. Do not install imperfect, damaged, or damp panels.

E. Locate joints over supports. For applications over conventional gypsum board base layers, stagger joints with joints in base layers. For single ply applications, stagger joints with joints on opposite sides of walls and partitions.

F. Attach prefinished gypsum board panels to underlying construction according to GA-224, manufacturer's written instructions, and as follows:

1. Mechanically fasten panels to framing members with concealed fasteners per manufacturer's instructions; supplemented with temporary bracing where required to obtain bond of panels with framing members. Prebow panels before applying according to manufacturer's written instructions.
2. Only at locations indicated, fasten face layer with adhesive. Comply with manufacturer's written recommendations and temporarily brace or fasten panels until fastening adhesive has set.

G. Space fasteners in prefinished gypsum panels according to referenced installation standard and manufacturer's written instructions.

H. At exterior corners, butt panels together with light contact to produce close fitting, uniform joints. Do not force panels into place.

I. At interior corners, butt adjoining panels together with light contact to produce close fitting, uniform joints. Do not force panels into place.

J. At vertical joints between panels in the same plane, butt panels at edges with light contact to produce close fitting, uniform joints. Do not force panels into place.

K. Cover exposed cut edges with facing material by cutting facing not less than 1 inch wider than gypsum board core and wrapping facing over cut edge. Fasten wrapped facing to back of panel according to manufacturer's written instructions and GA-224.

L. Cut holes in panels for services according to manufacturer's written instructions to avoid loosening facing at openings.

M. Install prefinished trim accessories to conceal fasteners and exposed panel edges. Comply with manufacturer's written instructions for securing trim units and jointing trim. Provide trim in longest lengths available to eliminate or minimize number of running trim joints.

1. Cover bottom edges of panels at floor with prefinished trim.
2. Cover top edges of panels at ceiling with prefinished trim.
3. Cover exterior corners with prefinished trim.
4. Cover flat, vertical joints between adjacent panels with prefinished trim.
5. Cover interior corners with prefinished trim.
6. Cover exposed edges with prefinished trim.

N. Install wall covering where indicated and where penetrating services or unusual profiles make wall surfaces unsuitable for prefinished gypsum board application.

1. Provide gypsum board for wall-covering substrate with core matching type, thickness, and size indicated for adjacent prefinished panels. Provide a smooth gypsum board surface with joints and fasteners finished with joint compound, and aligned with the surface of adjacent prefinished panels' gypsum board core.
2. Cover joints between field-applied wall covering and prefinished gypsum board panels as indicated for similar joints between prefinished panels.

3.4 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and installer that ensure installation is without damage or deterioration at the time of Substantial Completion.

3.5 SITE ENVIRONMENTAL PROCEDURES

A. Waste Management: As specified in Section 01 74 19 "Construction Waste Management" and as follows:

1. Select panel sizes and layout panels to minimize waste; reuse cutoffs to the greatest extent possible.

END OF SECTION 09 29 84

SECTION 09 51 13 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes acoustical panels and exposed suspension systems for ceilings for high seismic areas.

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.
2. VOC Content: 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).

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 exposed product and for each color and texture specified, 6 inches in size.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale and dimensioned, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Items penetrating finished ceiling including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.

3. Perimeter moldings coordinate with seismic requirements.
4. Location of seismic compression struts.
5. Location of seismic joint clips.
6. Location if required for seismic separation gap.

7. Location of fixed and unfixed perimeter

B. Qualification Data: For testing agency.

C. Product Test Reports: For each acoustical panel ceiling, for tests performed by manufacturer and witnessed by a qualified testing agency.

D. Evaluation Reports: For each acoustical panel ceiling suspension system and anchor and fastener type, from ICC-ES.

E. Field quality control reports.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For finishes 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. Acoustical Ceiling Panels: Full-size panels equal to 2 percent of quantity installed.
2. Hold-Down Clips: Equal to 2 percent of quantity installed.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to NVLAP for testing indicated.

B. Pre-Installation Conference: Conduct conference at Project site.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical panels, suspension system components, and accessories to Project site in original, unopened packages 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 stabilized moisture content.

C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, 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 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Acoustical ceiling shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 and as noted on the Drawings.

B. 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: Comply with ASTM E 1264 for Class A materials.
2. Smoke-Developed Index: 50 or less.

2.2 ACOUSTICAL PANELS

A. General:

1. Recycled Content: Post-consumer recycled content plus one-half of pre-consumer recycled content not less than 50 percent.
2. Low-Emitting Materials: Acoustical panel ceilings shall comply with testing and product requirements of local regulations controlling use of volatile organic compounds (VOC's).
3. Source Limitations: Obtain each type of acoustical ceiling panel and supporting suspension system from single source from single manufacturer.
4. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectance criteria unless otherwise indicated.

    a. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches away from test surface according to ASTM E 795.

5. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.

    a. Where appearance characteristics of acoustical panels are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by the COR from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.

B. Acoustical Panels:

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. Armstrong World Industries, Inc.
    b. CertainTeed Corp.
    c. Chicago Metallic Corp.

2. Basis of Design: As indicated on material finish schedules on the Drawings.
3. Classification: Provide panels complying with ASTM E 1264 for type, form, and pattern as follows:

    a. Type and Form: Type III, mineral base with painted finish; Form 2, water felted.
    b. Pattern: As indicated by manufacturer's designation.

4. Physical Characteristics:

    a. Color: White.
    b. LR: Not less than 0.80.
    c. NRC: Not less than 0.50.
    d. CAC: Not less than 35.
    e. AC: Not less 200.
    f. Edge/Joint Detail: Tongue and groove.
    g. Thickness: 3/4 inch.
    h. Modular Size: As indicated on the Drawings.

5. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical panels treated with manufacturer's standard 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 and evaluated according to ASTM D 3274 or ASTM G 21.

2.3 METAL SUSPENSION SYSTEMS

A. General:

1. Recycled Content: Post-consumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.

2. Metal Suspension System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635/C 635M.

3. 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.

    a. 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.

4. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:

   a. Zinc-Coated, Carbon Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
   b. Size: Select wire diameter so 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 provide not less than 0.106 inch diameter wire.

5. Seismic Stabilizer Bars: Manufacturer's standard perimeter stabilizers designed to accommodate seismic forces.
6. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.
7. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure acoustical panels in place.
8. Hold-Down Clips: Where indicated, provide manufacturer's standard hold-down clips spaced 24 inches on center on all cross tees.

B. Metal Suspension System:

1. Products: Subject to compliance with requirements, provide or comparable product by one of the following:

   a. Armstrong World Industries, Inc.; Seismic Rx® Suspension System.
   b. CertainTeed Corp.; Seismic Suspension Systems (ESR-3336).
   c. Chicago Metallic Corp.; Seismic 1200 Exposed Grid System.

2. Narrow-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; pre-painted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 coating designation; with prefinished 9/16 inch wide metal caps on flanges.

   a. Structural Classification: Heavy duty system.
   b. End Condition of Cross Runners: Butt-edge type.
   c. Face Design: Flat, flush.
   d. Cap Material: Steel cold-rolled sheet.
   e. Cap Finish: Painted white.

2.4 METAL EDGE MOLDINGS AND TRIM

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Armstrong World Industries, Inc.

2. CertainTeed Corp.
3. Chicago Metallic Corporation.

B. Provide over-sized O rings per seismic requirements for ceiling panel penetrations. Coordinate work with other disciplines.

C. 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. Provide manufacturer's standard edge moldings that fit acoustical panel edge details and suspension systems indicated and that match width and configuration of exposed runners unless otherwise indicated.
2. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.

D. Extruded Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded aluminum edge moldings and trim of profile indicated or referenced by manufacturer's product designations, complying with the following requirements:

1. Aluminum Alloy: Alloy and temper recommended by aluminum producer/finisher for type of finish indicated and with not less than strength and durability properties of aluminum extrusions complying with ASTM B 221/B 221M for alloy (temper 6063-T5).
2. Finish:

a. Baked Enamel: AA-C12-C42-R1x. Apply in compliance with paint manufacturer's specifications for cleaning, conversion coating, and painting.

1) Organic Coating: Thermosetting modified acrylic enamel primer and topcoat system complying with AAMA 2603, except with a minimum dry film thickness of 2.0 mils, medium gloss.
2) Color: Match color of finish on flanges of suspension system surfaces.

3. Basis of Design: Product specified is "Axiom" as manufactured by Armstrong World Industries, Inc. Item specified is 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.

2.5 ACOUSTICAL SEALANT

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. Acoustical Sealant for Exposed and Concealed Joints:

a. Pecora Corp.; AC-20 FTR Acoustical and Insulation Sealant.
b. USG Corp.; SHEETROCK Acoustical Sealant.

B. Acoustical Sealant: Manufacturer's standard sealant complying with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

1. Exposed and Concealed Joints: Non-sag, paintable, non-staining latex sealant.
2. Acoustical 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. 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.

1. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.

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. 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, and comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION

A. General: Install acoustical panel ceilings to comply with ASTM C 636/C 636M and seismic design requirements indicated, according to manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

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 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 spacing that interfere with location of hangers at spacing 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 either to structures 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. 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.
6. 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.
7. Do not attach hangers to steel deck tabs.
8. Do not attach hangers to steel roof deck unless permitted with written authorization from COR. Attach hangers to structural members.
9. 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.
10. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

C. 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, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.
3. Do not use exposed fasteners, including pop rivets, on moldings and trim.

D. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

E. 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 a neat, precise fit.

1. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension system runners and moldings.
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. For reveal-edged panels on suspension system members with box-shaped flanges, install panels with reveal surfaces in firm contact with suspension system surfaces and panel faces flush with bottom face of runners.
4. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended for this purpose by panel manufacturer.
5. Install seismic hold-down clips in corridors and at exits, in areas required by authorities having jurisdiction; space as recommended by panel manufacturer's written instructions unless otherwise indicated. Refer to ASCE 31.

6. Protect lighting fixtures and air ducts to comply with requirements indicated for fire-resistance-rated assembly.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:

1. Compliance of seismic design.

B. Perform the following tests and inspections of completed installations of acoustical panel ceiling hangers and anchors and fasteners in successive stages. Do not proceed with installations of acoustical panel ceiling hangers for the next area until test results for previously completed installations show compliance with requirements.

1. Extent of Each Test Area: When installation of ceiling suspension systems on each floor has reached 20 percent completion but no panels have been installed.

a. 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 200 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 440 lbf of tension.
b. 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.

C. Acoustical panel ceiling hangers and anchors and fasteners will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 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. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

3.6 PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to the Installer that shall ensure that the acoustical panel ceilings shall be without damage at time of Substantial Completion.

END OF SECTION 09 51 13

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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: 178 Pewter 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. 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.

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. 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. Rubber floor tile.
2. Vinyl composition floor tile.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. High Performance Sustainable Building Submittals:

1. VOC Content: For 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).

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 RUBBER 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. Mannington.
2. Roppe Corp., USA.

B. Basis of Design: Product specified is "Roppe Health & Learning Rubber Tile, Color HL08 Simple Salt" as manufactured by Roppe Corp., USA. 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:

C. Tile Standard: ASTM F 1344, Class I-A, homogeneous rubber tile, solid color.

D. Hardness: Not less than 85 as required by ASTM F 1344, measured using Shore, Type A durometer per ASTM D 2240.

E. Wearing Surface: Textured or hammered.

F. Thickness: 0.125 inch.

G. Size: 24 inches by 24 inches.

H. Colors and Patterns: As indicated on the Drawings.

2.3 VINYL COMPOSITION 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. Armstrong World Industries, Inc.
2. Roppe Corp., USA.

B. Basis of Design: Product specified is "Roppe Health & Learning Vinyl Tile, Color HL08 Simple Salt" as manufactured by Roppe Corp., USA. 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:

C. Tile Standard: ASTM F 1066, Class 1, solid color tile.

D. Wearing Surface: Smooth.

E. Thickness: 0.125 inch.

F. Size: 12 inches by 24 inches.

G. Colors and Patterns: As indicated on 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 floor tile manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.

1. Adhesives shall comply with the following limits for VOC content:

a. Vinyl Composition Tile Adhesives: 50 g/L or less.
b. Rubber Floor Adhesives: 60 g/L or less.

2. Adhesives shall comply with the testing and product requirements of local regulations controlling use of volatile organic compounds (VOC's).

C. Floor Polish: Provide protective, liquid floor polish products recommended by floor tile manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. 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.

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. 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.

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 non-permanent 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 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. Floor Polish: Remove soil, adhesive, and blemishes from floor tile surfaces before applying liquid floor polish.

1. Apply two coats.

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

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SECTION 09 67 23 - RESINOUS FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Industrial resinous flooring systems.

B. Related Sections:

1. Section 07 92 00 "Joint Sealants" for sealants installed at joints in resinous flooring systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include manufacturer's technical data, application instructions, and recommendations for each resinous flooring component required.

B. High Performance Sustainable Building Submittals:

1. VOC Content: For liquid-applied flooring components, documentation indicating that products comply with the testing and product requirements of local regulations controlling use of volatile organic compounds (VOC's).

C. Samples:

1. Samples for Initial Selection: For each type of exposed finish required.
2. Samples for Verification: For each resinous flooring system required, 6 inches square, applied to a rigid backing by Installer for this Project.

1.3 INFORMATIONAL SUBMITTALS

A. Installer Certificates: Signed by manufacturer certifying that installers comply with specified requirements.

B. Material Certificates: For each resinous flooring component, from manufacturer.

C. Material Test Reports: For each resinous flooring system.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For resinous flooring to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of flooring systems required for this Project.

1. Engage an installer who is certified in writing by resinous flooring manufacturer as qualified to apply resinous flooring systems indicated.

B. Source Limitations: Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, from single source from single manufacturer. Provide secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from source recommended by manufacturer of primary materials.

C. Pre-Installation Conference: Conduct conference at Project site.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring application.

B. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring application.

C. Close spaces to traffic during resinous flooring application and for not less than 24 hours after application unless manufacturer recommends a longer period.

D. Coordinate with COR location of where fumes and odors from installation of flooring system can be exhausted.

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. BASF Construction Chemicals, Inc.; BASF Building Systems.
2. Crossfield Products Corp.; Dex-O-Tex.
3. DUDICK, Inc.

4. Dur-A-Flex, Inc.
5. Key Resin Co.
6. NEOGARD; div. of JONES-BLAIR.
7. Pacific Polymers, Inc.
8. Stonhard, Inc.

2.2 MATERIALS

A. VOC Content of Liquid-Applied Flooring Components: Not more than 100 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

2.3 INDUSTRIAL RESINOUS FLOORING

A. Resinous Flooring: Abrasion-resistant, impact-resistant, and chemical-resistant, aggregate-filled, resin-based, monolithic floor surfacing designed to produce a seamless floor and integral cove base.

1. Provide a system comprised of a penetrating, moisture-tolerant, two-component epoxy primer; a high performance, three-component mortar consisting of epoxy resin, curing agent, and selected, graded aggregates blended with inorganic pigments; and a two-component, 100 percent solids, general service, epoxy coating.

B. System Characteristics:

1. Color and Pattern: As indicated on the Drawings.
2. Wearing Surface: Textured for slip resistance.
3. Overall System Thickness: 1/4 inch .

C. System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested according to test methods indicated:

1. Compressive Strength: 10,000 psi (ASTM C 579).
2. Tensile Strength: 1750 psi (ASTM C 307).
3. Elongation: 0.15 percent (ASTM D 638).
4. Flexural Strength: 4000 psi (ASTM C 580).
5. Hardness: 85 to 90 Shore D durometer (ASTM D 2240).
6. Bond Strength: 400 psi minimum; 100 percent concrete failure (ASTM D 4541).
7. Indentation: No Indentation (MIL-D-3134).
8. Abrasion Resistance: 0.1 gram maximum weight loss (ASTM D 4060, Taber Abrader CS-17 wheel).
9. Coefficient of Friction: 0.60 (ASTM D 2047).
10. Flexural Modulus of Elasticity: 2.0 x 10^6 psi (ASTM C 580).
11. Flammability: Self-extinguishing; extent of burning 0.25 inch maximum (ASTM D 635).
12. Thermal Coefficient of Linear Expansion: 3.5 x 10^{-5} inch per inch per degree F (ASTM E 831).
13. Water Absorption: 0.2 percent (ASTM C 413).
14. Heat Resistance Limitation: 140 degrees F for continuous exposure; 200 degrees F for intermittent spills.

15. Cure Rate: At 77 degrees F; 6 hours for foot traffic, 18 hours for light traffic, and 24 hours for normal operations.

D. Basis of Design: Product specified is "Stonclad GS" coated with "Stonkote GS4" as manufactured by Stonhard, Inc. Items specified are to establish a standard of quality for design, function, materials, and appearance. Equivalent products by other manufacturers are acceptable. The COR will be the sole judge of the basis of what is equivalent.

2.4 ACCESSORIES

A. Primer: Type recommended by manufacturer for substrate and body coats indicated.

B. Reinforcing Membrane: Flexible resin formulation that is recommended by manufacturer for substrate and primer and body coats indicated and that prevents substrate cracks from reflecting through resinous flooring.

C. Patching and Fill Material: Resinous product of or approved by resinous flooring manufacturer and recommended by manufacturer for application indicated.

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.

2. Coordinate with COR location where fumes and odors can be exhausted from space without impacting building occupants.

3.2 PREPARATION

A. General: Prepare and clean substrates according to resinous flooring manufacturer's written instructions for substrate indicated. Provide clean, dry substrate for resinous flooring application.

B. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form release agents, dust, dirt, grease, oil, and other contaminants incompatible with resinous flooring.

1. Roughen concrete substrates as follows:

a. Comply with ASTM C 811 requirements unless manufacturer's written instructions are more stringent.

2. Repair damaged and deteriorated concrete according to resinous flooring manufacturer's written instructions.
3. Verify that concrete substrates are dry and moisture vapor emissions are within acceptable levels according to manufacturer's written instructions.

   a. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with application of resinous flooring only after substrates have maximum moisture vapor emission rate of 3 lb of water/1000 sq. ft. of slab area in 24 hours.
   b. Perform plastic sheet test, ASTM D 4263. Proceed with application only after testing indicates absence of moisture in substrates.
   c. Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.

4. Alkalinity and Adhesion Testing: Verify that concrete substrates have pH within acceptable range. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.

C. Resinous Materials: Mix components and prepare materials according to resinous flooring manufacturer's written instructions.

D. Use patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.

E. Treat control joints and other non-moving substrate cracks to prevent cracks from reflecting through resinous flooring according to manufacturer's written instructions.

F. Provide fans to exhaust fumes and odors from space. Coordinate with COR requirements and acceptability.

3.3 APPLICATION

A. General: Apply components of resinous flooring system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated.

1. Coordinate application of components to provide optimum adhesion of resinous flooring system to substrate, and optimum intercoat adhesion.
2. Cure resinous flooring components according to manufacturer's written instructions. Prevent contamination during application and curing processes.
3. At substrate expansion and isolation joints, comply with resinous flooring manufacturer's written instructions.

B. Apply primer over prepared substrate at manufacturer's recommended spreading rate.

C. Apply reinforcing membrane to substrate cracks and as required by the manufacturer.

D. Integral Cove Base: Apply cove base mix to wall surfaces before applying flooring. Apply according to manufacturer's written instructions and details including those for taping, mixing, priming, troweling, sanding, and topcoating of cove base. Round internal and external corners.

1. Integral Cove Base: 4 inches high.

E. Apply troweled or screeded body coats in thickness indicated for flooring system. Hand or power trowel and grout to fill voids. When cured, remove trowel marks and roughness using method recommended by manufacturer.

F. Apply grout coat, of type recommended by resinous flooring manufacturer, to fill voids in surface of final body coat and to produce wearing surface indicated.

G. Apply topcoats in number indicated for flooring system and at spreading rates recommended in writing by manufacturer.

3.4 FIELD QUALITY CONTROL

A. Core Sampling: At the direction of COR and at locations designated by COR, take one core sample per 1000 sq. ft. of resinous flooring, or portion of, to verify thickness. For each sample that fails to comply with requirements, take two additional samples. Repair damage caused by coring and correct deficiencies.

B. Material Sampling: COR may at any time and any number of times during resinous flooring application require material samples for testing for compliance with requirements.

1. Engage an independent testing agency to take samples of materials being used. Material samples will be taken, identified, sealed, and certified in presence of Contractor.
2. Testing agency will test samples for compliance with requirements, using applicable referenced testing procedures or, if not referenced, using testing procedures listed in manufacturer's product data.
3. If test results show applied materials do not comply with specified requirements, pay for testing, remove non-complying materials, prepare surfaces coated with unacceptable materials, and reapply flooring materials to comply with requirements.

3.5 PROTECTION

A. Protect resinous flooring from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by resinous flooring manufacturer.

B. Exhaust odors and fumes from installation of resinous flooring so as to not impact building occupants or operations. Coordinate with COR regarding location for exhaust.

END OF SECTION 09 67 23

SECTION 09 69 00 - ACCESS FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Access flooring panels.
2. Understructure.
3. Refer to the Drawings for seismic design category and forces.
4. Replacing existing access flooring in B101 as indicated and providing additional seismic bracing where new and existing access flooring join.

1.2 DEFINITIONS

A. Concentrated Static Load: Concentrated loads are applied on a small area and are typically imposed by stationary furniture and equipment with legs. A concentrated load is applied to the surface of the panel resulting in deflection and permanent set. Deflection and permanent set (rebound) is measured at the top surface after the load is removed.

B. Uniform Static Load: Uniform loads are applied over the entire area of the panel and are typically imposed by stationary furniture and equipment without legs. The uniform load rating is specified in pounds per square foot.

C. Ultimate Static Load: The load at which the panel has structurally failed and can no longer accept any loading. This is sometimes expressed as a multiple of concentrated load and referred to as a safety factor.

D. Rolling Dynamic Load: Rolling loads are typically imposed by equipment on wheels moving across the access floor. They are defined by the number of passes, size and hardness of wheel and the combined weight of the cart and its contents on each wheel. Rolling loads are the most important performance criteria because they have a more damaging effect on the panel than a static load.

E. Impact: Impact loads are imposed by objects accidentally dropped onto an access floor. These loads are defined by the weight of the load and the height or distance dropped. Impact loads generate severe shocks which can cause structural and panel damage. Impact loads most often occur during construction, move in and equipment/furniture rearrangements.

F. Non-Combustibility: Non-Combustibility defines the floor system's susceptibility to fire and its capability to generate smoke or toxic vapors.

G. Static Dissipation: The floor system's capability to create an effective path for static charge dissipation can be critical in areas where sensitive equipment is operated.

1.3 RAILING PERFORMANCE REQUIREMENTS

A. Delegated Design: Design railings, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:

1. Aluminum: The lesser of minimum yield strength divided by 1.65 or minimum ultimate tensile strength divided by 1.95.

C. Structural Performance: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Handrails and Top Rails of Guards:

a. Uniform load of 50 lbf/ ft. applied in any direction.
b. Concentrated load of 200 lbf applied in any direction.
c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:

a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.
b. Infill load and other loads need not be assumed to act concurrently.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. High Performance Sustainable Building Submittals:

1. VOC Content: For carpet tile floor covering, 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: Include layout of access flooring system and relationship to adjoining Work based on field-verified dimensions.

1. Details and sections with descriptive notes indicating materials, finishes, fasteners, typical and special edge conditions, accessories, and understructures including locations of seismic bracing.

2. Provide details and seismic bracing for new access floor system in room B101. Provide where feasible additional seismic bracing to carry lateral loads from existing floor system to new floor system. Existing access floor system has cable trays and other items located within the system. Coordinate seismic bracing with existing below floor equipment.

D. Samples:

1. Floor Covering: Full-size units for each color and texture specified.
2. Exposed Metal Accessories: Approximately 10 inches in length.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For each type of access flooring system.

C. Product Test Reports: For each type of flooring material and exposed finish, for tests performed by a qualified testing agency.

D. Seismic Calculations: Data on earthquake load resistance, essential facility, in the form of structural computations that have been signed and sealed by a qualified professional engineer responsible for their preparation. Include structural computations, material properties, and other information needed for structural analysis and for verification that system will withstand earthquake loads indicated. Refer to structural drawings for exact seismic requirements.

1. Provide additional calculation for room B101 where new access flooring joins existing access flooring. Existing access floor system has a number of underfloor cable trays, conduits and other items that may impact location of seismic bracing.

E. Certification: Certify that electrical resistance of the grounded flooring and floor covering system complies with performance requirements specified, when tested in accordance with NFPA 75 test methods.

F. Maintenance Information: Provide maintenance information for access floor system. Include instruction for proper removal and re-installation of panels to prevent damage. Refer to Section 01 78 23 "Operation and Maintenance Manual Data."

G. Single Source Responsibility: Obtain access flooring from one source and by single manufacturer.

H. Professional Engineer Qualifications: A professional engineer who is legally authorized to practice in the jurisdiction where Project is located, and who is experienced in providing engineering services of the kind indicted. Engineering services are defined as those performed for installations of access flooring systems that are similar to that indicated for this Project in material, design, and extent.

I. Provide floor panels that are clearly and permanently marked on their underside with the panel type and concentrated load rating.

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. Flooring panels.

2. Pedestals.
3. Stringers.
4. Carpet tile with nubs.

B. Access flooring attic stock shall include material required to infill HOST Equipment Room, B134, where existing sections of access flooring under existing sensitive operational equipment shall remain during this project. FAA shall install this attic stock as part of future work projects. Materials shall include all anchors and ancillary devices in addition to that listed. Attic stock shall match access flooring installed under this project in all regard.

C. Furnish quantity of full-size carpet tile units equal to 2 percent of amount installed.

D. Coordinate with COR delivery of attic stock and extra materials to back end of parking lot at the north end of site. Material to be stored in FAA's storage containers.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Pre-Installation Conference: Conduct conference at Project site.

1. Review connection with mechanical and electrical systems.
2. Review requirements related to sealing the plenum.
3. Review procedures for keeping underfloor space clean.

C. Coordination:

1. Coordinate location of mechanical and electrical work in underfloor cavity to prevent interference with access flooring pedestals.
2. Mark pedestal locations on subfloor using a grid to enable mechanical and electrical work to proceed without interfering with access flooring pedestals.
3. Develop work plan with COR to identify how work shall be accomplished. Work plan shall indicate how Signal Reference Grounding (SRG) grid shall be installed, how access floor system shall be removed and replaced, how sensitive operational equipment on existing access floor system to remain shall be protected from damage, disturbance, dust, and vibrations, and how floor plenum air pressure shall be maintained.

1.8 PROJECT CONDITIONS

A. Environmental Conditions: Do not proceed with installation of access flooring until installation area is enclosed and has an ambient temperature of between 40 and 90 degrees F and a relative humidity of not more than 70 percent.

B. Field Measurements: Check actual locations of walls and other construction to which access flooring must fit by accurate field measurements before preparing Shop Drawings; show recorded measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1. Mark pedestal locations with a grid of size indicated below on concrete subfloor so that mechanical and electrical work can proceed without interfering with pedestals.

   a. 120 by 120 inches.

C. Do not proceed with installation of access flooring until after Substantial Completion of other construction within affected spaces.

1.9 WARRANTY

A. Special Perforated Panel Warranty: Written warranty, signed by access flooring manufacturer agreeing to replace perforated panels that fail within the warranty period. Manufacturer warrants full replacement of panels due to breakage, cracking and splitting between the perforations. Warranty does not include breakage due to unusual traffic, failure of substrate, vandalism or abuse.

   1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Performance Requirements, General: Provide access flooring systems to comply with the following:

   1. Access flooring systems are proprietary portable systems composed of modular floor panels on elevated supports (understructures) forming accessible underfloor cavities (air spaces) to accommodate electrical and mechanical services.
   2. Installed access flooring system shall comply with performance requirements specified as determined by manufacturers' current standard products representing those indicated for this Project.
   3. System shall be tested as required in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC." Tests shall be performed with solid access floor panels with no cutouts. Provide additional panels as required to perform this test.

B. Seismic Performance: Access flooring shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

C. Structural Performance: Provide access flooring systems capable of complying with the following performance requirements according to testing procedures in CISCA's "Recommended Test Procedures for Access Floors."

   1. Floor Panels:

      a. Concentrated Load Performance: Panel shall be capable of supporting a concentrated load of 1250 pounds, placed on a one square inch area (using a round or square indenter) at any location on the panel with a maximum top surface

deflection of 0.100 inch. Panel shall not exceed a permanent set of 0.010 inch, after the load is removed. Panel shall demonstrate ductility by being loaded to a deflection of 0.100 inch without incurring damage.

b. Uniform Load: Panel shall be capable of supporting a uniform load of 300 pounds placed on a one square foot area at any location on the panel with a maximum top surface deflection of 0.060 inch. Panel shall not exceed a permanent set of 0.010 inch after the load is removed. Note, the uniform load rating of an access floor panel as specified herein shall not be confused with the uniform live load as specified in seismic zone applications.

c. Ultimate Load Performance: Panel shall be capable of withstanding a concentrated load of 3100 pounds applied onto a one square inch area (using a round or square indenter) at any location on the panel without failure. Failure is defined as the point at which the panel will no longer accept the load. Certified test report shall be provided attesting to this ultimate load.

d. Rolling Load; Panel and supporting understructure shall be able to withstand the following rolling loads at any location on the panel without developing a local and overall surface deformation greater than 0.040 inch. Note, wheel 1 and wheel 2 tests shall be performed on two separate panels.

1) Wheel 1:

a) Size: 3 inch diameter by 1-13/16 inches wide.
b) Load: 1000 pounds.
c) Passes: 10.

2) Wheel 2:

a) Size: 6 inch diameter by 1-1/2 inches wide.
b) Load: 800 pounds.
c) Passes: 10,000.

e. Impact Load: Panel and supporting understructure shall be capable of supporting an impact load of 150 pounds dropped from a height of 36 inches onto a one square inch area (using a round or square indenter) at any location on the panel.

f. Panel Drop Test: Panel shall be capable of being dropped face up onto a concrete slab from a height of 36 inches after which it shall continue to meet all load performance requirements as previously defined.

g. Panel Cutout: Panel with 8 inch diameter cutout shall be capable of withstanding an ultimate load without failure of 1500 pounds anywhere on the panel.

h. Flammability: System shall meet Class A spread requirements for flame spread and smoke development. Tests shall be performed in accordance with ASTM E 84.

2. Pedestals: Provide pedestals with the following:

a. Axial Load: Pedestal assembly shall provide a minimum 6000 pound axial load without permanent deformation.

b. Overturning Moment: Pedestal assembly shall provide an average overturning moment of 1000 in-lbs. when glued to a clean, sound, uncoated concrete surface. ICBO number for the specific system or structural calculations shall be required to the lateral stability of the system under seismic conditions.

c. Concentrated Loads (Static Load): 1250 pounds.
d. Uniform Loads (Static): 300 pounds.
e. Ultimate Loads (Static): 3750 pounds.
f. Rolling Load: 1000 pounds at 10 passes. 800 pounds at 10,000 passes.
g. Impact Load: 100 pounds.

D. Panel to Understructure Resistance: Not more than 10 ohms.

E. Electrical Resistance: Not less than 2.5 x 104 ohms, nor more than 1.0 x 108 ohms, as determined by testing identical products according to the method for conductive flooring specified in NFPA 99, RTT, RTG, point-to-point (diagonal corner-to-corner across face of panel), point-to-ground, and tile-to-tile. Tile-to-tile method shall be tested across the seams. Total combined electrical resistance at the floor covering systems shall include carpet tile, conductive adhesive, foil, connectors, clips, access floor panels, and pedestal heads, to groundable point, and shall be less than 1.0 x 108 when tested in accordance with NFPA 99, RTT, RTG. Conduct test measurements at five different locations at installed area.

2.2 FLOOR PANELS

A. General: Modular field panels shall be similar to industry standard products. Provide accessible panels that will allow one person, using a portable lifting device, to interchange with field panels without disturbing adjacent panels or understructure. When properly installed, furnished panels will be free of exposed metal edges with floor covering in place.

1. Nominal Panel Size: 24 by 24 inches.
2. Panel Attachment to Understructure: By gravity.
3. Fabrication Tolerances: Fabricate panels to the following tolerances with squareness tolerances expressed as the difference between diagonal measurements from corner to corner.

a. Size and Squareness: Plus or minus 0.015 inch of required size, with a squareness tolerance of plus or minus 0.030 inch, unless tolerances are otherwise indicated for a specific panel type.
b. Flatness: Plus or minus 0.030 inch, measured on a diagonal on top of panel.

B. Panel shall have an electrically conductive epoxy paint finish.

C. Corner of panel shall have a locating tab and integral shape design to interface with the pedestal head for positive lateral retention and positioning with or without fasteners.

D. Fit between the pedestal head, panel, and screw shall enable an installation with an average panel-to-panel gap of 0.015 inch.

E. Cementitious Core Steel Panels: Fabricated from cold-rolled steel sheet, with the die-cut flat top sheet and die-formed and stiffened bottom pan welded together, and with metal surfaces protected against corrosion by manufacturer's standard factory-applied finish. Fully grout internal spaces of completed units with manufacturer's standard cementitious fill.

1. Basis of Design Product: Subject to compliance with requirements, provide ConCore 1250 Panel, manufactured by Tate Access Floors, Inc., including accessories as specified in this Section or comparable product by one of the following:

    a. Computer Environments, Inc.
    b. Haworth, Inc.

F. Panel finish shall be either PosiTile Conductive Carpet or Conductive High Pressure Laminate. Refer to the Drawings for location of finishes.

2.3 UNDERSTRUCTURE

A. Pedestals: Assembly consisting of base, column with provisions for height adjustment, and head (cap); made of steel.

1. Square base plate, Type 1 Pedestal Base, designed for bracing and supporting pedestals, bolted to slab. Base plate shall be sized to accommodate seismic and meet specified performance criteria. Minimum size shall be 4 inch by 4 inch.
2. Provide vibration-proof leveling mechanism for making and holding fine adjustments in height over a range of not less than 2 inches. Include means of locking leveling mechanism at a selected height that requires deliberate action to change height setting and prevents vibratory displacement.
3. Head: Designed for direct, non-bolted support of panels.
4. Post-Installed Expansion Anchors: Each Pedestal Base mechanically anchored as required to comply with performance requirements. Provide expansion anchors that have the capability to sustain, without failure, a load equal to 5 times that specified under Part 1 Article "Performance Requirements."

B. Stringer Systems: Modular steel stringer systems made to interlock with pedestal heads and form a basket weave pattern placing stringers under each edge of each floor panel and a pedestal under each corner of each floor panel. Protect steel components with manufacturer's standard galvanized or corrosion-resistant paint finish.

1. Bolted Stringers: System of main and cross stringers connected to pedestals with threaded fasteners accessible from above.

    a. Provide stringers to support each edge of each panel where required to meet design load criteria.

2.4 FABRICATION

A. Fabrication Tolerances:

1. Size: Plus or minus 0.020 inch of required size.
2. Squareness: Plus or minus 0.015 inch between diagonal measurements across top of panel.
3. Flatness: Plus or minus 0.035 inch, measured on a diagonal on top of panel.

B. Panel Markings: Clearly and permanently mark floor panels on their underside with panel type and concentrated load rating.

C. Bolted Panels: Provide panels with holes drilled in corners to align precisely with threaded holes in pedestal heads and to accept countersunk screws with heads flush with top of panel.

1. Captive Fasteners: Provide fasteners held captive to panels.

D. Cutouts: Fabricate cutouts in floor panels for cable penetrations and service outlets. Provide reinforcement or additional support, if needed, to make panels with cutouts comply with structural performance requirements.

1. Number, Size, Shape, and Location: As indicated.
2. Grommets: Where indicated, fit cutouts with manufacturer's standard grommets; or, if size of cutouts exceeds maximum grommet size available, trim edge of cutouts with manufacturer's standard plastic molding with tapered top flange. Furnish removable covers for grommets.
3. Provide foam rubber pads for sealing annular space formed in cutouts by cables.

2.5 ACCESSORIES

A. Post-Installed Anchors: For anchoring pedestal bases to subfloor, provide two or four post-installed expansion anchors made from carbon steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (5 microns) for Class SC 1 (Mild), with the capability to sustain, without failure, a load equal to 1.5 times the loads imposed by pedestal overturning moment on fasteners, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

B. Colors and Finishes: For exposed accessories available in more than one standard color or finish, provide color or finish complying with Interior Finish Material Schedule.

C. Cutouts: Contractor shall coordinate with COR quantity and location of floor cutouts. Fabricate cutouts for floor panels for cable penetrations. Comply with requirements indicated for size, shape, number, and location. Provide reinforcement or additional support, if needed, to make panels with cutouts comply with standard performance requirements.

1. Provide trim edge of cutouts with manufacturer's standard plastic molding or grommets.
2. Provide airtight installation to maintain integrity of underfloor plenum.
3. Fit cutouts with manufacturer's standard grommets in sizes indicated or, where size of cutouts exceed maximum grommet size available, trim edge of cutouts with manufacturer's standard plastic molding having tapered top flange.
4. Provide removable covers for grommets.
5. Seal cutouts to comply with manufacturer's requirements.
6. Provide foam rubber pads for sealing annular space formed in cutouts by cables and trim edge of cutout with molding having flange and ledge for capturing and supporting pads.

D. Panel Lifting Device: Manufacturer's standard portable lifting device of type and number required for lifting panels with floor covering provided.

1. Provide four lifting devices of each type required.

E. Perforated Panels: Provide load bearing perforated panels with 25 percent open area interchangeable with standard field panels and complying with the following requirements:

1. Air Distribution Characteristics of Units with Dampers: Capable of delivering 390 cfm at 0.05 inch wg static pressure.
2. Structural Performance: Capable of supporting a 1250 lbf concentrated load.
3. Number of Grilles: As indicated on the Drawings.

F. Cavity Dividers: Provide manufacturer's standard metal dividers located where indicated to divide underfloor cavities.

G. Closures: Where underfloor cavity is not enclosed by abutting walls or other construction, provide metal closure plates with manufacturer's standard finish.

H. Sponge Gasket: Closed cell neoprene/EPDM Polymeric blend tape with adhesive on one side.

1. Basis of Design: Monmouth Rubber & Plastics Corp; Durafoam DK1111.
2. One inch high tape, thickness as required.

I. Ramps: Manufacturer's standard ramp construction of width and slope indicated, but not steeper than 1:12, with raised disc or textured rubber or vinyl tile floor coverings, and of same materials, performance, and construction requirements as access flooring.

J. Ramp Transitions: Provide heavy extruded aluminum ramp transitions accommodating changes in floor plan at top and bottom of ramps. Wall thickness of extrusions shall be no less than 0.125 inch. Surface shall be grooved to provide positive slip resistance. Anchors shall be locked machine bolts with flat heads countersunk in to top face of transitions. Finish shall be clear anodized.

K. Steps: Provide steps of size and arrangement indicated with floor coverings to match access flooring. Apply non-slip aluminum nosings to treads unless otherwise indicated.

L. Railings: Standard extruded aluminum railings at ramps and open-sided perimeter of access flooring where indicated. Include handrail, intermediate rails, posts, brackets, end caps, wall returns, wall and floor flanges, plates, and anchorages where required.

1. Provide railings that comply with structural performance.
2. Post Support: Provide heavy duty floor flange to anchor posts to floor slab. Height of post to be 12 inches. Coordinate diameter of flange post with pipe post of guard rails system.

    a. Basis of Design: Julius Blum & Co., Inc. Model 7471.

M. Perimeter Support: Where indicated, provide manufacturer's standard method for supporting panel edge and forming transition between access flooring and adjoining floor coverings at same level as access flooring.

2.6 CARPET TILE FLOOR COVERING

A. PosiTile Carpet Tile: Access floor system designed to accommodate modular PosiTile carpet tiles that precisely match one carpet tile to one ConCore panel. This is accomplished utilizing four precisely located ultrasonically welded buttons on the carpet tile which engage into positioning holes in the surface of the floor panel. The carpet tile's durable backing maintains dimensional stability, holds the carpet tile flat and is provided from the factory with small areas of releasable pressure sensitive adhesive to simplify the installation process. Adhesive shall not be applied during installation except where the carpet is cut and more than two buttons are removed. PosiTile nubs shall be installed to carpet tile by the access floor manufacturer.

B. Basis of Design: Provide the following.

1. Static Smart Environments by Julie Industries.

a. Color: Refer to Interior Materials Finish Schedule.

C. Fiber Content: Performa SD Type nylon 6.

D. Fiber Type: Continuous conductive StaticSmart FibreLink monofilament in every tuft.

E. Pile Characteristic: Textured graphic loop pile.

F. Pile Height: High 6/32 inch, low 4/32 inch.

G. Stitches: 10 per inch.

H. Total Weight: 98.98 oz/sq. yd. for finished carpet tile.

I. Backing System: Dissipative StaticWorx backing, 100 percent PVC-free recyclable, made from recycled material.

1. Carpet tile which does not need to be installed using the StaticSmart ESD Carpet system may be manufactured with different backing system. Contractor may choose the alternate backing system offered by manufacturer.

J. Size: 24 inches by 24 inches.

K. Adhesives: Conductive releasable adhesive for carpet tile 1.0×10^6 Ohms RTT.

1. Adhesive for carpet tile not installed over access flooring does not require conductive adhesive. Provide adhesive recommended by the manufacturer.

L. Grounding Frequency: 1 per 1000 square feet.

M. Performance Characteristics: As follows:

1. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm.
2. Dry Breaking Strength: Not less than 100 lbf per ASTM D 2646.
3. Tuft Bind: Not less than 3 lbf per ASTM D 1335.

4. Delamination: Not less than 3.5 lbf/in per ASTM D 3936.
5. Dimensional Tolerance: Within 1/32 inch of specified size dimensions, as determined by physical measurement.
6. Dimensional Stability: 0.2 percent or less per ISO 2551 (Aachen Test).
7. Resistance to Insects: Comply with AATCC 24.
8. Colorfastness to Crocking: Not less than 4, wet and dry, per AATCC 165.
9. Colorfastness to Light: Not less than 4 after 40 AFU (AATCC fading units) per AATCC 16, Option E.
10. Antimicrobial Activity: Not less than 2 mm halo of inhibition for gram-positive bacteria; not less than 1 mm halo of inhibition for gram-negative bacteria; no fungal growth; per AATCC 174.
11. VOC Limits: Provide carpet tile that complies with the following limits for VOC content when tested according to ASTM D 5116:

    a. Total VOCs: 0.5 mg/sq. m x h.
    b. 4-PC (4-Phenylcyclohexene): 0.05 mg/sq. m x h.
    c. Formaldehyde: 0.05 mg/sq. m x h.
    d. Styrene: 0.4 mg/sq. m x h.

12. Electrical Resistance:

    a. ESD S7.1/NFPA 99 Resistive Characterization of Materials: Six or more readings from surface to groundable point. Tested with an applied voltage of 100V. Measured in Ohms, 1.0×10^5 minimum, 5.0×10^8 maximum.
    b. ESD S7.1/NFPA 99 Resistance Characterization of Materials: Six or more readings between electrodes placed 1 foot apart. Tested with an applied voltage of 100V. Measured in Ohms, 2.5×10^4, minimum, 5.0×10^7 maximum.
    c. Electrical Resistance/Voltage Test ANSI/ESD S-20.20, compliant when using approved conductive footware system. Results within recommended range $<35 \times 10^6$ Ohm or $<35 \times 10^6$ Ohm or <100 volts.
    d. Roller Caster Electrical Test (CET) Assessment. After 100,000 chair caster cycles there was no depreciable change in conductivity or electrical performance.

13. Groundable Path: StaticSmart Ground Strip or RTG Connector Kit.
14. Grounding Frequency: 1 per 1000 sq. ft.

2.7 CONDUCTIVE HIGH PRESSURE LAMINATE

A. Conductive Properties: Provide static control high pressure laminate flooring with static control properties indicated as determined by testing identical products per test method indicated by an independent testing and inspecting agency.

1. Electrical Resistance: Test per NFPA 99, Chapter 3.

    a. Average greater than 25,000 ohms and less than 1 megohm when test specimens and installed floor coverings are tested surface to surface (point to point).
    b. Average greater than 25,000 ohms with no single measurement less than 10,000 ohms when installed floor coverings are tested surface to ground.

2. Static Generation: Less than 100 V when tested per AATCC-134 at 20 percent relative humidity with conductive footwear.
3. Static Decay: 5000 to zero V in less than 0.25 second when tested per FED-STD-101C/4046.1.

B. Thickness: 0.125 inch minimum.

C. Finish: Textured, a low sheen, matte finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer and manufacturer's representative present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Verify that substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, foreign deposits, and debris that might interfere with attachment of pedestals.
2. Verify that concrete floor sealer and finish have been applied and cured.
3. Examine layout of construction and equipment to remain assuring that new access flooring layouts proposed accommodate existing conditions and incorporate field verified dimensions.

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 COORDINATION

A. In order to not impact existing or future cable tray installations, power feeds, etc., coordinate seismic bracing with COR.

3.3 PREPARATION

A. Lay out floor panel installation to keep the number of cut panels at floor perimeter to a minimum. Avoid using panels cut to less than 6 inches. Provide neoprene gasketing along perimeter to provide airtight seal.

B. Closures: At column enclosures within access floor areas seal penetrations at column bases air-tight with neoprene gasketing

C. Locate each pedestal, complete any necessary subfloor preparation, and vacuum subfloor to remove dust, dirt, and construction debris before beginning installation.

3.4 INSTALLATION

A. Install access flooring system and accessories under supervision of access flooring manufacturer's authorized representative to produce a rigid, firm installation that complies with performance requirements and is free of instability, rocking, rattles, and squeaks.

B. Mechanical Attachment of Baseplate: Attach baseplate to subfloor with post-installed mechanical anchors according to manufacturers instructions and approved Shop Drawings.

C. Adjust pedestals to permit top of installed panels to be set flat, level, and to proper height.

D. Stringer Systems: Secure stringers to pedestal heads according to access flooring manufacturer's written instructions.

E. Install flooring panels securely in place, properly seated with panel edges flush. Do not force panels into place.

F. Scribe perimeter panels to provide a close fit with adjoining construction with no voids greater than 1/8 inch where panels abut vertical surfaces.

G. Cut and trim access flooring and perform other dirt-or-debris-producing activities at a remote location or as required to prevent contamination of subfloor under already-installed access flooring.

H. Grounded Flooring Access Panel Systems: Ground flooring system as recommended by manufacturer and as needed to comply with performance requirements for electrical resistance of floor coverings.

   1. Panel-to-Understructure Resistance: Not more than 10 ohms as measured without floor coverings.

I. Underfloor Dividers: Scribe and install underfloor cavity dividers to closely fit against subfloor surfaces, and seal with mastic.

J. Closures: Scribe closures to closely fit against subfloor and adjacent finished floor surfaces. Set in mastic and seal to maintain plenum effect within underfloor cavity.

K. Clean dust, dirt, and construction debris caused by floor installation, and vacuum subfloor area as installation of floor panels proceeds.

L. Seal underfloor air cavities at construction seams, penetrations, and perimeter to control air leakage, according to manufacturer's written instructions.

M. Install access flooring without change in elevation between adjacent panels and within the following tolerances:

   1. Plus or minus 1/8 inch in any 10 foot distance.
   2. Plus or minus 1/8 inch from a level plane over entire access flooring area.

N. Install ramp transitions to assure that machine bolt anchors provide positive support that will not loosen in service.

3.5 TESTING

A. Testing Electrical Resistance: Testing shall be in accordance with NFPA 99 modified by placing one electrode on the center of panel surface and connecting the other electrode to the metal flooring support. Measurements shall be made at five or more locations. Each measurement shall be the average of five readings of 15 seconds duration at each location. Relative humidity and temperature during tests shall be 45 to 55 percent and 69 degrees F to 75 degrees F, respectively. The panels used in the testing shall be selected at random and shall include two panels most distant from the ground connection. Electrical resistance shall be measured with instruments, which are accurate within two percent and have been calibrated within 60 calendar days prior to the performance of the resistance tests.

B. Coordinate with mechanical testing and balancing technician for testing as specified in Section 23 05 93 "Testing, Adjusting, and Balancing of HVAC."

3.6 ADJUSTING AND CLEANING

A. Adjusting: Re-level and re-adjust floor prior to Substantial Completion and to satisfaction of COR.

B. After completing installation, vacuum clean access flooring and cover with continuous sheets of reinforced paper or plastic. Maintain protective covering until the time of Substantial Completion.

C. Replace access flooring panels that are stained, scratched, otherwise damaged, or not complying with specified requirements.

3.7 PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to the Installer that shall ensure that the access flooring shall be without damage at time of Substantial Completion.

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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.

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: 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 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 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: Back mounted with manufacturer's standard metal clips or bar hangers, secured to substrate.

1) 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.

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, non-combustible, copolymer sheet laminated to face of core.

B. Facing Material: Refer to Interior Material Finish Schedule.

C. Mounting Devices: Concealed on back of unit, recommended by manufacturer to support weight of unit, and as follows:

1. 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.

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. Examine fabric, fabricated units, substrates, areas, and conditions, for compliance with requirements, installation tolerances, and other conditions affecting performance of sound-absorbing wall units.

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. 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

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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. Concrete.
2. Steel.
3. Galvanized metal.
4. Gypsum board.
5. Concrete masonry units (CMU).

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 traditional 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:

1. 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).

    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 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

1.5 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.

1.6 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. Rustoleum.
6. Sherwin-Williams Co. (The).

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 the Drawings.

2.3 PRIMERS/SEALERS

A. Block Filler, Latex, Interior/Exterior: MPI #4.

2.4 PRIMERS/SEALERS

A. Interior Latex Primer/Sealer: MPI #50.

2.5 METAL PRIMERS

A. Industrial Low-Odor/VOC flat Acrylic primer.

B. Primer, Alkyd, Anti-Corrosive, for Metal: MPI #79.

C. Primer, Galvanized, Water Based: MPI #134.

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 FLOOR COATINGS

A. Sealer, Water Based, for Concrete Floors: MPI #99.

B. Sealer, Solvent Based, for Concrete Floors: MPI #104.

2.8 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. 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. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
3. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

B. 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 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.

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.

3.6 INTERIOR PAINTING SCHEDULE

A. Steel Substrates:

1. Institutional Low-Odor/VOC Latex System, corresponds to MPI INT 5.1S:

a. Prime Coat: Primer, rust-inhibitive, water based MPI #107.
b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
c. Topcoat:

1) Latex, interior, institutional low odor/VOC, (Gloss Level 3), MPI #145.
2) Latex, interior, institutional low odor/VOC, semi-gloss (Gloss Level 5), MPI #147.

d. Basis of Design: Refer to Interior Materials Finish Schedule on Drawings.

B. Gypsum Board 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, semi-gloss (Gloss Level 5), MPI #147.

d. Basis of Design: Refer to Interior Materials Finish Schedule on Drawings.

C. Concrete Substrates, Non-Traffic Surfaces:

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: Latex, interior, institutional low odor/VOC, (Gloss Level 3), MPI #145.
d. Basis of Design: Refer to Interior Materials Finish Schedule on Drawings.

D. 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 Interior Materials Finish Schedule on Drawings.

E. CMU Substrates:

a. Block Filler: Block filler, latex, interior/exterior, MPI #4.
b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
c. Topcoat: Latex, interior, institutional low odor/VOC, (Gloss Level 3), MPI #145.
d. Basis of Design: Refer to Interior Materials Finish Schedule on Drawings.

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

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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.

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.

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.

PART 3 - EXECUTION

3.1 EXAMINATION

A. 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.

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 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 6 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 10 26 16 - EDGE BUMPER GUARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Polyurethane edge bumper guards.

1.2 ACTION SUBMITTALS

A. Product Data: Include details, material descriptions, fire test response characteristics, dimensions of individual components and profiles, and finishes for each edge bumper guard.

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, documentation indicating that products comply with the testing and product requirements of local regulations controlling use of volatile organic compounds (VOC's).

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each edge bumper guard to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Surface-Burning Characteristics: Provide edge bumper guards with surface-burning characteristics as determined by testing identical products per ASTM E 84, NFPA 255, or UL 723 by UL or another qualified testing agency.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install edge bumper guards 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 PERFORMANCE REQUIREMENTS

A. Recycled Content of Products: Post-consumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.

B. Low-Emitting Materials: Adhesives shall comply with local regulations controlling use of volatile organic compounds (VOC's).

2.2 MANUFACTURED UNITS

A. Edge Bumper Guards:

1. Materials:

   a. Cushion: Recycled polyurethane foam.

      1) Thickness: Approximately 1-9/16 inch diameter.

   b. Adhesive: Light-resistant and aging-resistant, modified, durable acrylic adhesive.

      1) Adhesive Strength: 25 N/in.

2. Temperature Range:

   a. Material: From -31 degrees F to 176 degrees F in normal dry conditions.
   b. Adhesive: From -31 degrees F to 176 degrees F in normal dry conditions.

3. Installation Materials: Manufacturer's standard self-adhesive strips.
4. Locations: As indicated on the Drawings
5. Finish: Manufacturer's standard black/yellow striped, matte smooth.
6. Length of Bumper Guards: 39-3/8 inches. See the Drawings.
7. Basis of Design: Product specified is "Warehouse Bumper Guard, Item No. R5600, Type A" as manufactured by SafetySign.com, div. of Brimar Industries, Inc. Items specified are to establish a standard of quality for design, function, materials, and appearance. Equivalent products by other manufacturers are acceptable. The COR will be the sole judge of the basis of what is equivalent.

2.3 FABRICATION

A. Fabricate edge bumper guards to comply with requirements indicated for design, dimensions, and member sizes, including thicknesses of components.

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 PREPARATION

A. Complete finishing operations, including painting, before installing edge bumper guards.

B. Before installation, clean substrate to remove dust, debris, and loose particles.

3.3 INSTALLATION

A. General: Install edge bumper guards in accordance with reviewed product data manufacturer's written instructions and recommendations, and as indicated on the Drawings.

3.4 CLEANING

A. Cleaning: Clean surfaces, and touch-up finishes as required and in accordance with 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 edge bumper guards shall be without damage at time of Substantial Completion.

END OF SECTION 10 26 16

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SECTION 10 44 13 - FIRE PROTECTION CABINETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire protection cabinets for portable fire extinguishers.

B. Related Requirements:

1. Section 10 44 16 "Fire Extinguishers."

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Show door hardware, cabinet type, trim style, and panel style. Include roughing-in dimensions and details showing semi-recessed mounting method and relationships of box and trim to surrounding construction.

B. Shop Drawings: For fire protection cabinets. Include dimensioned plans, elevations, sections, details, and attachments to other work.

C. Samples for Initial Selection: For each type of exposed finish required.

D. Product Schedule: For fire protection cabinets. Coordinate final fire protection cabinet schedule with fire extinguisher schedule to ensure proper fit and function.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance Data: For fire protection cabinets to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. Pre-Installation Conference: Conduct conference at Project site.

B. Coordination:

1. Coordinate size of fire protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
2. Coordinate sizes and locations of fire protection cabinets with wall depths.

1.5 SEQUENCING

A. Apply vinyl lettering on field-painted fire protection cabinets after painting is complete.

PART 2 - PRODUCTS

2.1 FIRE PROTECTION CABINET

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. J.L. Industries.
2. Kidde Residential and Commercial.
3. Larsens Manufacturing Co.
4. Potter Roemer.

B. Cabinet Type: Suitable for fire extinguisher.

C. Cabinet Construction: Non-rated.

D. Cabinet Material: Cold-rolled steel sheet.

1. Shelf: Same metal and finish as cabinet.

E. Recessed Cabinet:

1. Trimless with Hidden Flange: Flange of same metal and finish as box overlaps surrounding wall finish and is concealed from view by an overlapping door.

F. Semi-Recessed Cabinet: One-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).

1. Rolled Edge Trim: 2-1/2 inchbackbend depth.

G. Cabinet Trim Material: Same material and finish as door.

H. Door Material: Steel sheet.

I. Door Style: Vertical duo panel with frame.

J. Door Glazing: Tempered float glass (clear).

K. Door Hardware: Manufacturer's standard door operating hardware of proper type for cabinet type, trim style, and door material and style indicated.

1. Provide projecting lever handle with cam-action latch.
2. Provide continuous hinge, of same material and finish as trim, permitting door to open 180 degrees.

L. Accessories:

1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked enamel finish.
2. Door Lock: Cam lock that allows door to be opened during emergency by pulling sharply on door handle.
3. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location.

    a. Identify fire extinguisher in fire protection cabinet with the words "FIRE EXTINGUISHER"

        1) Location: Applied to cabinet door.
        2) Application Process: Pressure-sensitive vinyl letters.
        3) Lettering Color: Red.
        4) Orientation: Vertical.

M. Materials:

1. Cold-Rolled Steel: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.

    a. Finish: Baked enamel or powder coat.
    b. Color: White.

2. Tempered Float Glass: ASTM C 1048, Kind FT, Condition A, Type I, Quality q3, 3 mm thick, Class 1 (clear).

2.2 FABRICATION

A. Fire Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.

1. Weld joints and grind smooth.
2. Provide factory-drilled mounting holes.
3. Prepare doors and frames to receive locks.
4. Install door locks at factory.

B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles.

1. Fabricate door frames with tubular stiles and rails and hollow metal design, minimum 1/2 inch thick.
2. Fabricate door frames of one-piece construction with edges flanged.
3. Miter and weld perimeter door frames.

C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.3 FINISHES

A. Steel Finishes:

1. Comply with NAAMM AMP 500 "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Protect mechanical finishes on exposed surfaces of fire protection cabinets from damage by applying a strippable, temporary protective covering before shipping.
3. Finish fire protection cabinets after assembly.
4. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining 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 walls and partitions for suitable framing depth and blocking where recessed and semi-recessed cabinets will be installed.

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. Prepare recesses for recessed and semi-recessed fire protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

A. General: Install fire protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights indicated below:

1. Fire Protection Cabinets: 52 inches above finished floor to top of cabinet.

B. Fire Protection Cabinets: Fasten cabinets to structure, square and plumb.

1. Unless otherwise indicated, provide recessed fire protection cabinets. If wall thickness is inadequate for recessed cabinets, provide semi-recessed fire protection cabinets.
2. Fasten mounting brackets to inside surface of fire protection cabinets, square and plumb.

C. Identification: Apply vinyl lettering at locations indicated.

3.4 ADJUSTING AND CLEANING

A. Remove temporary protective coverings and strippable films, if any, as fire protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.

B. Adjust fire protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.

C. On completion of fire protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.

D. Touch up marred finishes, or replace fire protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire protection cabinet and mounting bracket manufacturers.

E. Replace fire protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

3.5 PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to the Installer that shall ensure that the fire protection cabinets shall be without damage at time of Substantial Completion.

END OF SECTION 10 44 13

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SECTION 10 44 16 - FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Portable fire extinguishers and mounting brackets for fire extinguishers.

B. Related Requirements:

1. Section 10 44 13 "Fire Protection Cabinets."

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.

B. Product Schedule: For fire extinguishers. Coordinate final fire extinguisher schedule with fire protection cabinet schedule to ensure proper fit and function.

1.3 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Pre-Installation Conference: Conduct conference at Project site.

B. Coordination: Coordinate type and capacity of fire extinguishers with fire protection cabinets to ensure fit and function.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers which fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Failure of hydrostatic test according to NFPA 10.
   b. Faulty operation of valves or release levers.

2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

1. Provide fire extinguishers approved, listed, and labeled by FM Global.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each fire protection cabinet and mounting bracket 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. JL Industries.
   b. Kidde Residential and Commercial.
   c. Larsens Manufacturing.
   d. Potter Roemer.

2. Valves: Nickel-plated, polished brass body.
3. Handles and Levers: Stainless steel.
4. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B, and bar coding for documenting fire extinguisher location, inspections, maintenance, and recharging.

B. Regular Dry Chemical Type: UL-rated 2A:10B:C portable fire extinguishers in locations as shown on the Drawings. Basis of design unit is Model 3005, 5lbs, by Potter Roemer.

C. Clean Agent (Halotron 1) Type in Steel Container: UL-rated 2-A:10-B:C, 15.5 lb nominal capacity with HFC blend agent and inert material in enameled steel container, with pressure-indicating gauge.

D. Fire extinguishers to be located as noted on the Drawings.

2.3 MOUNTING BRACKETS

A. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or red baked enamel finish.

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. JL Industries.
b. Kidde Residential and Commercial.
c. Larsens Manufacturing.
d. Potter Roemer.

B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated on drawings.

1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.

a. Orientation: Vertical.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fire extinguishers for proper charging and tagging.

1. Remove and replace damaged, defective, or undercharged fire extinguishers.

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 fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.

1. Mounting Brackets: 48 inches above finished floor to top of fire extinguisher.

B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

3.3 PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to the Installer that shall ensure that the fire extinguishers shall be without damage at time of Substantial Completion.

END OF SECTION 10 44 16

SECTION 10 81 13 - BIRD CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: The work specified in this Section includes, but shall not be limited to, Bird netting, complete with accessories and hardware.

1.2 SUBMITTALS

A. Product Data: Submit product data showing material proposed. Submit sufficient information to determine compliance with the Drawings and Specifications.

B. Shop Drawings: Submit shop drawings for each product and accessory required. Include information not fully detailed in manufacturer's standard product data.

C. Samples:

1. Submit samples for initial color selection. Submit samples of each specified finish. Submit samples in form of manufacturer's color charts showing full range of colors and finishes available. Where finishes involve normal color variations, include samples showing the full, range of variations expected.
2. Submit samples for verification purposes, as follows:

    a. Submit sample of bird netting, in the specified color, not less than 4 inches square.

D. Qualification Data: Submit qualification data for firms and persons specified in Quality Assurance Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names of architects and owners, and other information specified.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer Qualifications: Manufacturer shall be a firm engaged in the manufacture of bird control devices of types and sizes required, and whose products have been in satisfactory use in similar service for a minimum of five years.
2. Installer Qualifications: Installer shall be a firm that shall have a minimum of five years of successful installation experience with projects utilizing bird control devices similar in type and scope to that required for this Project.

B. Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances, and regulations of Federal, State, and local authorities having jurisdiction. Obtain necessary approvals from such authorities.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the Project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and lot number, if any.

B. Store materials in their original, undamaged packages and containers, inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

1.5 PROJECT CONDITIONS

A. Field Measurements: Take field measurements prior to fabrication of the work and preparation of shop drawings, to ensure proper fitting of the work. Show recorded measurements on final shop drawings. Notify the COR, in writing, of any dimensions found which are not within specified dimensions and tolerances in the Contract Documents, prior to proceeding with the fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the work.

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. Bird B Gone.
2. Bird Barrier America.
3. Nixalite of America, Inc.

2.2 BIRD NETTING

A. System Description:

1. Bird netting shall be constructed of high density polyethylene (HDPE) that shall be abrasion-resistant, flame-resistant, rot-resistant, and UV-resistant. Bird netting shall be a 3/4 inch square mesh.
2. Bird netting hardware shall fasten the bird netting to all types of surface shapes and materials. A variety of netting installation tools and accessories shall be available to make the netting installation an efficient process.
3. Provide surface cleaning system consisting of surface disinfectants and deodorizers to neutralize potentially hazardous bird and/or animal wastes and properly prepare the surface for installation.

B. Bird Netting:

1. Material: High density polyethylene (HDPE). Netting shall be waterproof.
2. Color: Black mesh.

3. Construction: Knotted mesh netting, comprised of multi-ply strands with minimum 40 pound knotted breaking strength. Bird netting pieces shall be both seamless and borderless for clean edges and easier perimeter fastening.
4. Standards: Meet ISO 9001 quality management standards.
5. Mesh Size: 3/4 inch square mesh.
6. Netting Sizes: Manufacturer's standard to suit the Project application.
7. Thermal and Physical Properties:

    a. Softening point shall be 250 degrees F.
    b. Melting point shall be 293 degrees F.
    c. Flash point shall be 660 degrees F.
    d. Shall remain flexible at very low temperatures.
    e. Specific gravity shall be 0.96. Bird netting shall not absorb water.
    f. Shall be chemically inert and resistant to acids and alkalis at room temperature.

C. Bird Netting Hardware: The Installer shall comply with manufacturer's recommendations for bird netting hardware applications, hardware combinations, as well as other items and procedures.

1. Finishing Hardware:

    a. Net Rings: Stainless steel net rings shall be used to attach the netting mesh to the cables, to close openings in the netting mesh, and to fasten the net zippers to the netting. Net ring quantity requirements per attachment shall be per manufacturer's recommendations.
    b. Net Zipper: Shall allow for access to areas behind the bird netting installation. Shall be available in color to match netting. Provide heavy duty, marine-grade, net zipper with 3/4 inch heavy fabric tape, open top, and auto lock slider.

D. Surface Disinfectants:

1. Surface Disinfectant and Bactericide: Designed to neutralize bird waste, making it safe for removal. Surface disinfectant and bactericide shall quickly kill disease-causing bacteria, parasites, fungi, insects, etc. Product shall become completely inert after it dries. Do not use with broad spectrum product on the same surface at the same time.
2. Broad Spectrum Disinfectant, Cleaner, and Deodorizer: Used to sanitize hard surfaces as well as fabrics and clothing. Use to kill a wide spectrum of organisms and disease causing bacteria. Do not use with surface disinfectant and bactericide on the same surface at the same time.
3. Anti-Microbial Personal Protection Products: Helps prevent disease transmittal before, during, and after working on and around surfaces contaminated with bird and animal wastes. Use to compliment personal protection equipment standards (PPE).
4. Safety Equipment: Use personal protection equipment (PPE) to protect personnel from the hazards related to pest bird and animal waste materials.

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. Note areas, surfaces, or objects that may require maintenance or periodic replacement after the bird netting is installed (i.e., lights, electrical equipment, etc.). Use the appropriate netting accessories to allow access behind the installed netting system.
2. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

3.2 PREPARATION

A. Clean installation surfaces thoroughly. Remove bird droppings and related refuse. Remove closely overhanging foliage, if any. Surface shall be clean and dry before installation.

B. Make sure installation surface finishing requirements have been accomplished before installing the bird netting. Bird netting shall be the last item installed on each specified surface. Do not apply any surface coating or treatment (paint, sealer, etc.) over or on the installed bird netting or the mounting hardware.

3.3 INSTALLATION

A. General: Install bird control devices in accordance with manufacturer's written recommendations, reviewed product data, and final shop drawings.

B. Bird Netting:

1. Surface Cleaning:

a. Surfaces shall be clean, dry, and free of obstructions before the bird netting is installed.
b. If bird waste is present, treat, neutralize, and safely remove bird waste from installation surfaces. Installer shall follow municipal, State, and Federal regulations regarding the proper removal and disposal of bird droppings and waste materials such as nests and dead birds.
c. Use manufacturer's surface cleaning products to neutralize any bird droppings, nests, and related waste materials that may be present. Allow surfaces to air dry completely, and then reapply to sanitize and deodorize the surface before proceeding. Strictly follow treatment instructions provided with surface cleaning products.
d. Use manufacturer's anti-microbial and anti-bacterial personal protection products to help prevent disease transmittal when working around surfaces contaminated with bird droppings.

2. Installation:

a. Make sure the installation surfaces are clean, dry, and free of any debris or obstructions.

b. Install the bird netting hardware as recommended by manufacturer.
c. Install bird netting as recommended by the manufacturer. If necessary cut the bird netting to fit the area. If multiple pieces are needed, join the pieces together with the recommended net ring hardware. Use the net rings to fasten the netting mesh to the perimeter and support cables. Tighten the turnbuckles to eliminate any wrinkles in the netting.
d. Install bird netting to avoid contact with machinery, vehicles, extreme heat, tree branches, etc. Make necessary adjustments to keep netting a sufficient distance from these objects or conditions.
e. Finished bird netting installation shall be taught, free of wrinkles, gaps, and openings.

3.4 ADJUSTING AND CLEANING

A. Inspect finished installation and make adjustments as necessary to conform to manufacturer's recommendations.

B. Remove debris and waste material from the Project site.

3.5 PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to the Installer that shall ensure that the bird control devices shall be without damage at time of Substantial Completion.

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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 on/off fire sprinkler system. This specification applies only to the aboveground part of the system, starting from existing fire main.

1. Provide new Viking Firecycle III on/off single-interlock preaction sprinkler system in B101 area.

2. Existing Firecycle systems are currently installed and protecting the Control Wing area basement level. Modifications to the fire suppression systems are required to comply with NFPA 13 as well as manufacturer's installation requirements. Additionally, modifications may be required to coordinate with any impact of architectural, mechanical or electrical changes in the area. New air compressors shall be provided for existing Firecycle systems.

B. The sprinkler systems shall be designed, installed, and tested in accordance with NFPA 13, International Building Code, and this specification. The on/off system shall provide alarm and supervisory devices in accordance with NFPA 13 and this specification.

C. The on/off systems shall be hydraulically designed in accordance with the hazard classifications indicated in NFPA 13.

D. Supports 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 Officer's Representative (COR), who will provide written clarification.

F. Electric alarm 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 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 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 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. Government 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 REFERENCE STANDARDS

A. General: Unless a specific edition is noted, 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), 2012 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.
2. 25: Standard for Inspection, Testing and Maintenance of Water Based Fire Protection Systems.
3. 70: National Electrical Code.
4. 72: National Fire Alarm Code.

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.

1.4 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.

1.5 SYSTEM DESCRIPTIONS

A. B101 Area: Supply and install a Viking Firecycle III single interlocked sprinkler system for this area. The system shall include: Firecycle VFR-400 panel, automatic sprinkler system, Firecycle detection system, fire control panel timer and back-up battery source power supply.

B. Control Wing Basement: Modify the existing Firecycle cycling single interlocked preaction type systems as necessary to coordinate with any impacting architectural, mechanical and electrical changes in the Control Wing Basement area. Modifications to the Firecycle system shall include, but not be limited to: automatic sprinkler system, Firecycle detection system, fire control panel timer and back-up battery source power supply.

C. Sprinkler System Protection Limits: Spaces within areas indicated, including closets, the top and bottom landing of each stair, and special applications areas.

1.6 SYSTEM PERFORMANCE REQUIREMENTS

A. Design and obtain approval from COR for fire protection systems specified

B. 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. Reductions per NFPA 13 are permitted for the use of quick response sprinklers.

C. Hydraulically Design Sprinkler Systems according to Sprinkler System Occupancy Hazard Classifications:

1. Office, Computer and Public Areas: Light hazard.
2. Storage Areas: Ordinary hazard, Group 1.
3. Mechanical Rooms: Ordinary hazard, Group 1.
4. Service Areas: Ordinary hazard, Group 1.

D. Minimum Density Requirements for Automatic Sprinkler System Hydraulic Design:

1. Light Hazard: 0.10 GPM over 1500 sq. ft. area.
2. 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. Light Hazard: 225 sq. ft. / sprinkler.
2. Ordinary Hazard, Group 1: 130 sq. ft. / sprinkler.

F. Components and Installation: UL listed for the following maximum working pressure ratings except where indicated otherwise.

1. Sprinkler Systems: 175 psig.

1.7 SUBMITTALS

A. Annotated Product Data for Fire Protection System Components:

1. Sprinkler piping and fittings.
2. Valves.
3. Specialty valves, accessories, and devices.
4. Alarm and supervisory devices. Include electrical data.
5. Thermal detector, detector cable and conduit.
6. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other data.
7. Releasing panel.
8. Hangers and bracing.

B. Installer qualification: Submit proof that the installer meets the specified qualifications.

C. Shop Drawings: Submit piping layout, hydraulic and battery calculations for approval. Show dimensions, locations of sprinklers, fittings, hangers, accessories and other similar items of the system. Show instrumentation and piping schematics. In addition, show thermal detector layout on sprinkler shop drawings, showing 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 Licensed Professional Engineer.

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.

H. Documentation of NICET Level IV certification as a sprinkler designer or registration as a Licensed Professional Engineer for the designer.

I. Test Plan: Provide a detailed testing plan to the COR 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. Include layout of piping mains and branches, instrumentations, valves, sprinklers, and other components.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: Firms whose equipment, specialties, and accessories are listed by product name and manufacturer in UL Fire Protection Equipment Directory and 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, or a Licensed Professional Engineer.

D. Sprinkler piping shall be shop welded per NFPA 13.

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.

1.9 SINGLE INTERLOCK VIKING ON/OFF PREACTION SYSTEM 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, the break contact circuit action energizes and alters the solenoid valves in the on/off fire sprinkler system trim lines. This releases the top chamber pressure, the clapper opens, water issues from the discharge chamber and the resulting increase in piping system pressure activates the pressure switches for alarm purposes. Once the temperature is sufficient, 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 the set time period is exceeded. At that time, the solenoid valves stop the flow of water and the flow control valve clapper is closed as the pressure builds up. 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.

1.10 COORDINATION

A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

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. Sprinkler Cabinets: Finished, wall-mounting, steel cabinet with hinged cover, with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13. Include separate cabinet with sprinklers and wrench for each type of sprinkler on this Project. Provide a cabinet adjacent to sprinkler riser for the associated system.

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 on/off 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. Control Panels:

1. Viking VFR-400 Control Panel: The control panel shall be a programmable microprocessor controlled releasing panel. The panel shall be programmed for program #6 – single interlocked. The on/off system control shall be fully self-contained and shall incorporate all circuitry, relays, switches, fuses, alarm horn, timer, and trouble lamps for complete control of the on/off fire sprinkler system. The control panel shall have the capability to connect to a normally closed initiating device circuit configured as a Class B circuit. The control panel shall include a soak timer which allows flow to continue for an adjustable time period after the thermal detectors have reset. The soak timer shall be adjustable from 30 seconds to 15 minutes (initially set at 5 minutes). The panel shall be wired to incorporate an emergency back-up power supply in addition to the primary main power source. The latter is to be 115 Volt/60Hertz. The panel shall have a vented enclosure and shall incorporate a full face locking front located door. The enclosure shall be painted red and shall incorporate wall- mounting lugs. The panel shall include two auxiliary dry form C contacts for alarm and trouble outputs to the fire detection system. The contacts shall be rated for 2 amps at 30 V AC resistive.

a. Known Acceptable Source: Viking VFR-400 Control Panel.

C. Back-Up Power Supply: The emergency back-up power supply shall be comprised of a minimum of two appropriately sized 12 V rechargeable batteries connected in series to attain the 24 VDC required by the release system. Batteries shall be of the sealed lead acid type. Batteries shall be capable of operating system in the standby mode for 24 hours and alarm mode of 2 hours at the end of the standby period or, provide 12 amp-hour batteries, whichever is greater.

D. Thermal Detectors: On/off system thermal detectors shall be the 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. Known Acceptable Source: Viking Model B.

E. 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, Part number 09954.

F. Solenoid valves: On/off system solenoid release valves shall be constructed of a 1/2 inch brass body; with a stainless steel core, core tube, plugnut and springs. Solenoid valve shall have a maximum working pressure of 175 psi. Electrical rating shall be 24 VDC. There shall be one normally closed and one normally open solenoid valve as required for a cycling single interlock preaction system. Solenoid valves shall be listed for use with the flow control valves.

G. System check valves: The on/off system check valve shall be a combination swing-check/drain unit for use in a system riser. Body shall be ductile iron with flanged or grooved end connections. The swing clapper rubber shall be EPDM. With the exception of the seat which shall be brass, other internal parts shall be stainless steel, as shall be the access plate. The body shall be tapped 3 inch NPT for drain connection (2-1/2 inch NPT for 2-1/2 inch valve); 1/2 inch NPT for air release connection to the solenoid valves; 1/4 inch NPT for pressure gage connection.

1. Known Acceptable Source: Viking Model E-1 or F-1.

H. System valves: The system valves shall be OS&Y gate or butterfly type, for use in piping 2 1/2 inches and larger, with a working pressure rating of 175 psi. Valves shall be UL listed and FM approved for use in fire protection systems. Valves shall include manual operator with handwheel and tamper switch.

1. OS&Y gate valves: OS&Y gate valve, with iron body, designed to fit between ANSI B16.5, Class 150 flanges.

2. Butterfly valves: Wafer-Body designed to fit between ANSI B16.5, Class 150 flanges.

I. Angle valves: Drain and trim angle valves shall be screwed bronze body rising stem with screw-in bonnet.

J. Flow Control Valve: The flow control valve shall be of the configuration application intended, quick opening differential diaphragm type with a spring loaded floating clapper. Valve shall be capable of automatic on/off control through trim lines specifically designed for an on/off type sprinkler system. Diaphragm and seat rubbers shall be field replaceable. Valve body and cover shall be ductile iron and be tapped for all required drain and trim connections. Diaphragm and seat rubbers shall be EPDM. Retaining screws, spring and seat rubber reinforcing ring shall be stainless steel. The clapper, damp ring and seat shall be bronze. The flow control valve shall be provided with the necessary trim package required by the manufacturer for use on a cycling single interlocked preaction system.

1. Known Acceptable Source: Viking Model H-1.

K. Auto ball drip: Trim and drain auto drip valves shall be 1/2-inch bronze body.

L. Ball Valve (compressed air): 2 inches and smaller. Cast bronze body conforming to ASTM B584 with stainless steel ball and reinforced 15 percent glass fill seal, stems made from brass conforming to ASTM B16. Designed for 150-psi non-shock working pressure.

M. Identification signs: Signs shall be made of a durable metal that can withstand the ambient conditions at the job site. Signs shall have a red background with white lettering as outlined in NFPA 13. Signs shall be provided for alarm valve, system riser, auxiliary drain, inspectors test, main drain, and auto sprinkler.

N. Sprinklers:

1. Sprinkler shall be upright, pendant (concealed) or sidewall type for the specific application. Pendent and sidewall 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. Sprinklers shall be quick response.
2. Sprinklers shall be quick response fusible link type with a temperature rating of 165 degrees F, 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 (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.

O. Sprinkler guards: Sprinklers below 7 ft above finish floor level or subject to the possibility of physical damage, shall be provided with sprinkler guards:

P. Supervisory Components and Alarms:

1. Pressure switches: The pressure switch shall be compatible with the flow control valve trim. The switch shall reset automatically on pressure drop. The switch shall provide single pole double throw contacts and be suitable for connection to the on/off system control panel. Each switch shall be monitored by the FACP through addressable interface devices as indicated in Section 28 31 00, "Fire Detection and Alarm."

    a. Known Acceptable Source: Viking Model A-1.

2. Tamper switches: The tamper switch shall be used to provide supervision of the open position for all control valves. The switch shall provide single pole double throw contacts and be housed in the manufacturers standard enclosure. Each switch shall be monitored by the FACP through addressable interface devices as indicated in Section 28 31 00, "Fire Detection and Alarm."

2.3 PIPE AND FITTINGS

A. Above ground system pipe shall be galvanized steel, black steel shall 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.
6. All fittings in the "dry" portion of the system shall be galvanized.

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.

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 setscrew 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. Sidewall sprinklers with chrome finish and matching thread on escutcheon.
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.

2.8 PRESSURE GAGES

A. Pressure Gages: UL 393, 3-1/2 to 4-1/2 inches diameter dial with dial range of 0-250 psig.

2.9 AIR COMPRESSOR

A. Air compressor shall be an electric motor-driven, air-cooled, single-stage, oil-less compressor. Compressor shall be equipped with check valve, and provide regulated and restricted air supply. Permanently lubricated cylinder compressor shall produce 2.1 SCFM at 50 psi continuous operating pressure. Safety relief valve shall be set at 65 psi. This unit shall be used to automatically maintain air pressure in the preaction sprinkler system. Known acceptable source: Viking Model F-1.

PART 3 - EXECUTION

3.1 GENERAL

A. All parts of the on/off 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. 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 for seismic design category D.

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 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, 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. On/off fire sprinkler system piping shall be installed to the slope requirements stipulated for dry pipe systems in NFPA 13, as listed in Section 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.

E. UL listed through-penetration firestop systems: Provide at sprinkler pipe penetrations through fire rated floors and walls in accordance with requirements of Section 07 84 13 "Penetration Firestopping".

F. 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.

3.3 SPRINKLERS

A. Sprinklers shall be located so as 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. Pendent and sidewall sprinklers shall be installed on return bend piping arrangements. 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 approved guards. Install quick response sprinklers.

3.4 VALVES

A. Valves shall be installed in an accessible location and in accordance with NFPA 13 requirements for pre-action systems. Tamper switches shall be provided on all water supply and control valves.

3.5 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.

3.6 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. In areas with suspended ceilings, the thermal detectors shall be installed in the semi-recessed configuration per the manufacturer installation requirements. 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), provide coverage as indicated on the drawings, spacing has been reduced in

certain areas. Modify spacing per NFPA 72 criteria and manufacturers criteria for other than smooth ceilings. 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.

3.7 WIRING

A. Wiring: Wiring shall be installed in accordance with NFPA 72 for Class B circuits and the manufacturers' recommendations. Wire all thermal detectors in series, T-Tapping is not allowed. Viking porcelain wire nuts are the only acceptable means of connecting wires. All wiring shall be installed in conduit.

3.8 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.

3.9 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 gage.
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. 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.
4. All tests shall be conducted as required by and in accordance with NFPA 13 requirements.
5. All tests shall be performed in the presence of the COR. Test date shall occur not sooner than 7 days after approval of test procedure by the Government. Test procedure review period required by the Government shall be not less than 30 days. Test date scheduling shall not be submitted until test procedures have been approved.
6. Perform on/off system tests per manufacturers test procedures.

B. A complete system acceptance test, including all detectors and cycling of system, is 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 on/off sprinkler system control system including valves, pressure switches, indicator lights, backup power supply, thermal detectors, alarm detection circuits, and alarm outputs to FACP according to manufacturers written test procedures and NFPA requirements.

3.10 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.

3.11 COMMISSIONING

A. Starting Procedures: Follow manufacturer's written procedures.

B. Coordinate with fire alarm system tests. Operate systems as required.

3.12 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 24 hours, 7 days a week. Response to warranty requests shall be verbally responded to within one hour and on site response within four hours.

END OF SECTION 21 13 13

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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 13 - COMMON MOTOR REQUIREMENTS FOR PLUMBING 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 plumbing equipment schedules or Sections.

B. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. 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: NEMA 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 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 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. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

C. Motors 1/20 HP and Smaller: Shaded-pole type.

D. 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 22 05 13

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.

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. One-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

1. Known Acceptable Source:

a. American Valve, Inc.
b. Conbraco Industries, Inc.; Apollo Valves.
c. NIBCO INC.

2. Description:

a. Standard: MSS SP-110.
b. CWP Rating: 400 psig.
c. Body Design: One piece.
d. Body Material: Bronze.
e. Ends: Threaded.
f. Seats: PTFE or TFE.
g. Stem: Bronze.
h. Ball: Chrome-plated brass.
i. 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

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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

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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. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Open-spring isolators.
5. Housed-spring isolators.
6. Restrained-spring isolators.
7. Housed-restrained-spring isolators.
8. Pipe-riser resilient supports.
9. Resilient pipe guides.
10. Elastomeric hangers.
11. Spring hangers.
12. Snubbers.
13. Restraint channel bracings.
14. Restraint cables.
15. Seismic-restraint accessories.
16. 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.

2.2 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 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts:

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. Mounting Plates:

   a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
   b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.

3. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts:

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. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

   a. Housing: Cast-ductile iron or welded steel.
   b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.5 OPEN-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators:

1. Known Acceptable Source: Subject to compliance with requirements, provide

   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. 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. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig.
7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.6 HOUSED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing:

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. 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. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.

    a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
    b. Top housing with attachment and leveling bolt.

2.7 RESTRAINED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:

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. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.

    a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
    b. Top plate with threaded mounting holes.
    c. Internal leveling bolt that acts as blocking during installation.

3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.8 HOUSED-RESTRAINED-SPRING ISOLATORS

A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing:

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. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.

   a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
   b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.

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.

2.9 PIPE-RISER RESILIENT SUPPORT

A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch- thick neoprene.

1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
2. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

2.10 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.

2.11 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.

2.12 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.

2.13 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.

2.14 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.

2.15 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.

2.16 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.

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 Architect, 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.

END OF SECTION 22 07 19

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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. Specialty valves.
   2. Dielectric fittings.
   3. 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. Drain valves.
4. Balancing valves
5. 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 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.

2.5 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

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SECTION 22 13 16 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following for soil, waste, and vent piping inside the building:

1. Pipe, tube, and fittings.
2. Special pipe fittings.

1.2 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

C. TPE: Thermoplastic elastomer.

1.3 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water.

1.4 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. Shop Drawings:

1. Drainage System: Include plans, elevations, sections, and details.

C. Field quality-control inspection and test reports.

1.5 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

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 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Extra-Heavy class.

B. Gaskets: ASTM C 564, rubber.

C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.4 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.

1. Standard, Shielded, Stainless-Steel Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.

a. Known Acceptable Sources:

1) ANACO.
2) Fernco, Inc.
3) Ideal Div.; Stant Corp.
4) Mission Rubber Co.
5) Tyler Pipe; Soil Pipe Div.

2.5 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, Type S, Grade B, Standard Weight or Schedule 40, galvanized. Include ends matching joining method.

B. Drainage Fittings: ASME B16.12, threaded, cast-iron drainage pattern.

C. Pressure Fittings:

1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, galvanized, seamless steel pipe. Include ends matching joining method.
2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
3. Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, standard pattern.
4. Cast-Iron Flanges: ASME B16.1, Class 125.
5. Cast-Iron, Flanged Fittings: ASME B16.1, Class 125.

2.6 COPPER TUBE AND FITTINGS

A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.

1. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

B. Hard Copper Tube: ASTM B 88, Types L and M, water tube, drawn temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
3. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.7 BACKWATER VALVES

A. Horizontal, Cast-Iron Backwater Valves:

1. Known Acceptable Source:

a. Josam Company; Josam Div.
b. MIFAB, Inc.
c. Smith, JR. Mfr. Co.; Division of Smith Industries, Inc.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products Inc.
f. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.14.1.
3. Size: Same as connected piping.
4. Body: Cast iron.
5. Cover: Cast iron with bolted or threaded access check valve.
6. End Connections: Hub and spigot or hubless.
7. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed.
8. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

B. Drain-Outlet Backwater Valves:

1. Known Acceptable Source:

a. Josam Company; Josam Div.
b. Smith, JR. Mfr. Co.; Division of Smith Industries, Inc.
c. Watts Drainage Products Inc.
d. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Size: Same as drain piping.
3. Body: Cast iron or bronze made for vertical installation.
4. Check Valve: Removable ball float.
5. Inlet: Threaded.
6. Outlet: Threaded or spigot.

2.8 FUNNEL DRAIN

1. Known Acceptable Source:

a. Josam Company; Josam Div.
b. Smith, JR. Mfr. Co.; Division of Smith Industries, Inc.
c. Watts Drainage Products Inc.
d. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Cast iron funnel and trap drain, complete with bronze bottom cleanout plug.

2.9 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.

a. NPS 2: 4-inch- minimum water seal.
b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 4 and smaller shall be the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.

2. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.
3. Steel pipe, drainage fittings, and threaded joints.
4. Copper DWV tube, copper drainage fittings, and soldered joints.

C. Aboveground, soil and waste piping NPS 5 and larger shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.
3. Steel pipe, drainage fittings, and threaded joints.
4. Dissimilar Pipe-Material Couplings: Shielded, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

D. Aboveground, vent piping NPS 4 and smaller shall be the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.
3. Steel pipe, drainage fittings, and threaded joints.
4. Copper DWV tube, copper drainage fittings, and soldered joints.
    a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2: Hard copper tube, Type M; copper pressure fittings; and soldered joints.
5. Dissimilar Pipe-Material Couplings: Shielded, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

E. Underground, soil, waste, and vent piping NPS 4 and smaller shall be the following:

1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
2. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

F. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

G. Install deep-seal traps on floor drains and other waste outlets, if indicated.

H. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

3.2 PIPING INSTALLATION

A. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

B. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

C. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:

1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

D. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.3 JOINT CONSTRUCTION

A. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

B. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.4 VALVE INSTALLATION

A. General valve installation requirements are specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping."

B. Shutoff Valves: Install shutoff valve on each sump pump discharge.

1. Install gate or full-port ball valve for piping NPS 2 and smaller.
2. Install gate valve for piping NPS 2-1/2 and larger.

C. Backwater Valves: Install backwater valves in piping subject to sewage backflow.

1. Horizontal Piping: Horizontal backwater valves.

2. Floor Drains: Drain outlet backwater valves, unless drain has integral backwater valve.
3. Install backwater valves in accessible locations.

3.5 HANGER AND SUPPORT INSTALLATION

A. Pipe hangers and supports are specified in Section 23 05 29 "Hangers and Supports for Plumbing Piping and Equipment." Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Install individual, straight, horizontal piping runs according to the following:

    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. Install supports according to Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6: 60 inches with 3/4-inch rod.

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 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: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
7. NPS 6: 12 feet with 3/4-inch rod.

H. Install supports for vertical steel piping every 15 feet.

I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 72 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
3. NPS 2-1/2: 108 inches with 1/2-inch rod.
4. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
5. NPS 6: 10 feet with 5/8-inch rod.

J. Install supports for vertical copper tubing every 10 feet.

K. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

3.7 FIELD QUALITY CONTROL

A. During installation, notify COR at least fifteen (15) calendar days hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by COR to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. 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 separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
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 required corrective action.

3.8 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 22 13 16

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SECTION 22 13 19 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following sanitary drainage piping specialties:

1. Cleanouts.
2. Through-penetration firestop assemblies.
3. Miscellaneous sanitary drainage piping specialties.

1.2 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FRP: Fiberglass-reinforced plastic.

C. HDPE: High-density polyethylene plastic.

D. PE: Polyethylene plastic.

E. PP: Polypropylene plastic.

F. PVC: Polyvinyl chloride plastic.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:

1. Cleanouts.
2. Firestop Assemblies.
3. Sanitary drainage piping specialties.

B. Field quality-control test reports.

C. Operation and Maintenance Data: For drainage piping specialties to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.5 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 03 30 00 "Cast-in-Place Concrete."

B. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Exposed Metal Cleanouts:

1. Known Acceptable Sources:

a. Josam Company; Josam Div.
b. MIFAB, Inc.
c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products Inc.
f. Zurn Plumbing Products Group; Specification Drainage Operation.
g. Josam Company; Blucher-Josam Div.

2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
3. Size: Same as connected drainage piping
4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch as required to match connected piping.
5. Closure: Countersunk, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Closure: Stainless-steel plug with seal.

B. Cast-Iron Wall Cleanouts:

1. Known Acceptable Sources:

a. Josam Company; Josam Div.
b. MIFAB, Inc.
c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products Inc.
f. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.

4. Body: Hub-and-spigot, cast-iron soil pipe T-branch as required to match connected piping.
5. Closure: Countersunk, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, deep, chrome-plated bronze cover plate with screw.
8. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

2.2 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

1. Known Acceptable Sources:

   a. ProSet Systems Inc.

2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
3. Size: Same as connected soil, waste, or vent stack.
4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
5. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
6. Special Coating: Corrosion resistant on interior of fittings.

2.3 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Section 22 05 00 "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

D. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

E. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

F. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 13 19

SECTION 22 34 00 - FUEL-FIRED, DOMESTIC-WATER 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:

1. Commercial, gas-fired, high-efficiency, storage, domestic-water heaters.
2. Domestic-water heater accessories.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Commercial domestic-water 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 from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.4 ACTION SUBMITTALS

A. Product Data: For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For fuel-fired, domestic-water heaters, 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.

B. Product Certificates: For each type of commercial, gas-fired, domestic-water heater, from manufacturer.

C. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

D. Source quality-control reports.

E. Field quality-control reports.

F. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuel-fired, domestic-water heaters to include in emergency, operation, and maintenance manuals.

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. ASHRAE/IESNA Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.

C. ASME Compliance:

1. Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.

D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects."

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.9 WARRANTY

A. Special Warranty: Parts and Labor On-Site, Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including 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. Commercial, Gas-Fired, Storage, Domestic-Water Heaters:

1) Storage Tank: Five years.
2) Controls and Other Components: Two year(s).

PART 2 - PRODUCTS

2.1 COMMERCIAL, GAS-FIRED, STORAGE, DOMESTIC-WATER HEATERS

A. Commercial, Gas-Fired, High-Efficiency, Storage, Domestic-Water Heaters:

1. Known Acceptable Source: Subject to compliance with requirements, provide products by one of the following:

a. Ajax Boiler Inc.
b. American Water Heaters.
c. Heat Transfer Products, Inc.
d. Basis of Design: Lochinvar, LLC, Shield
e. Smith, A. O. Corporation.

2. Standard: ANSI Z21.10.3/CSA 4.3.
3. Description: Manufacturer's proprietary design to provide at least 96 percent (AHRI Certified) combustion efficiency at optimum operating conditions.
4. Storage-Tank Construction: ASME-code steel with 150-psig minimum working-pressure rating.

a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.

1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
2) NPS 2-1/2 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.

b. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
c. Lining: Glass complying with NSF 61 Annex G barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.

5. Factory-Installed Storage-Tank Appurtenances:

a. Anode Rod: Replaceable magnesium.
b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
c. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
d. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
e. Jacket: Steel with enameled finish.
f. Burner or Heat Exchanger: Comply with UL 795 or approved testing agency requirements for gas-fired, high-efficiency, domestic-water heaters and natural-gas fuel. Stainless Steel Heat Exchanger. Minimum 5:1 turndown. Low NOx meeting SCAQMD Rule 1146.2. Condensate neutralization kit on combustion drain.
g. Temperature Control: Adjustable, storage-tank temperature-control fitting and flow switch, interlocked with circulator and burner.
h. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
i. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4-M. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

6. Draft Hood: Draft diverter, complying with ANSI Z21.12.

7. Concentric Direct Vent Sidewall Kit.

2.2 DOMESTIC-WATER HEATER ACCESSORIES

A. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.

B. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2, as applicable.

C. Heat-Trap Fittings: ASHRAE 90.2.

D. Manifold Kits: Domestic-water heater manufacturer's factory-fabricated inlet and outlet piping for field installation, for multiple domestic-water heater installation. Include shutoff valves to isolate each domestic-water heater and calibrated, memory-stop balancing valves to provide balanced flow through each domestic-water heater.

E. Comply with requirements for shutoff valves specified in Section 22 05 23 "General Duty Valves for Plumbing Piping."

1. Comply with requirements for balancing valves specified in Section 22 11 19 "Domestic Water Piping Specialties."

F. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M, manually operated. Furnish for installation in piping.

G. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include 1/2-psig, 2-psig, or 5-psig pressure rating as required to match gas supply.

H. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.

I. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.
2. Oil-Fired, Domestic-Water Heaters: ASME rated and stamped.

J. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.

K. Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect assembled domestic-water heaters specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Commercial, Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete base.

1. Maintain manufacturer's recommended clearances.
2. Arrange units so controls and devices that require servicing are accessible.
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. For supported equipment, 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. Install gas-fired, domestic-water heaters according to NFPA 54.

1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.
4. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in Section 23 11 23 "Facility Natural-Gas Piping."

C. Install commercial domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

D. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

E. Install water-heater drain and condensate neutralization drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 22 11 19 "Domestic Water Piping Specialties."

F. Install thermometer on outlet piping of domestic-water heaters. Comply with requirements for thermometers specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."

G. Assemble and install inlet and outlet piping manifold kits for multiple domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each domestic-water heater outlet. Comply with requirements for valves specified in Section 22 05 23 "General Duty Valves for Plumbing Piping" and comply with requirements for thermometers specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."

H. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.

I. Fill domestic-water heaters with water.

J. Charge domestic-water compression tanks with air.

3.2 CONNECTIONS

A. Comply with requirements for domestic-water piping specified in Section 22 11 16 "Domestic Water Piping."

B. Comply with requirements for gas piping specified in Section 23 11 23 "Facility Natural-Gas Piping."

C. Drawings indicate general arrangement of piping, fittings, and specialties.

D. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

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.
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 operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements Section 01 73 00 "Execution" for requirements for correcting the Work.

C. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial, gas-fired, storage, domestic-water heaters.

END OF SECTION 22 34 00

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SECTION 22 45 00 - EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Combination Units.
2. Emergency Water-Tempering Equipment.

1.2 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. Tepid: Moderately warm, 85 Deg F.

1.3 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.

C. Warranty: Manufacturers Standard,

1. 1 year Parts and Labor On-Site: All of system.

2. 10-year non pro-rated tank warranty from date of startup.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: Submit certificates of performance testing specified in "Source Quality Control" Article.

B. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For emergency plumbing fixtures to include in 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. Heating Elements: Separate lot and equal to at least 100 percent of amount of elements in each unit.

2. Manufacturer's recommended spare parts in published manuals.

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. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."

C. 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.

D. 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 COMBINATION UNITS

A. Standard, Plumbed Emergency Shower with Eyewash Combination Units:

1. Known Acceptable Source: Subject to compliance with requirements, provide products by one of the following:

a. Acorn Safety.
b. Bradley Corporation.
c. Encon Safety Products.
d. Guardian Equipment Co.
e. Haws Corporation.
f. Sellstrom Manufacturing Company.
g. Speakman Company.

h. Therm-Omega-Tech, Inc.
i. WaterSaver Faucet Co.

2. Piping:

a. Material: Chrome-plated brass or stainless steel.
b. Unit Supply: NPS 1-1/2.
c. Unit Drain: Outlet at back or side near bottom.

3. Shower:

a. Capacity: Not less than 20 gpm for at least 15 minutes.
b. Supply Piping: NPS 1 with flow regulator and stay-open control valve.
c. Control-Valve Actuator: Pull rod.
d. Shower Head: 8-inch-minimum diameter, chrome-plated brass or stainless steel.
e. Mounting: Pedestal.

4. Eyewash Unit:

a. Capacity: Not less than 0.4 gpm for at least 15 minutes.
b. Supply Piping: NPS 1/2 with flow regulator and stay-open control valve.
c. Control-Valve Actuator: Paddle.
d. Spray-Head Assembly: Two receptor-mounted spray heads.
e. Receptor: Chrome-plated brass or stainless-steel bowl.
f. Mounting: Attached shower pedestal.
g. Drench-Hose Option: May be provided instead of eyewash unit.

1) Capacity: Not less than 0.4 gpm for at least 15 minutes.
2) Drench Hose: Hand-held spray head with squeeze-handle actuator and hose.
3) Mounting: Bracket on shower pedestal.

2.2 EMERGENCY WATER-TEMPERING EQUIPMENT

A. Water-Tempering Equipment:

1. Known Acceptable Source: Subject to compliance with requirements, provide products by one of the following:

a. Haws Corporation.
b. Hubbell Water Heaters.
c. Hughes North America Inc.
d. Basis of Design: ThermOmegaTech, Inc., EMV Emergency Safety Shower.

2. Description: Factory-fabricated equipment with thermostatic mixing valve. Packaged water heater system designed to meet the requirements of ANSI Z358.1-2009 for tepid water delivery to an emergency drench system.

a. Water Heater: Electric water heater with 120 gallon capacity,
   1) Vertical carbon steel tank lined with 1/2" thick Hydrastone cement. Heater shall not require any type of anodic protection.
   2) Fully insulated with 3" thick polyurethane foam to minimize stand-by heat loss.
   3) Outer protective jacket shall be a dent resistant composite jacket to resist rust and corrosion.
   4) Tank inlet and outlet water connections shall be a minimum of 1-1/4" NPT non-ferrous copper-silicon/brass.

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 diaphragm operated valve actuator to ensure a continuous delivery flow 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 and hot water.

e. Water pressure drop across the system must not exceed 5psi 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) Low watt density immersion heating element
   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.

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 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. Install valves in locations where they can easily be reached for operation. Comply with requirements for valves specified in Section 22 05 23 "Ball Valves for Plumbing Piping" and

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 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 22 11 16 "Domestic Water Piping."

F. Install thermometers in supply and outlet piping connections to water-tempering equipment. Comply with requirements for thermometers specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."

G. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Comply with requirements for escutcheons specified in Section 22 05 00 "Common Work Results for Plumbing Piping."

3.3 CONNECTIONS

A. Connect hot- and cold-water-supply piping to hot- and cold-water, water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for hot- and cold-water piping specified in Section 22 11 16 "Domestic Water Piping."

B. 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 22 05 53 "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 22 45 00

SECTION 22 47 00 - DRINKING FOUNTAINS AND WATER COOLERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following drinking fountains and water coolers and related components:

1. Water-station water coolers.
2. Fixture supports.

1.2 DEFINITIONS

A. Accessible Water Cooler: Fixture that can be approached and used by people with disabilities.

B. Cast Polymer: Dense, cast-filled-polymer plastic.

C. Drinking Fountain: Fixture with nozzle for delivering stream of water for drinking.

D. Fitting: Device that controls flow of water into or out of fixture.

E. Fixture: Drinking fountain or water cooler unless one is specifically indicated.

F. Water Cooler: Electrically powered fixture for generating and delivering cooled drinking water.

1.3 SUBMITTALS

A. Product Data: For each fixture indicated. Include rated capacities, furnished specialties, and accessories.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For fixtures 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. Regulatory Requirements: Comply with requirements in ICC 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 fixtures for people with disabilities.

C. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

D. ARI Standard: Comply with ARI's "Directory of Certified Drinking Water Coolers" for style classifications.

E. ARI Standard: Comply with ARI 1010, "Self-Contained, Mechanically Refrigerated Drinking-Water Coolers," for water coolers and with ARI's "Directory of Certified Drinking Water Coolers" for type and style classifications.

F. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant, unless otherwise indicated.

G. Equipment should meet the Energy Star Certification requirements.

1.5 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. Filter Cartridges: Equal to 100 percent of amount installed for each type and size indicated, but no fewer than two of each.

PART 2 - PRODUCTS

2.1 WATER STATION WATER COOLERS

A. Water Coolers:

1. Known Acceptable Source:

a. Elkay Manufacturing Co.
b. Halsey Taylor.
c. Haws Corporation.
d. Oasis Corporation.
e. Sunroc Corp.

2. Description: ADA Compliant, Bi-level with bottle filling station, Accessible, Self-contained, electric refrigerated, pressure with bubbler, wall-mounting water cooler with bottle filling station for barrier free access.

a. Cabinet: All stainless steel.

b. Bubbler: two, with adjustable stream regulator, located on each cabinet deck.
c. Control: Push button.
d. Supply: NPS 3/8 with ball valve.
e. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
f. Drain(s): Grid with NPS 1-1/4 minimum horizontal waste and trap complying with ASME A112.18.1.
g. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.

1) Capacity: 8 gph of 50 deg F cooled water from 80 deg F inlet water and 90 deg F ambient air temperature.
2) Electrical Characteristics: 1/5 hp; 120-V ac; single phase; 60 Hz.

h. Support: Type II, water cooler carrier. Refer to "Fixture Supports" Article.

2.2 FIXTURE SUPPORTS

A. 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:

1. Josam Co.
2. MIFAB Manufacturing, Inc.
3. Smith, Jay R. Mfg. Co.
4. Tyler Pipe; Wade Div.
5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
6. Zurn Plumbing Products Group; Specification Drainage Operation.

B. Description: ASME A112.6.1M, water cooler carriers. Include vertical, steel uprights with feet and tie rods and bearing plates with mounting studs matching fixture to be supported.

1. Type II: Hanger-type carrier with vertical uprights.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before fixture installation. Verify that sizes and locations of piping and types of supports match those indicated.

B. Examine walls and floors for suitable conditions where fixtures are to be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Use carrier off-floor supports for wall-mounting fixtures, unless otherwise indicated.

B. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view. Plain copper tube, fittings, and valves may be used in concealed locations.

3.3 INSTALLATION

A. Install off-floor supports affixed to building substrate and attach wall-mounting fixtures, unless otherwise indicated.

B. Install fixtures level and plumb. For fixtures indicated for children, install at height required by authorities having jurisdiction.

C. Install water-supply piping with shutoff valve on supply to each fixture to be connected to water distribution piping. Use ball valve. Install valves in locations where they can be easily reached for operation.

D. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

E. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding pipe fittings.

F. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Sealants are specified in Section 07 92 00 "Joint Sealants."

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

C. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Water Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties.

1. Remove and replace malfunctioning units and retest as specified above.
2. Report test results in writing.

3.6 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

B. Adjust water cooler temperature settings.

3.7 CLEANING

A. After completing fixture installation, 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.

END OF SECTION 22 47 00

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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. Hot Taps/Line stops.
8. Drip Pans.
9. Mechanical Demolition.
10. Equipment installation requirements common to equipment sections.
11. Painting and finishing.
12. Concrete bases.
13. Supports and anchorages.
14. For grounding of mechanical materials, see electrical Sections.

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.
4. Piping materials.
5. Sleeves.
6. Escutcheons.
7. Grout.
8. Drip pans.
9. Hot Taps.

B. Welding certificates.

C. Prepare coordination drawings to a 1/4-inch scale. Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Show where sequence and coordination of installations are important to the efficient flow of the Work. Show proposed locations of piping, ductwork, equipment, and materials. Include the following:

1. Planned piping layout, including valve and specialty locations and valve stem movement.
2. Planned duct systems layout, including elbow radii and duct accessories.
3. Clearances for installing and maintaining insulation.
4. Clearances for servicing and maintaining equipment include space for equipment disassembly required for periodic maintenance.
5. Equipment service connections and support details.
6. Exterior wall, floor, and foundation penetrations.
7. Fire-rated wall and floor penetrations.
8. Sizes and location of required concrete pads and bases.
9. Access panel and access door locations.
10. Scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
11. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
12. Reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.

13. Drawings detailing fabrication and installation for metal supports and anchorage for mechanical materials and equipment. Supports and anchorage shall include vibration isolation and seismic bracing per Division 23 Section "Vibration and Seismic Control for HVAC."

D. Welder certificates signed by Contractor certifying that welders comply with requirements specified below.

E. Material Safety Data Sheets (MSDS): Submit MSDS for adhesives, paints, solvents, fireproofing, sealants and any other product which may cause acute or chronic health or safety effects to facility occupants.

F. Ventilation Plan: Submit ventilation plan which defines how temporary local ventilation will be provided. The ventilation plan must be approved by COR prior to start of work.

G. Prepare and distribute operations and maintenance data as specified in Div 1 Section, "Operation and Maintenance Manual Data."

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 larger equipment is approved, no additional costs shall be approved for these increases. 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. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. When stored inside, do not exceed structural capacity of the floor.

C. Protect flanges, fittings, and piping specialties from moisture and dirt.

D. Provide covered shelters for storage of all mechanical equipment. Cover all equipment with polyethylene covering.

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 Div 1 Section, "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.

2.9 DRIP PANS

A. Provide drip pans fabricated from minimum 22 gauge galvanized sheet metal with water tight joints and three inch high sides. Reinforce top with structural angle or by rolling top lip of side over 1/4 inch diameter steel rod. Provide drain hole, gasket, and flange at bottom low point for 1-inch drain line connection. Slope drip-pan minimum of 1/8-inch 1-ft towards drain connection. Support drip pan every 6-ft.

2.10 HOT TAP FITTINGS AND SPECIALTIES

A. Hot tap connections with stopple fittings shall be made in the hydronic system where shown on the drawings to bypass or isolate existing portions of the system without interruption of service.

B. Hot tap and stopple fittings and accessories shall meet ANSI class 150 service ratings after plugging equipment has been removed.

C. Stopple tee shall be 3-way type, to facilitate connection and use of a plugging machine to temporarily isolate a portion of the existing piping, while allowing flow to be diverted to new piping.

D. Tees shall be fabricated from ASTM A106 grade B pipe, or ASTM A234 Grade WPB steel.

E. Tee shall be provided with a matching cover flange and gasket, bolts and plastic carplugs, and a completion plug with O-ring.

F. Completion plug with O-ring shall allow plugging of 3-way tee for application of cover flange at the end of the hot tapping procedure.

G. Provide necessary services and equipment for hot tap connections.

H. Known Acceptable Source: TDW Inc.

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.

3.10 TEMPORARY HVAC AND LOCAL VENTILATION

A. Provide local ventilation during construction for any activity, which produces vapors, gases, odors, dust, fumes, etc. Air shall be exhausted to the exterior of the building. Provide ventilation for welding operations and for the application or use of adhesives, paints, solvents, fireproofing, sealants or any other product, which may cause acute or chronic health or safety effects to facility occupants. Ventilation shall comply with Occupational Safety and Health Administration (OSHA) and American Conference of Government Industrial Hygienists (ACGIH) requirements. The ventilation shall maintain the dust, gas, odor, fume, and vapor concentrations below the OSHA and ACGIH exposure limits as defined on the product MSDS and in "TLVs and BEIs, Threshold Limit Values for Chemical Substances and Physical Agents."

B. Provide Control Wing local ventilation to maintain a negative differential pressure of 0.05 to 0.1 inches of water column from the Control Wing work area with respect to the DSR Control Room (with doors to DSR closed) at all times. Maintain a minimum of ½ air change per hour in the work area during construction activities. The Ventilation System shall prevent fumes, vapors, and dust from entering the DSR Control Room.

C. Provide local ventilation as required to remove dust, fumes and vapors from the work area and to prevent the spread of dust, fumes, and vapors to other occupied areas of the facility.

D. Provide temporary heating as required to maintain a minimum space temperature of 55 degrees Fahrenheit within the work area. Comply with applicable NFPA and OSHA requirements for partially occupied buildings under constructions.

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.

B. Derating: Motors shall be design/rated to account for altitude at site elevation 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 similar to Aegis SGR.

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

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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.

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.

3.2 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 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

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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.

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.

C. 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 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 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.

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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 00 "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 a 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

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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- 2009) and ASCE-07. 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-2009 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)
ZOA – Oakland, California Importance Factor = 1.5	D	D	1.011	0.6

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.
Chillers	Piping Flexible Connectors	Required
Cooling Towers	Piping Flexible Connectors	Required
Temporary Equipment	Not Required	Required

END OF SECTION 23 05 48

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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. 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 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.

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. Omit intermediately spaced labels.

D. 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. Coordinate with controls for water flow in 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 in automatic and bypass. 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.

D. TABLE 3.7:

EQ ID	DESCRIPTION	Fac ID	Area	GPM
AHU-1	Computer room Air Handling Unit	AUTOWING	1st flr	30
AHU-2	Computer room Air Handling Unit	AUTOWING	1st flr	30
AHU-3	Computer room Air Handling Unit	AUTOWING	1st flr	30
AHU-4	Computer room Air Handling Unit	AUTOWING	1st flr	30
AHU-5	Computer room Air Handling Unit	AUTOWING	1st flr	30
AHU-6	Computer room Air Handling Unit	AUTOWING	Bsmt	45
AHU-7	Computer room Air Handling Unit	AUTOWING	Bsmt	45
AHU-8	Computer room Air Handling Unit	AUTOWING	Bsmt	45
AHU-9	Computer room Air Handling Unit	AUTOWING	Bsmt	45
AHU-10	Computer room Air Handling Unit	AUTOWING	Bsmt	45
AHU-11	Air Handling Unit	AUTOWING	1st flr	26.8
AHU-12	Air Handling Unit	AUTOWING	Attic	40
AHU-13	Air Handling Unit	AUTOWING	Attic	39
AHU-21	Computer room Air Handling Unit	ADMINWING	B119	75
AHU-22	Computer room Air Handling Unit	ADMINWING	B119	75
AHU-23	Computer room Air Handling Unit	ADMINWING	B119	75
AHU-24	Computer room Air Handling Unit	ADMINWING	B119	75
AHU-100	Computer room Air Handling Unit	TM&O	B101	71
AHU-101	Computer room Air Handling Unit	TM&O	B101	71
AHU-102	Air Handling Unit	CONTWING	Bsmt	50
AHU-103	Computer room Air Handling Unit	CONTWING	Bsmt	50

EQ ID	DESCRIPTION	Fac ID	Area	GPM
AHU-104	Computer room Air Handling Unit	CONTWING	Bsmt	50
AHU-105	Computer room Air Handling Unit	CONTWING	Bsmt	36
AHU-106	Computer room Air Handling Unit	CONTWING	Bsmt	36
AHU-107	Computer room Air Handling Unit	CONTWING	Bsmt	36
AHU-108	Computer room Air Handling Unit	CONTWING	Bsmt	36
AHU-111	Air Handling Unit	CONTWING	Bsmt	10
AHU-160	Air Handling Unit	CONTWING	Bsmt	Field Verify
P-201A	DSR attic blended circuit - SCHW	CONTWING	DSR Attic	Offline
P-201B	DSR attic blended circuit - SCHW	CONTWING	DSR Attic	Offline
AHU-201	Air Handling Unit	CONTWING	DSR Attic	60.4
AHU-202	Air Handling Unit	CONTWING	DSR Attic	60.4
AHU-203	Air Handling Unit	CONTWING	DSR Attic	60.4
AHU-204	Air Handling Unit	CONTWING	DSR Attic	60.4
201 Bypass	Air Handling Unit	CONTWING	DSR Attic	60.4
202 Bypass	Air Handling Unit	CONTWING	DSR Attic	60.4
203 Bypass	Air Handling Unit	CONTWING	DSR Attic	60.4
204 Bypass	Air Handling Unit	CONTWING	DSR Attic	60.4
AHU-205A	Air Handling Unit	CONTWING	DSR Attic	47.4
AHU-205B	Air Handling Unit	CONTWING	DSR Attic	47.4
AHU-206	Air Handling Unit	CONTWING	Attic	Field Verify
AHU-207	Air Handling Unit	CONTWING	Attic	Field Verify
AHU-209	Air Handling Unit	CONTWING	Attic	Field Verify
AHU-210A	Air Handling Unit	CONTWING	Attic	Field Verify

EQ ID	DESCRIPTION	Fac ID	Area	GPM
AHU-210B	Air Handling Unit	CONTWING	Attic	Field Verify
AHU-211	Air Handling Unit	CONTWING	Mezz	32.5
AHU-212	Air Handling Unit	CONTWING	Mezz	60.7
AHU-300	Air Handling Unit	ADMINWING	Bsmt	48
AHU-310	Air Handling Unit	ADMINWING	Locker	29
AHU-320	Air Handling Unit	ADMINWING	1st flr	47
AHU-330	Air Handling Unit	ADMINWING	Bsmt	57
AHU-350	Air Handling Unit	ADMINWING	Lower Roof	32.0
AHU-510	Air Handling Unit	PSB	2nd flr	120.0
AHU-515	Air Handling Unit	PSB	2nd flr	120.0
AHU-520	Air Handling Unit	PSB	2nd flr	45.0
FCU-01	Fan Coil Unit	ADMINWING	Bsmt	3.1
FC-101	Fan Coil Unit	ADMINWING	1st flor	1.5
FC-102	Fan Coil Unit	ADMINWING	1st flr	3.9
FC-103	Fan Coil Unit	ADMINWING	1st flr	3.9
FC-104	Fan Coil Unit	ADMINWING	1st flr	3.9
FC-105	Fan Coil Unit	ADMINWING	1st flr	3.9
FC-106	Fan Coil Unit	ADMINWING	1st flr	3.9
FC-107	Fan Coil Unit	ADMINWING	1st flr	2.2
FC-108	Fan Coil Unit	ADMINWING	1st flr	2.2
FC-109	Fan Coil Unit	ADMINWING	1st flr	2.2
FC-110	Fan Coil Unit	ADMINWING	1st flr	2.2
FC-111	Fan Coil Unit	ADMINWING	1st flr	2.2
FC-112	Fan Coil Unit	ADMINWING	1st flr	2.2

EQ ID	DESCRIPTION	Fac ID	Area	GPM
FC-113	Fan Coil Unit	ADMINWING	1st flr	3.9
FC-114	Fan Coil Unit	ADMINWING	1st flr	3.9
FC-115	Fan Coil Unit	ADMINWING	1st flr	3.9
FC-116	Fan Coil Unit	ADMINWING	1st flr	3.9
FC-117	Fan Coil Unit	ADMINWING	1st flr	3.9
FC-118	Fan Coil Unit	ADMINWING	1st flr	3.9
FC-119	Fan Coil Unit	ADMINWING	1st flr	3.9
FC-120	Fan Coil Unit	ADMINWING	1st flr	3.9
FC-121	Fan Coil Unit	ADMINWING	1st flr	3.9
FC-122	Fan Coil Unit	ADMINWING	1st flr	2.5
FC-123	Fan Coil Unit	ADMINWING	1st flr	2.5
FC-201	Fan Coil Unit	ADMINWING	2nd flr	3.9
FC-202	Fan Coil Unit	ADMINWING	2nd flr	3.9
FC-203	Fan Coil Unit	ADMINWING	2nd flr	3.9
FC-204	Fan Coil Unit	ADMINWING	2nd flr	3.9
FC-205	Fan Coil Unit	ADMINWING	2nd flr	2.2
FC-206	Fan Coil Unit	ADMINWING	2nd flr	3.1
FC-207	Fan Coil Unit	ADMINWING	2nd flr	3.1
FC-208	Fan Coil Unit	ADMINWING	2nd flr	2.2
FC-209	Fan Coil Unit	ADMINWING	2nd flr	2.2
FC-210	Fan Coil Unit	ADMINWING	2nd flr	3.1
FC-211	Fan Coil Unit	ADMINWING	2nd flr	3.1
FC-212	Fan Coil Unit	ADMINWING	2nd flr	3.1
FC-213	Fan Coil Unit	ADMINWING	2nd flr	3.1

EQ ID	DESCRIPTION	Fac ID	Area	GPM
FC-214	Fan Coil Unit	ADMINWING	2nd flr	2.2
FC-215	Fan Coil Unit	ADMINWING	2nd flr	3.1
FC-216	Fan Coil Unit	ADMINWING	2nd flr	3.1
FC-217	Fan Coil Unit	ADMINWING	2nd flr	3.1
FC-218	Fan Coil Unit	ADMINWING	2nd flr	2.2
FC-219	Fan Coil Unit	ADMINWING	2nd flr	2.2
FC-220	Fan Coil Unit	ADMINWING	2nd flr	2.2
FC-221	Fan Coil Unit	ADMINWING	2nd flr	2.2
FC-222	Fan Coil Unit	ADMINWING	2nd flr	2.2
FC-223	Fan Coil Unit	ADMINWING	2nd flr	2.2
FC-224	Fan Coil Unit	ADMINWING	2nd flr	2.2
FC-225	Fan Coil Unit	ADMINWING	2nd flr	2.2
FC-226	Fan Coil Unit	ADMINWING	2nd flr	2.2
FCU-1033-1	Fan Coil Unit	ADMINWING	1st flr	Field Verify
FCU-1033-2	Fan Coil Unit	ADMINWING	1st flr	Field Verify
FCU-1033-3	Fan Coil Unit	ADMINWING	1st flr	Field Verify
FCU-1033-4	Fan Coil Unit	ADMINWING	1st flr	Field Verify
FCU-1033-5	Fan Coil Unit	ADMINWING	1st flr	Field Verify

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 for water flow through each evaporator and condenser to be within specified tolerances of indicated flow with all 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 and blowdown 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 PROCEEDURES FOR HIGH EFFICIENCY FILTRATION UNITS

A. Balance water flow through filtration unit to within specified tolerances of indicated flow with all pumps operating. Do not exceed the flow for the maximum recommended by the filter manufacturer. Measure and record the following data with filter operating at design conditions:

1. Measure water flow through filter.
2. Measure pressure drop across unit for both normal and backflush operation.
3. Adjust feed rate of makeup water system for backflush operation.

3.15 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.

3.16 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.

3.17 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-open flow rate in gpm.
e. Full-open 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.

3.18 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.

3.19 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

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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. 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. 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.

F. 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. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums and casings.
5. Flexible connectors.
6. Vibration-control devices.
7. 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 23 07 13

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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.
   2. Section 23 07 13 “Duct Insulation”

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.

1.6 SCHEDULING

A. Schedule insulation application after pressure testing systems. 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. 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 ceilings and shafts.

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.

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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 HVAC equipment furnished and installed under this renovation project. This installation will be the beginning of a program that will replace the existing TAC I/Net DDCS currently controlling and monitoring the HVAC system and other building systems throughout the ARTCC. In the future, after this project is complete, the FAA intends to solicit proposals to replace the remainder of the existing TAC I/Net DDCS with a compatible BACnet based DDCS.

B. The new DDCS shall be a Schneider Electric StruxureWare / Andover Continuum BACnet DDCS.

C. The chilled/condenser water system and heating hot water system is currently being retrofitted under Utility Energy Services Contract (UESC) project, which includes the installation of third party control system, LOBOS system, and control sequence modifications. The data points from the existing I/Net system will be collected by the LOBOS system and used for system optimization, which requires system integration, data points mapping and communication between the LOBOS system and existing I/Net system. The LOBOS system and functionality of the system optimization provided under UESC project shall be maintained while the existing I/Net system associated with chilled/condenser water system is replaced with new DDCS under this project. Since the LOBOS system provided under UESC project is a proprietary system, the data point mapping, testing and system validation for the LOBOS system shall be performed by the controls contractor who installed the LOBOS system under UESC project. Coordinate with the FAA for the contact information of controls contractor and other support required for this project.

D. The controls contractor shall integrate the new BACnet DDCS provided under this project into the existing I/Net DDCS and ensuring the existing DDCS network communications components are at a level of compatibility that will allow the two systems to operate together for operator functionality through the existing I/Net Operator Workstation(s) (OWS). The existing I/Net OWS shall be configured and act as the primary access point for the DDCS installed as part of this project. The contractor shall be responsible for making any modifications necessary to integrate the new BACnet DDCS into the existing I/Net DDCS, including control and monitoring points mapping and graphical displays. An operator shall be able to control and monitor the mechanical equipment controlled by new DDCS using graphical displays on the existing I/Net OWS. New BACnet front-end software shall be loaded on the existing I/Net 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 factory authorized to work on it;
2. Have received training on the new BACnet DDCS;
3. Be familiar with the existing TAC I/Net DDCS and factory authorized to work on it;
4. Have received training on the existing TAC I/Net DDCS; and
5. Have a minimum of 5 years experience with applications similar in nature to the requirements of this project.

E. All necessary hardware and software including the specific components of StruxureWare / Andover Continuum product 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 in the FAA En-Route facilities throughout the country. 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 design 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 Andover Continuum 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. Application graphics for the control and monitoring of the HVAC systems as described in this specification.
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 I/Net 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

William Ryan / Program Manager
bill.ryan@schneiderelectric-critical.com
Mobile: 240-793-3451

Alternate Point of Contact

Bryan Schroers / Program Coordinator
bryan.schroers@schneiderelectric-critical.com
Mobile: 410-227-1233

F. 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 HVAC Control Diagrams and DDCS Point Function Schedule shown on the mechanical drawings. The existing 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 BACnet-compliant and listed by the BACnet Testing Laboratory (BTL).

G. Non-BACnet-compliant or proprietary equipment or systems including gateways are not acceptable and are strictly prohibited, with the exception of network interfaces used for the chillers and computer room air conditioning units provided with the manufacturer's non-BACnet packaged controls. Any gateway or network interface supplied by the equipment manufacturer for the chillers and computer room air conditioning units shall be directly connected to the DDCS network using the BACnet communication protocol.

H. The building controller shall communicate with the existing I/Net OWS in the existing CCMS Monitoring Room (B117), as well as other OWS(s) in the ARTCC. The OWS is a data processing system specifically designed to monitor and control the Heating, Ventilating and Air Conditioning (HVAC) systems through the controllers or other control units. This Section includes controllers capable of monitoring and controlling all HVAC equipment indicated.

1. Provide BC, AAC and ASC for monitoring and control of new and existing HVAC equipment, including but not limited to chilled/condenser water system, air handling units and fans. Coordinate control system requirements with equipment manufacturer requirements.

   a. Chilled Water System (CH-200 and CH-300): Existing DDC controllers associated with CH-200, CH-300, P-1A, P-1B, P-1C and P-1D shall be replaced with new BACnet controllers. Disconnect and remove existing controllers and control devices from the respective control panels, and provide new controls for new equipment. Coordinate the sequence of controls replacement and installation of new controllers and panels with the COR. Disconnect and remove existing controllers and control devices from the respective control panels, and provide new controls for the equipment. 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.

Existing control and monitoring points that are not associated with the replacement equipment shall remain in operation and protected during construction. The controls contractor shall coordinate with the FAA and provide necessary programming and graphics for all existing control and monitoring points. Provide new refrigerant alarm panel, sensing tube and associated alarm horn, light strobe and manual switches as indicated in the mechanical plans.

b. Chilled Water System (CH-100 and CH-400): Once new chillers and related equipment are provided and new controls are installed, disconnect and remove all existing controllers, control devices and panels associated with CH-100 and CH-400 and other miscellaneous equipment in Room B115. Turn over the controllers to the FAA for use as spare parts. Provide new BACnet controllers and reconnect all existing control and monitoring points to new controllers. Existing sensors and control devices that not compatible with new BACnet controllers shall be replaced with BACnet compatible devices. When the installation of new control devices is complete, the controls contractor shall program and make necessary changes to the DDCS to run the chilled water system as described under "Sequence of Operation."

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. 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 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. New conduit and pull boxes for use of new control wiring in Pump House will be provided by Division 26. Provide new control wiring and conduit from the pull boxes to pump house and cooling towers as required. New DDC panels for condenser water system shall be installed in Chiller Room. Coordinate locations of pull boxes and conduit routing with Division 26.

d. AHU-21 (Room B119): Remove existing controls associated with the existing computer room air handling unit, AHU-21, including panels, electric control devices, sensors, wiring and conduit. Turn over the controllers to the FAA for use as spare parts. Provide new BACnet controls for the new air handling unit, AHU-21.

e. AHU-105 and AHU-106 (Room B120): Demolish existing controls associated with the existing computer room air handling units, AHU-105 and AHU-106, in Room B120, including controllers, control devices, sensors, wiring and conduit. The controls associated with the replacement air handling units including unit controller, control devices and BACnet network card shall be provided by the unit manufacturer, as specified in Division 23, "Computer Room Air Conditioners." These units shall be connected to 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. AHU-102 (Room B120): Provide new controls for new air handling unit, AHU-101, in Room B120.

g. AHU-109 (Room B101): Provide new controls for new outdoor air handling unit, AHU-109, in Room B101.
h. AHU-390 (Room B116): Provide new controls for new outdoor air handling unit, AHU-390, in Room B116.
i. Water Leak Detection (Room B119 and B120): Demolish existing water leak detection panels and associated leak detection cables in Room B120 and provide new leak detection panels and leak detection cables. Provide new leak detection panel and leak detection cable in Room B119.
j. Water Leak Detection (Room B115): Two TraceTek leak detection modules are currently installed in Room B115. Connect alarm output from each module to new DDCS for water leak detection alarm.

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.
5. Provide separate controllers for primary and back-up HVAC units, which provide redundant HVAC service to 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: The existing refrigerant leak monitor and alarm system will be provided under UESC project. See the "DDCS Point Function Schedule" for the list of refrigerant alarm monitoring points that must be connected to new DDCS.
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. Division 28, "Fire Alarm and Detection System" contains requirements that relate to this Section.

E. Division 28, "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. 135-2010: 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, 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. 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.

C. 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.

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. Computer Room Air Handling Unit (AHU-21)

1. General: New air handling unit (AHU-21) and existing air handling units (AHU-22 through AHU-24) serve the Host Computer Room (Room B134). Three units shall serve as the lead unit, which shall operate continuously 24 hours a day, seven days a week, and one unit shall serve as a standby that shall be turned on automatically in the event of a failure of the lead unit. Provide an automatic program, that is Government re-programmable, to alternate the lead unit weekly to maintain even use of the units. It shall be possible for maintenance personnel to select the lead and standby unit through the associated graphical displays of the OWS.
2. Supply Fan Hand-Off-Auto Operation: A Hand-Off-Auto operation switch shall be provided as part of the unit controller. In the Off mode, the fan shall be stopped. In the Hand mode, the isolation damper CD-1 shall open. When the isolation 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, to 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 isolation damper in both the Hand and Auto modes.
3. Supply Fan Operation Automatic Mode: The unit shall be started and stopped by the unit controller. In the event of power failure, the unit(s) that we running prior to the power

failure shall be restarted on resumption of power. To start a unit, the unit controller shall send a start signal to the motor starter, which will 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. 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, 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.

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 space temperature sensor TS-21, 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. Dehumidification Control: When the space humidity in the space, as sensed by space humidity sensor, HS-21, rises above the space dehumidification set point, space temperature control of the chilled water valve, CV-1, shall be overridden. Instead the chilled water valve shall modulate to maintain the space humidity at set point. The space dehumidification set point shall be initially set at 55 percent RH (adjustable). The hot water valve, CV-2, shall modulate to maintain the space temperature set point, to avoid over cooling of the space. When the space humidity falls below the space dehumidification set point, control of the chilled water valve and hot water valve shall return to normal operation.
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 (PDI-1) located at the filters shall indicate the differential pressure across the filters.
8. Fan Status: A status 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. 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.
10. Additional Monitoring: In addition to the points mentioned in these sequences provide the additional monitoring points listed in the "DDCS Point Function Schedule."

F. Computer Room Air Handling Units (AHU-105 and AHU-106)

1. General: New air handling units (AHU-105 and AHU-106) and existing air handling units (AHU-107 and AHU-108) serve the Equipment Room (Room B120). Three units shall serve as the lead unit, which shall operate continuously 24 hours a day, seven days a week, and one unit shall serve as a standby that shall be turned on automatically in the event of a failure of the lead unit. Provide an automatic program, that is Government re-programmable, to alternate the lead unit weekly to maintain even use of the units. It shall

be possible for maintenance personnel to select the lead and standby unit through the associated graphical displays of the OWS

2. The Computer Room Air Handling Unit shall be controlled by a unit controller provided by the unit manufacturer, as specified in Division 23, "Computer Room Air Conditioners." 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. Provide an automatic program, that is Government re-programmable, to rotate the lead and standby units weekly to maintain even use of units.
3. Unit Manual On, Manual Off and Auto Operation: The Manual On, Manual Off and Auto functions shall be provided as part of the unit controller. The operator shall be able to operate the unit in Manual On, Manual Off, or Auto mode through the unit mounted display using key pads. When the unit is placed in the Manual Off mode, the fan shall be stopped. When the unit is placed in the Manual On mode, the isolation damper CD-1 shall open. Once the isolation damper is fully open, the associated damper position switch DI-1 shall energize the fan. When the fan is running in the Manual On mode, the chilled water control valve position can be manually adjusted through the unit mounted display using key pads. When the unit is placed in Auto mode, the unit controller will operate the unit as described below. Program a time delay into the unit controller to stagger the restart of unit after a power failure to prevent creating a spike in the facility electrical demand.
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. A status contact shall provide operating status of the fan. If the lead unit 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. 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 space temperature sensor TS-XXX (XXX represents associated unit number), 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.
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 (PDI-1) located at the filters shall indicate the differential pressure across the filters.
8. Fan Status: A status 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. 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.
10. Additional Monitoring: In addition to the points mentioned in these sequences provide the additional monitoring points listed in the "DDCS Point Function Schedule."

G. Outdoor Air Handling Unit (AHU-109)

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 outside 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 the 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 outside 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 the unit, the unit controller shall send a stop signal to the motor starter, which shall close the outside 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 55 °F (adjustable).
4. Heating Control: When the supply air temperature, as sensed by supply air temperature sensor TS-1, drops below the supply air temperature set point, the unit controller shall modulate the hot 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 hot water valve shall be modulated in coordination with the chilled water valve so as to not be open when the chilled water valve is open. When the unit status is off, the hot water control valve CV-2 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-1 between fully open and fully closed as required to maintain a supply air temperature TS-1 at the supply air temperature set point. When the unit status is off, the chilled water control valve CV-1 shall be closed.
6. 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-109, at or above the humidification set point, which shall be initially set at 40 % RH. When the fan is off, or upon a loss of air flow, the humidifier output shall be disabled. The humidifier shall be hard wire interlocked with an air flow switch, AFS-1, which shall disable the humidifier if no air flow is present.
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 (PDI-1) located at the filters shall indicate the differential pressure across the filters.

8. Freezestat: When a freeze condition occurs at the freezestat, FZ-1, the unit shall be stopped and outdoor air damper shall be closed. On a freeze alarm signal, the DDCS shall fully open the pre-heat hot water valve CV-2 and the chilled water valve CV-1. An alarm shall be generated in the DDCS and displayed at the OWS. The freezestat shall be set to trip at 34 °F (manually adjustable) and must be manually reset at the freezestat.
9. Fan Status: A 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.
10. 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.
11. Additional Monitoring: In addition to the points mentioned in these sequences provide the additional monitoring points listed in the "DDCS Point Function Schedule."

H. Outdoor Air Handling Unit (AHU-390)

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 outside 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 the 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 outside 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 outside 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 55 °F (adjustable).
4. 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-1 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-1 shall be closed.
5. Heating Control: When the supply air temperature, as sensed by supply air temperature sensor TS-1, drops below the supply air temperature set point, the unit controller shall modulate the hot 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 hot

water valve shall be modulated in coordination with the chilled water valve so as to not be open when the chilled water valve is open. When the unit status is off, the hot water control valve CV-2 shall be closed.

6. Freezestat: When a freeze condition occurs at the freezestat, FZ-1, the unit shall be stopped. On a freeze alarm signal, the DDCS shall fully open the chilled water valve CV-1 and the hot water valve, CV-2. An alarm shall be generated in the DDCS and displayed at the OWS. The freezestat shall be set to trip at 34 °F (manually adjustable) and must be manually reset at the freezestat.
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 (PDI-1) located at the filters shall indicate the differential pressure across the filters.
8. Fan Status: Current relays shall be used to monitor the status of the unit supply fans. If the status indicated does not match the commanded output for the fan an alarm shall be generated and sent to the OWS.
9. 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.
10. Additional Monitoring: In addition to the points mentioned in these sequences provide the additional monitoring points listed in the "DDCS Point Function Schedule."

I. Air Handling Unit (AHU-102)

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 fan shall be energized. In the Auto position the unit controller will start/stop the unit as described below. Program a time delay into the unit controller to stagger the restart of the 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 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 DDCS shall send a start signal to the motor starter, which will start the fan. 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 DDCS 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.
3. Heating Control: When the space temperature, as sensed by TS-102, drops below the space temperature set point, the unit controller shall modulate the hot water valve CV-2 between fully open and fully closed as required to maintain the space temperature at the set point. The hot water valve shall be modulated in coordination with the chilled water valve so as to not be open when the chilled water valve is open. When the unit status is off, the hot water control valve CV-2 shall be closed.
4. Cooling Control: When the space temperature, as sensed by space temperature sensor TS-102, rises above the space temperature set point, the unit controller shall modulate the chilled water valve CV-1 between fully open and fully closed as required to maintain the space temperature at the set point. When the unit status is off, the chilled water control valve CV-1 shall be closed.

5. 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.
6. Fan Status: A 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.
7. 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.
8. Additional Monitoring: In addition to the points mentioned in these sequences provide the additional monitoring points listed in the "DDCS Point Function Schedule."

J. Exhaust Fan (EF-310) – Chiller Room Ventilation

1. Exhaust Fan Hand-Off-Auto Operation: Provide a Hand-Off-Auto operation switch at the fan disconnect. 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 be opened and the exhaust fan shall start. 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 associated intake and isolation damper (CD-1) and 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.

K. Exhaust Fan (EF-1) – Pump House Ventilation:

1. The exhaust fan shall be started and stopped by the space thermostat in Pump House. When the space temperature exceeds the space thermostat set point, the fan shall start. The space temperature set point shall be set at 85°F (adjustable). When the space temperature drops below the set point, the exhaust fan shall be stopped. The exhaust fan shall be controlled by a thermostat not through DDCS.

L. Electric Unit Heater (Typical)

1. Electric Unit Heater: When the temperature drops below the set point, initially set at 55°F (adjustable), the electric heater shall be enabled and the fan shall operate. When the temperature rises above the set point, the electric heater shall be disabled and the fan shall stop. The electric unit heater shall be controlled by a unit mounted thermostat, not through the DDCS.

M. Water Leak Detection System Monitoring: The DDCS shall monitor alarms from the leak detection system.

N. Chilled Water System

1. General

a. Two chillers, four chilled water pumps and three cooling towers 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 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. The chilled water system shall consist of four chillers (CH-100 through CH-400), four chilled water pumps (P-1A through P-1D), four cooling towers (CT-1A through CT-1D) and three condenser water pumps (P-3A through P-3C). 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 "First Stage", "Second Stage", "Third Stage" (Chillers, Cooling Towers and Chilled Water Pumps only), and "Standby" 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 "Third Stage" chiller; and one chiller shall be designated as the "Standby" 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 "Third Stage" pump; and one chilled water pump shall be designated as the "Standby" 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; one cooling tower shall be designated as the "Third 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-xC refers generically to cooling tower CTR isolation valves FCV-1C through FCV-4C.
6) CH-x00 refers generically to chillers CH-100 through CH-400.
7) CT-1x refers generally to cooling towers CT-1A through CT-1D.

2. 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-xC, 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) When there is a call for the "Second Stage" chiller, the DDCS shall increase the speed of "First Stage" condenser water pump to meet the required cooling tower water flow for two chillers as indicated in the mechanical equipment schedule. This pump speed shall be determined in consulting with the balancing contractor during the TAB process.
2) "Second Stage" cooling tower isolation valve, FCV-xC, shall be opened by the DDCS, enabling the "Second Stage" cooling tower CT-1x.
3) Once the "First Stage" condenser water pump is running at the required speed and "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.
4) 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.
5) 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.
6) 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."
7) 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.
8) 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.
9) 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.

3. 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-xC 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-xC shall be closed by the DDCS.

4. 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.
5. Chiller Rotation: When switching the "First Stage", "Second Stage", "Third Stage" and "Standby" 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 "Standby" equipment, the "Second Stage" equipment shall become the "First Stage" equipment, the "Third Stage" equipment shall become the "Second Stage", and the "Standby" units shall become the "Third Stage" units.

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-xC shall be closed by the DDCS.

b. "Third Stage" Chiller (Assumes two chillers and two chilled water pumps are in operation):

1) When there is a call for the "Third Stage" chiller during the chiller rotation, the DDCS shall override the VFD speed control of "First Stage" condenser water pump and maintain the last command speed until the "Second Stage" condenser pump has reached at the required speed as described below.
2) While the "First Stage" condenser water pump is running at the last command speed, the "Second Stage" condenser water pump 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 "Third Stage" 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) Once the "Second Stage" condenser 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-xB in the cooling tower water supply to the "Third Stage" chiller and the "Third Stage" cooling tower isolation valve, FCV-xC, shall be opened, enabling the "Third Stage" cooling tower, CT-1x.
4) The DDCS shall override the VFD speed control of "First Stage" and "Second Stage" chilled water pumps and maintain the last command speed until the "Third Stage" chiller is enabled.
5) When the "First Stage" and "Second Stage" chilled water pumps are running at the last command speed, the "Third Stage" chilled water pump 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 "Third Stage" chiller as indicated in the mechanical equipment schedule. This pump speed shall be determined in consulting with the balancing contractor during the TAB process.
6) During the transition, the DDCS shall override the differential control and modulate the chilled water bypass valve, FCV-6A, to maintain the differential pressure as described under "Chilled Water Bypass Valve Control."
7) Once the "Third 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 "Third Stage" chiller, CH-x00, shall open.

8) When both cooling tower water and chilled water isolation valves have been proven open through the valve position switches, the "Third Stage" chiller, CH-x00, shall be enabled by the DDCS.
9) Once the "Third Stage" chiller and "Third Stage" chilled water pump are in operation, the DDCS shall disable the "First Stage" chiller, CH-x.
10) 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.
11) Once both isolation valves associated with the "First Stage" chiller have been proven to be closed through the valve position switches, the associated "First Stage" chilled water pump, P-1x, and "First Stage" condenser water pump, P-3x, shall be stopped.
12) The "First Stage" cooling tower, CT-1x, shall then be disabled, and the cooling tower isolation valve, FCV-xC shall be closed by the DDCS.

6. 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."

7. Chilled Water Supply Temperature Control: Each chiller shall be controlled by its packaged controls to maintain the supply water temperature at the chilled water supply temperature at set point. The chilled water supply temperature set point and reset range shall be adjustable through the DDCS. The controls contractor shall verify the existing I/Net system and LOBOS system to see if the data points required for chilled water supply temperature reset are available for new DDCS. The contractor shall provide additional hardware and software and make necessary changes, including software upgrade to existing I/Net system, to monitor the required points from new DDCS. The two modes of chilled water supply temperature set point control described below shall be provided through new DDCS. The mode shall be manually selected by the operator through graphical displays on the OWS. The selected mode and chilled water supply temperature set point shall apply to all operating chillers.

   a. Manual Set Point Mode: The chilled water supply temperature set point shall be initially set at 44°F and manually adjusted by the operator between 44°F and 48°F (adjustable).

b. Automatic Reset Mode: The DDCS shall monitor the valve positions of chilled water control valves associated with the air handling units listed below, and reset the chilled water supply temperature set point between 44°F and 48°F (adjustable). When all chilled water control valves monitored by the DDCS are less than 75% open for certain period of time, initially set at 5 minutes (adjustable), the DDCS shall reset and raise the chilled water supply temperature by 0.5°F (adjustable). When any chilled water control valve monitored by the DDCS is greater than 90% open for certain period of time, initially set at 3 minutes (adjustable), the DDCS shall reset and lower the chilled water supply temperature by 0.5°F (adjustable).

c. The chilled water control valves on the following air handling units shall be monitored by the DDCS:

1) Automation Wing: AHU-1 through AHU-13
2) Host Mechanical Room: AHU-21 through AHU-22
3) Control Wing Basement: AHU-105 through AHU-108
4) Control Wing Attic: AHU-201 through AHU-204, AHU-205A and AHU-205B

d. The range of chilled water supply temperature set point shall be determined and adjusted by the operator and the DDCS shall not raise the chilled water supply temperature set point beyond the high limit.

8. 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.

9. 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-1B through FCV-4B.

   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.

10. 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 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" or "Third 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.

11. 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 the chilled water bypass valve 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 the chilled water bypass valve 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 the chilled water bypass valve 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 the chilled water bypass valve to maintain the differential pressure at set point.

O. 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-8, 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-8, 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-8.

    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 the 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 M501 for the pump shut-off water level set points for cooling tower water sump.

5. Cooling Tower Water Level Control

a. City Water Control: Provide a water level transmitter LS-4 in the cooling tower water sump which 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. Refer to M504 for the city water level set points.

b. Water Storage Tank Control: Provide a water level transmitter LS-5 in the water storage tank which transmits the water level to the DDCS. The DDCS shall maintain the water tank level by opening and closing the level control valve, LCV-3. When the water tank level drops below the tank water add level, the level control valve, LCV-3, shall open. When the tank water level is above the tank water valve shut-off level, the level control valve, LCV-3, shall close. The tank 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. Coordinate with the FAA for the tank water level set points.

P. Refrigerant Leak Monitor System

1. The existing refrigerant leak monitor system will be reused and connected to new DDCS.
2. 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.
3. Reconnect existing control points associated with the existing refrigerant ventilation fan, EF-310B, to new controller and provide necessary programming to run the fan when the refrigerant leak alarm is activated.

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 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 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 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 (One of each type)
6. Air Differential Pressure Switch
7. Valve Actuator (Each Type Used for AHU Application 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 StruxureWare Andover Continuum 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 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. Compaq
   b. Dell
   c. Hewlett-Packard

2. Provide a personal computer which meets 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 primary operator workstation complete with mouse, keyboard and color monitor. The operator workstation shall provide total keyboard-less operation as the primary operator interface.
4. 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.
5. 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 I/Net front-end software on the existing workstation will be the primary operator interface for both new and existing systems and the existing I/Net OWS will communicate with new BACnet system using a protocol convertor. 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.

B. 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.

C. 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.

D. 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.

E. 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.

F. 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.

G. 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.

H. 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.

I. 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.

J. 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.

K. 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.

L. 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.

M. 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 new BACnet system controllers into the existing I/Net system during this beginning phase of the program to replace the existing TAC/I/Net in the ARTCC.

B. 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.

C. 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.

D. 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.

E. 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 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 / Andover 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.

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 manufacturers recommendations.

2.17 DUCT SMOKE DETECTORS

A. Duct smoke detectors are specified in Division 28, "Fire Alarm and Detection Systems." Coordinate installation of duct smoke detectors with fire alarm and detection system work to provide the specified sequence of operation.

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 4 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 / Andover Continuum 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. This training shall also provide initial overview and day-to-day operation of two new chillers being installed. 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; and
f. Operation and control of new chillers.

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 ~~on site~~ 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 11 13 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.

1.2 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, 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 and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.3 PERFORMANCE REQUIREMENTS

A. Natural-Gas System Pressure within Buildings: More than 0.5 psig but not more than 2 psig

1.4 SUBMITTALS

A. Product Data: For each type of the following:

1. Piping specialties.
2. Corrugated, stainless-steel tubing with associated components.
3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
4. Pressure regulators. Indicate pressure ratings and capacities.
5. Dielectric fittings.
6. Escutcheons.

B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple

pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

C. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.

D. Welding certificates.

E. Field quality-control reports.

F. Operation and Maintenance Data.

1.5 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

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.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by FAA or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:

1. Notify COR no fewer than two days in advance of proposed interruption of natural-gas service.

1.7 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.

2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

    a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

B. 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.

2.4 MANUAL GAS SHUTOFF VALVES

A. Bronze Plug Valves: MSS SP-78.

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. Lee Brass Company.
    b. McDonald, A. Y. Mfg. Co.

2. Body: Bronze, complying with ASTM B 584.
3. Plug: Bronze.
4. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig.
7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.5 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

B. Line Pressure Regulators: Comply with ANSI Z21.80.

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. Actaris.
    b. American Meter Company.
    c. Eclipse Combustion, Inc.
    d. Fisher Control Valves and Regulators; Division of Emerson Process Management.
    e. Invensys.
    f. Maxitrol Company.
    g. Richards Industries; Jordan Valve Div.

2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 2 psig.

2.6 DIELECTRIC FITTINGS

A. Dielectric Unions:

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. Capitol Manufacturing Company.

b. Central Plastics Company.
c. Hart Industries International, Inc.
d. McDonald, A. Y. Mfg. Co.
e. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
f. Wilkins; Zurn Plumbing Products Group.

2. Combination fitting of copper alloy and ferrous materials.

2.7 SLEEVES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

2.8 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

B. Inspect natural-gas piping according to the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with the International Fuel Gas Code requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.

C. Install underground, PE, natural-gas piping according to ASTM D 2774.

D. Steel Piping with Protective Coating:

1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
3. Replace pipe having damaged PE coating with new pipe.

E. Install fittings for changes in direction and branch connections.

F. 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.

G. 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.

H. Install pressure gage downstream from each service regulator. Pressure gages are specified in Division 15 Section "Meters and Gages."

3.4 INDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. 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.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Install piping in concealed locations 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.

G. Locate valves for easy access.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. 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 Division 7 Section "Through-Penetration Firestop Systems."

L. Verify final equipment locations for roughing-in.

M. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

N. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

O. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

P. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

R. Connect branch piping from top or side of horizontal piping.

S. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

T. Do not use natural-gas piping as grounding electrode.

U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

V. Install pressure gage downstream from each line regulator. Pressure gages are specified in Division 15 Section "Meters and Gages."

3.5 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.

B. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

3.6 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. 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.

D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

3.7 HANGER AND SUPPORT INSTALLATION

A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 15 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

B. Comply with requirements for pipe hangers and supports specified in Division 15 Section "Hangers and Supports."

C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

3.8 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.9 LABELING AND IDENTIFYING

A. Comply with requirements in Section 15076 "Plumbing Identification" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.10 PAINTING

A. Comply with requirements in Division 9 painting Sections for painting interior and exterior natural-gas piping.

3.11 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.

3.12 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.

C. Natural-gas piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 23 11 13

SECTION 23 21 11 - 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 piping. (including Piping to/from Engine Generators)
4. Makeup-water piping.
5. Condensate-drain piping.
6. Blowdown-drain piping.
7. Air-vent piping.
8. 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. Makeup-Water Piping: 80 psig at 150 deg F.
5. Condensate-Drain Piping: 200 deg F.
6. Blowdown-Drain Piping: 200 deg F.
7. Air-Vent Piping: 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.

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. 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.

H. Condensate-Drain Piping: Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

I. Blowdown-Drain Piping: Schedule 80 Steel. Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

J. 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.

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

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SECTION 23 21 13.13 - UNDERGROUND HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Steel pipes and fittings.
   2. Transition fittings.
   3. Cased piping system.

1.2 PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing hydronic piping systems with the following minimum working-pressure ratings:
   1. Condenser-Water Piping: 100 psig at 150 deg F.

1.3 SUBMITTALS

A. Product Data: For the following:
   1. Cased piping.

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.

C. Material Test Reports: For cased piping.

D. Source quality-control reports.

E. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.

PART 2 - PRODUCTS

2.1 STEEL PIPES AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black with plain ends; type, grade, and wall thickness as indicated in "Piping Application" Article.

B. Steel Welding Fittings: ASME B16.9, seamless or welded.

1. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

C. Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

D. 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 -bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

E. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

2.2 CASED PIPING SYSTEM

A. Description: Factory-fabricated piping with carrier pipe, insulation, and casing.

1. Known Acceptable Source:
a. Basis of Design: Bredero Shaw - YellowJacket
b. Perma-Pipe, Inc.
c. Rovanco Piping Systems, Inc.
d. Thermacor Process, L.P.

B. Carrier Pipe: Schedule 40, ASTM A 53/A 53M, black with plain ends, Grade B ERW carbon steel pipe.

C. Carrier Pipe Insulation:

1. Polyurethane Foam Pipe Insulation (Yellow Jacket exempt): Rigid, cellular, high-pressure injected between carrier pipe and jacket.

a. Comply with ASTM C 591; thermal conductivity (k-value) shall not exceed 0.14 Btu x in./h x sq. ft. x deg F at 75 deg F after 180 days of aging.

D. Carrier Pipe Adhesive for Yellow Jacket:
1. Rubberized asphalt adhesive

E. Casing (Yellow Jacket exempt): HDPE, seamless, in accordance with ASTM D1248, type 3, Class C.

F. Casing for Yellow Jacket: Two layer high density polyethylene coating.

G. Casing accessories include the following:

1. Joint Kit: Half-shell, pourable or split insulation, casing sleeve, and shrink-wrap sleeve.
2. Expansion Blanket: Elastomeric foam, formed to fit over piping.
3. End Seals: Shrink wrap the casing material to seal watertight around casing and carrier pipe.

H. Source Quality Control: Factory test the carrier pipe to 150 percent of the operating pressure of system. Furnish test certificates.

PART 3 - EXECUTION

3.1 EARTHWORK

A. See Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATION

A. Condenser-Water Piping:

1. NPS 2-1/2 and larger shall be 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.

2. Cased piping with polyurethane carrier-pipe insulation.

   a. Piping Insulation Thickness: 1 inch.

   b. YellowJacket only: No insulation.

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 schedule 80 threadolet, NPS 3/4 steel ball valve, and short schedule 80 NPS 3/4 threaded nipple with cap, at building wall penetration and elsewhere as required for system drainage.

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 Division 23 Section for sleeves and mechanical sleeve seals through exterior building walls.

J. Secure anchors with concrete thrust blocks.

3.4 JOINT CONSTRUCTION

A. See Division 33 Section "Common Work Results for Utilities" for basic piping joint construction.

B. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

C. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

D. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

E. Welded Joints: Construct joints according to AWS D10.12M/D10.12.

F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

G. Conduit and Cased Piping Joints: Assemble sections and finish joints with pourable or split insulation and exterior jacket sleeve, and apply shrink-wrap seals.

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 Division 31 Section "Earth Moving" for warning-tape materials and devices and their installation.

3.6 FIELD QUALITY CONTROL

A. Perform the following 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.

B. Prepare test and inspection reports.

END OF SECTION 23 21 13.13

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SECTION 23 21 23 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Close-coupled, in-line centrifugal pumps.
2. Separately coupled, base-mounted, double-suction centrifugal pumps.
3. Separately coupled, vertically mounted, turbine centrifugal 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 points 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. Refer to Division 1 Section "Product Requirements."

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.

1.8 WARRANTY

A. Special Warranty: Parts and Labor on-site. Manufacturer's standard form in which manufacturer agrees to repair or replace components of pumps that fail in materials or workmanship within specified warranty period:

1. All components of pump.
2. Warranty Period: Five years parts and labor on-site from date of Substantial Completion.

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 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Known Acceptable Source:

1. Armstrong Pumps Inc.
2. Aurora Pump; Division of Pentair Pump Group.
3. Crane Pumps & Systems.
4. Flowserve Corporation.
5. Grundfos Pumps Corporation.
6. ITT Corporation; Bell & Gossett.
7. Mepco, LLC.
8. PACO Pumps.
9. Patterson Pump Co.; a subsidiary of the Gorman-Rupp Co.
10. Peerless Pump Company.
11. TACO Incorporated.
12. Thrush Company Inc.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically.

C. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, replaceable bronze wear rings, and threaded companion-flange or union-end connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, 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. Include water slinger on shaft between motor and seal.
5. Pump Bearings: Permanently lubricated ball bearings.

D. Motor: Single speed and rigidly mounted to pump casing.

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 requirements in Section 23 05 13 "Common Motor requirements for HVAC Equipment."

   a. Enclosure: TEFC

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.

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 similar to Aegis SGR.

2.4 SEPARATELY COUPLED, VERTICALLY MOUNTED, TURBINE CENTRIFUGAL PUMPS

A. Known Acceptable Source:

1. American-Marsh Pumps.
2. Crane Pumps & Systems.
3. Fairbanks Morse Pump; Div of Pentair Pump Group
4. Flowserve Corporation.
5. Mepco, LLC.
6. PACO Pumps.
7. Patterson Pump Co.; a subsidiary of the Gorman-Rupp Co.
8. Peerless Pump Company.

B. Description: Factory-assembled and -tested, single-stage or multistage, centrifugal, impeller-between-bearings, end-suction pump as defined in HI 2.1-2.2 and HI 2.3; designed for installation with pump and motor shafts mounted vertically and projecting into a sump. Pump construction shall match discharge flange elevation of existing pump casing to allow direct connect to existing piping without rework of the active header. Alternately, coordinate pump discharge elevation with steel plating to match existing piping elevation.

C. Pump Construction:

1. Pump Bowl: Cast iron, with cone or basket strainer, replaceable bronze wear ring, and suction bell. Water passages of intermediate bowls shall be coated with porcelain enamel.
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 sized according to manufacturer's requirements.
4. Pump Bearings: Water-lubricated bronze and rubber sleeve bearings in cast-iron housing.
5. Pump Column: ASTM A 53/A 53M, Grade B steel pipe.

6. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.

D. Shaft Coupling: Keyed with locking collets.

E. Discharge Head: ASME B16.1, Class 125 discharge flange with threaded gage tapping. Top of discharge head shall have a registered fit to accurately locate the driver.

F. Drive Ratchet: Non-reversing ratchet.

G. Hollow Shaft Motor: Variable speed and secured to discharge head.

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 Section 23 05 13 "Common Motor Requirements for HVAC Equipment" and as additionally required below:

    a. Enclosure: TEFC, IEEE-841 harsh environment with internal heaters, with Ingress Protection rating greater or equal to IP-55.

3. Motors shall be inverter duty and compatible with variable frequency drives provided in Division 26 29 23, "Variable Frequency Motor Controllers." Motors shall have shaft mounted static grounding ring similar to Aegis SGR.

PART 3 - EXECUTION

3.1 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.

3.2 CONCRETE BASES

A. Install concrete bases of dimensions indicated for pumps and controllers. Refer to Section 23 05 00, "Common Work Results for HVAC."

3.3 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

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.

3.4 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.

3.5 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 Division 26 Section "Grounding and Bonding for Electrical Systems."

H. Connect wiring according to Division 26 Section "Low Voltage Electrical Power Conductors and Cables."

3.6 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.

3.7 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 23 25 00 - HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following HVAC water-treatment systems:

1. Water treatment test equipment.
2. Sand Filtration units for HVAC hydronic systems.

1.2 DEFINITIONS

A. EEPROM: Electrically erasable, programmable read-only memory.

B. 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.

C. RO: Reverse osmosis.

D. TDS: Total dissolved solids.

E. UV: Ultraviolet.

1.3 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 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.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for the following products:

1. Sand Filters.
   a. It shall be the responsibility of the filter manufacturer to size the filtration system, based on their published literature, to meet the specification including section 2.1.A.3.c performance criteria.

b. Submit Particle Distribution Analysis results from at least three previous projects utilizing similar models of units where the criteria described in 2.1.A.3.a, b & c were met. Include closed loop temperatures, volumes and filtration rate. Include open loop tower tonnage, tower water circulation rate, temperature drop across the tower, and filtration rate. Note % of tower water circulation rate being filtered in each case. Include facility name, address, contacts and phone numbers. Analysis shall be on a THIRD PARTY LAB letter head with contact information.

B. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to HVAC systems. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: Power and control wiring.

C. Field quality-control test reports.

D. Project. Coordinate with Section 23 05 48 "Vibration Controls for HVAC Piping and Equipment."

E. Operation and Maintenance Data: For sensors, injection pumps, water filtration units, and controllers to include in emergency, operation, and maintenance manuals.

F. 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 the "Performance Requirements" Article above.
2. Water Analysis: Illustrate water quality available at Project site.

1.5 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.

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.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of filter that fail in materials or workmanship within specified warranty period.
1. Extended warranties include, but are not limited to, the following:
a. Complete filtration unit including piping, pumps, valves and controls.
b. Complete filter body assembly including sand media charge.
c. Parts and labor.
d. Loss of media for any reason.

2. Warranty Period: two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 HIGH EFFICIENCY SAND FILTER EQUIPMENT

A. Circulating Sand Filters:

1. Know Acceptable Source:

   a. AmeriWater, Distributed by Chemworks Filtration
   b. Diamond, Distributed by ONDEO Nalco Company

2. Description: Factory-fabricated and -tested, simplex, sand-filter system of filter tank, media, strainer, self-priming circulating pump, piping, and controls for removing sediment particles from water. This section specifies a High Efficiency Sand Filtration System rated for a particle removal of 0.25 micron for closed systems and 0.5 micron for open systems:

   a. Natural quartz media shall meet AWWA B-100, ANSI, and NSF-61 standards for consistently uniform and chemically inert filter media. Crushed or ground media is not acceptable.
   b. Valves shall be two-piece bronze-body ball type with multi-piece packing set, blowout proof stem design, adjustable packing gland, stainless ball and stem, RPTFE seat. Valves shall be actuated with individual 24V electric motors on each valve. Ports shall be provided for sample collection.
   c. Filter shall be equipped with two pressure gauges. The gauges shall be anti flutter and shall have a stainless steel casing, with brass internals. The minimum face size shall be no less than 2-1/2". One gauge marked (IN) shall be connected to the filter pump discharge and the second gauge marked (OUT) shall be connected to the outlet side of the filter.
   d. Top inlet distributor shall be Copper Under drain shall be 316 stainless steel wedgewire screen pipe.
   e. Backwash flow control shall be rated for full backwash flow from 25 PSIG to 120 PSIG.
   f. Filter pump shall be self-priming, cast iron, close coupled with mechanical seal. Pump motor to be TEFC with a service factor of not less than 1.15.
   g. Filter control shall be mounted in a NEMA 4X enclosure and shall contain the following:
      1) Allen Bradley 1200 Series PLC or equivalent.
      2) Allen Bradley motor starter and service disconnect or equivalent.
      3) A step-down transformer to convert 3phase power to 115 VAC to operate control components and convert 115 VAC to 24V for valve actuation.
      4) A pressure differential switch factory set to initiate backwash at 18 PSI (adjustable) differential across the filter bed.
      5) A manual backwash switch, of a momentary contact design, mounted on the outside of the control panel door.

6) A backwash indicating light, pump status light and pump on/off switch mounted on the outside of the control panel door.
7) A non-resettable backwash counter mounted on the outside of the control panel door to indicate the number of times the filter has backwashed.
8) PLC shall be programmed to control valve actuation, duration of the back-wash cycle, and pump on/off. Backwash shall be initiated by the 24-hour timer, pressure differential switch, or manual backwash button. An internal delay of no less than 15 seconds shall be built into the program timer to avoid false backwashing. Controls for unit shall be factory designed and installed to also prevent loss of system water due to a motorized valve failure. The controls shall monitor valve positions and/or individual supply-return-drain piping flow during backwash and normal operations to prevent a partially open (failed) valve from allowing system water to drain. Upon failure of a motorized valve to properly operate the unit shall close all motorized valves, shut down and alarm locally as well as to the BMS. Basis of Design: AmeriWater Factory- FAA Critical Valve Option.
9) PLC shall also include a set of dry contacts that can be connected to the BMS to monitor backwash frequency.

h. Filter Tank: Corrosion resistant with distribution system and media.

1) Construction:

a) Fabricate and label steel filter tanks.
b) Fabricate supports and base and attachment to tank with reinforcement strong enough to resist filter movement during a seismic event when filter base is anchored to building structure.

2) Pipe Connections NPS 2 and Smaller: Threaded according to ASME B1.20.1.
3) Steel Tank Pipe Connections NPS 2-1/2 and Larger: Steel, Class 150 flanges according to ASME B16.5 or grooved according to AWWA C606.

i. Piping: ASTM B 88, Type L copper water tube, copper-alloy solder-joint fittings, and brazed or flanged joints.
j. Safety Valves: Automatic and manual pressure relief.
k. Circulating Pump: Overhung impeller, close coupled, single stage, end suction, centrifugal. Comply with UL 778 and with HI 1.1-1.2 and HI 1.3.

1) Pump Construction: cast iron, close coupled with mechanical seal
2) Motor: General requirements for motors are specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."
3) Pump for condenser water system shall be self-priming.

l. Controls: Automatic for control of circulating pump and tank backwash; factory wired for single, external electrical connection.

1) Panel: NEMA 250, Type 4 enclosure with time clock and pressure gages.
2) Pump: Automatic and manual.
3) Backwash: Automatic; with differential-pressure-switch initiation device.

4) Backwash Valve: Tank mounted.

m. Support: Skid mounting.

3. Capacity and Characteristics: Refer to Equipment Schedule on Drawings.
   a. Filter shall be designed to provide 0.25 micron filtration (closed system) and 0.5 micron filtration (open system) by utilizing ultrafine sand with an effective size of not more than 0.08 millimeters.
   b. Filter design flow rate shall be greater than 20 GPM per square foot of surface area.
   c. Filter shall be sized to remove at least 50% (by count) of the 0.5 micron particles and at least 80 % (by count) of the 2 micron particles, within 30 days of startup.
   d. Filter system shall be rated for 85 PSIG inlet pressure to filter pump and 190 F Temperatures.
   e. Tanks shall be 304L stainless steel rated for 125 PSIG operating pressure.
   f. Manifold shall be Type L copper.
   g. Filter system and pump shall be mounted on a stainless steel skid.
   h. Filter pump shall be pre-wired 115 V 1 phase.
   i. System shall be factory assembled and tested for rated pressure and control functions.

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 structure.

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.

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 equipment to allow 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 23 05 00 "Common Work Results for HVAC."

D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Section 23 05 23 "General-Duty Valves for HVAC Piping."

E. Confirm applicable electrical requirements in Division 26 Sections for connecting electrical equipment.

F. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Section 26 05 19 "Low Voltage Electrical Power Conductors and Cables."

H. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

I. Install piping adjacent to equipment to allow service and maintenance.

J. Size and install the control loop piping to conductivity and optional sensors and/or corrosion coupon racks in the size PVC to match fittings provided. Install field provided full port ball valves for isolation of sensors and racks for routine maintenance. Control loop sensors shall not be installed directly in the piping mains.

K. Control loop shall be piped from the pressure side of the recirculating pump to the suction side of the pump, so that the control loop senses the highest temperature of the fluid system.

L. Blowdown line should not be attached to the control loop. Install the blowdown line on the pressure side of the recirculating pump, preferably from the bottom of the pipe to relieve the system of accumulated solids, dirt, and debris. Heating hot water system filter blow down will require tempering before release to drain.

M. Confirm applicable electrical requirements in Division 26 Sections for connecting electrical equipment. Power and control and interlock wiring materials and labor provided by Division 16

1. Provide proper electrical ground top the equipment.
2. 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 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. Tests and Inspections:

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 systems' 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. Remove and replace malfunctioning units and retest as specified above.

D. High Efficiency Sand Filter Startup and Testing

1. Startup by factory authorized agent shall be provided. Startup and 30 day samples will be collected from the same sampling port. Startup samples are not to be taken from cooling tower basin or sump. Samples shall be collected from the sampling ports on each filter. Sampling shall be conducted after a completed backwash cycle.

2. Submit water particle analysis reports showing count and volume of particles within the following micron size ranges: 0.5 to 1, 1 to 2, 2 to 5, 5 to 10, 10 to 20, and 20 and larger at time of startup.

3. Submit water particle analysis reports showing count and volume of particles within the following micron size ranges: 0.5 to 1, 1 to 2, 2 to 5, 5 to 10, 10 to 20, and 20 and larger 30 days after startup.

4. Submit report analyzing results from D.2 and D.3 above, confirming that systems meet performance specifications in section 2.1.A.3.c. Report shall include a record of chain of custody of samples with timeline.

E. Comply with ASTM D 3370 and with the following standards:

1. Silica: ASTM D 859.
2. Acidity and Alkalinity: ASTM D 1067.
3. Iron: ASTM D 1068.
4. Water Hardness: ASTM D 1126.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train FAA's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment. Refer to Section 01 79 00 "Demonstration and Training."

END OF SECTION 23 25 00

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

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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 "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 "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

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SECTION 23 34 23 – HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Propeller fans.
2. Centrifugal roof ventilators.

1.2 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on actual Project site elevations.

B. Operating Limits: Classify according to AMCA 99.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and 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. Fan speed controllers.

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.
2. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
3. 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.

C. Coordination Drawings: Reflected ceiling plans 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. Ceiling suspension assembly members.
2. Size and location of initial access modules for acoustical tile.

3. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For power ventilators 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. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standard: Power ventilators shall comply with UL 705.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.6 COORDINATION

A. Coordinate size and location of structural-steel support members.

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. Belts: One set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.1 PROPELLER FANS

A. Known Acceptable Source:

1. Acme Engineering & Mfg. Corp.
2. Loren Cook Company.
3. Penn Ventilation.

B. Description: Direct-driven propeller fans consisting of fan blades, hub, housing, orifice ring, motor, drive assembly, and accessories.

C. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring with baked-enamel finish coat applied after assembly.

D. Steel Fan Wheels: Formed-steel blades riveted to heavy-gage steel spider bolted to cast-iron hub.

E. Fan Wheel: Replaceable, cast or extruded-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.

F. Accessories:

1. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
2. Wall Sleeve: Galvanized steel to match fan and accessory size.
3. Weathershield Front Guard: Galvanized steel with expanded metal screen.
4. Variable-Speed Controller: For direct drive units, Solid-state control to reduce speed from 100 to less than 50 percent.
5. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

2.2 CENTRIFUGAL ROOF VENTILATORS

A. Known Acceptable Source:

1. Carnes Company.
2. Greenheck Fan Corporation.
3. Loren Cook Company.
4. PennBarry.

B. Housing: Removable, galvanized steel, mushroom-domed top; square, one-piece, aluminum base with venturi inlet cone.

1. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

D. Belt Drives:

1. Resiliently mounted to housing.
2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
4. Pulleys: Cast-iron, adjustable-pitch motor pulley.
5. Fan and motor isolated from exhaust airstream.

E. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.

F. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Built-in raised cant and mounting flange.
2. Sound Curb: Curb with sound-absorbing insulation.
3. Pitch Mounting: Manufacture curb for roof slope.
4. Metal Liner: Galvanized steel.
5. Burglar Bars: 1/2-inch-thick steel bars welded in place to form 6-inch squares.
6. Mounting Pedestal: Galvanized steel with removable access panel.
7. Vented Curb: Unlined with louvered vents in vertical sides. 24" in height.

2.3 MOTORS

A. Comply with requirements in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."

B. Enclosure Type: Totally enclosed, fan cooled.

2.4 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, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Vibration-control devices are specified in Section 23 05 48 "Vibration and Seismic Controls for Mechanical Piping and Equipment."

C. Install units with clearances for service and maintenance.

D. Label units according to requirements specified in Section 23 05 53 "Identification for Mechanical Piping and Equipment."

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors.

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 26 05 19 "Low Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connection 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.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Refer to Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

C. Lubricate bearings.

END OF SECTION 23 34 23

SECTION 23 37 13 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fixed face registers and grilles.

B. Related Sections:

1. Section 23 30 00 "Duct Accessories" for volume-control dampers not integral to diffusers, registers, and grilles.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

PART 2 - PRODUCTS

2.1 REGISTERS AND GRILLES

A. Adjustable Bar Register:

1. Known Acceptable Source:

a. Anemostat Products; a Mestek company.
b. Carnes.
c. Titus.
d. Tuttle & Bailey.

2. Material: Steel.
3. Finish: Baked enamel, color selected by COR.
4. Face Blade Arrangement: Horizontal spaced 3/4 inch apart.
5. Core Construction: Integral.
6. Rear-Blade Arrangement: Vertical spaced 3/4 inch apart.
7. Frame: 1-1/4 inches wide.
8. Mounting: Countersunk screw.
9. Damper Type: Adjustable opposed blade.

2.2 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13

SECTION 23 41 13 - PANEL AIR FILTERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes factory-fabricated air-filter devices and media used to remove particulate matter from air for HVAC applications.

1.2 DEFINITIONS

A. DOP: Dioctyl phthalate or bis-(2-ethylhexyl) phthalate.

1.3 SUBMITTALS

A. Product Data: Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.

B. Shop Drawings: Include plans, elevations, sections, and details to illustrate component assemblies and attachments.

1. Show filter rack assembly, dimensions, materials, and methods of assembly of components.
2. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.

C. Operation and Maintenance Data: For each type of filter and rack to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air filters and are based on the specific system indicated.

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 ARI 850.

D. Comply with ASHRAE 52.1 and ASHRAE 52.2 for method of testing and rating air-filter units.

E. Comply with NFPA 70 for installing electrical components.

F. Comply with NFPA 90A and NFPA 90B.

1.5 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

1.6 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. Provide one complete set of filters for each filter bank.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. 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:

1. Air Filters, and Filter-Holding Systems:

a. AAF International.
b. Airguard Industries, Inc.
c. Barnebey & Sutcliffe Corp.
d. Farr Co.
e. Flanders/CSC Corp.
f. Flanders Filters, Inc.
g. Purafil, Inc.

2.2 DISPOSABLE PANEL FILTERS (30 percent filters)

A. Description: Factory-fabricated, pleated panel type, disposable air filters with holding frames and self-supporting media. The filter shall be 2 inch thick as scheduled with a minimum MERV rating of 7 and minimum 12 pleats per lineal foot. Initial resistance at 500 fpm approach velocity shall not exceed 0.30 inches w.g. The final recommended resistance shall be a minimum of 1.0 inches water gage.

2.3 EXTENDED-SURFACE, SUPPORTED-MEDIA FILTERS (65 percent filters)

A. Description: Factory-fabricated, dry, extended-surface, mini-pleat, self-supporting filters with holding frames. The filter shall have a minimum MERV rating of 11 or 14, as scheduled. The

rated filter face velocity shall be 500 fpm and initial resistance of 0.39 inches water. The final resistance shall be 1.5 inch water gage.

B. Media: Fibrous material constructed so individual pleats are maintained in tapered form by flexible internal supports under rated-airflow conditions.

C. Filter-Media Frame: Galvanized steel or hard polyurethane foam with PVC gasketing designed to ensure a positive seal against leakage of unfiltered air.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install filter frames according to manufacturer's written instructions.

B. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.

C. Install filters in position to prevent passage of unfiltered air.

D. Install filter gage for each filter bank.

E. Install filter gage static-pressure tips upstream and downstream from filters to measure pressure drop through filter. Mount filter gages on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gages.

F. Coordinate filter installations with duct and air-handling unit installations.

G. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.2 FIELD QUALITY CONTROL

A. Field Service: Inspect field-assembled components, filter and filter-frame installation, and electrical wiring. Report results in writing.

3.3 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION 23 41 13

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SECTION 23 64 16 - CENTRIFUGAL WATER CHILLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Packaged, water-cooled, electric-motor-driven centrifugal chillers.

B. Related Section:

1. Section 28 35 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. 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.

B. 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.

C. 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. Oil capacity of chiller.
6. Fluid capacity of evaporator and condenser.
7. Characteristics of safety relief valves.
8. Minimum entering condenser-fluid temperature.
9. 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. Startup service reports.

E. Operation and Maintenance Data: For each chiller to include in emergency, operation, and maintenance manuals.

F. 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.

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 charge.

b. Complete compressor and drive assembly including refrigerant charge.
c. Refrigerant charge.
d. Parts and On-site 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. Sole Source: Chillers shall match existing chillers CH-100 and CH-400 with the additional feature specified herein: Contact Matt Kling / Havtech Maryland 301.302.5514

1. Daikin/McQuay, Magnitude model WMC290, Magnetic Bearing Chiller

2.2 EVAPORATOR

A. 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 1-inch drain connection at low point and vent connection at high point, each with threaded plug.

2.3 CONDENSER

A. 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.

2.4 CONTROLS

A. Power Loss Protection Features: Include manufacturer's option control programming or hardware to compensate for power loss/interruptions:

1. RapidRestore
2. FastLoading

2.5 FINISH

A. Provide FAA with spray container of paint used in application of topcoat to use in touch-up applications after Project Closeout.

2.6 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.

2. Allow Government access to place where chillers are being tested. Notify COR 15 working days in advance of testing.

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.

D. Charge chiller with refrigerant if not factory installed.

E. 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 inlet with shutoff valve, flexible connector, thermometer, and plugged tee with pressure gage. Connect to evaporator 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 inlet with shutoff valve, flexible connector, thermometer, and plugged tee with pressure gage. Connect to condenser 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 separate 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.

END OF SECTION 23 64 16

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SECTION 23 65 00 - COOLING TOWERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Open-circuit, induced-draft, counterflow cooling towers.
2. Open-circuit, induced-draft, crossflow cooling towers.

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. Hottaps 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.

1.4 PERFORMANCE REQUIREMENTS

A. Alternate Cooling Tower Manufacturer or Model Delegated Design: Submit 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 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: Parts and Labor on-site. Manufacturer's standard form in which manufacturer agrees to repair or replace 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 on-site from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 OPEN-CIRCUIT, INDUCED-DRAFT, COUNTERFLOW COOLING TOWERS

A. Known Acceptable Source:

1. Evapco – USS series

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: 304 stainless steel casing panels. 304 stainless steel casing frame. Stainless steel casing panels to be factory or field wire brushed with orbital sander to reduce glare/reflectance.

2. Frame Material: 304 stainless steel
3. Fasteners: 304 or 316 stainless steel.
4. Joints and Seams: Sealed watertight.
5. Welded Connections: Continuous and watertight.

D. Collection Shallow Basin:

1. Material: 304 stainless steel.
2. Strainer: Removable 304 or 316 stainless steel strainer with openings smaller than nozzle orifices.
3. Overflow connection.
4. Outlet Connection: ASME B16.5, Class 150 flange.
5. 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: Schedule 10, 304 or 316 stainless steel headers. Schedule 10, 304 or 316 stainless steel laterals.
2. Spray Nozzle Material: PVC.
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: 20 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: Multipass, 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. Hub Material: 304 or 316 stainless steel.
3. Blade Pitch: Field adjustable.
4. Protective Enclosure: Removable, 304 stainless steel, wire-mesh screens, complying with OSHA regulations.
5. Fan Shaft Bearings: Self-aligning ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F. Bearings designed for an L-10 life of 50,000 hours.
6. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.

J. Gear Drive: Right angle, reduced speed, and designed for cooling tower applications according to CTI STD 111. Motor and gear drive shall be aligned before shipment for factory testing, and again onsite during tower installation and startup.

1. Gear Drive and Coupling Service Factor: 2.0 based on motor nameplate horsepower.
2. Housing: Cast iron, with epoxy or polyurethane finish, beveled high-strength steel gears continuously bathed in oil, and with lubrication to other internal parts at all operating speed ranges.
3. Mounting: Directly mounted to fan hub and connected to motor so motor shaft is in horizontal position.
4. Operation: Able to operate both forward and in reverse.
5. Drive-to-Motor Connection: Connected to motor located outside of cooling tower casing by a full-floating drive shaft.
6. Drive Shaft Material: Stainless steel, and fitted with flexible couplings on both ends. Provide exposed shaft and couplings with guards according to OSHA regulations.
7. Extend oil fill, drain, and vent to outside of cooling tower casing using stainless-steel piping. Provide installation with oil-level sight glass. Oil shall be extended service (min 5 years), synthetic.

K. 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 casing and cooling tower discharge airstream.

9. Motor Base: Adjustable, or other suitable provision for adjusting shaft alignment.

L. Fan Discharge Stack: Material shall match casing, manufacturer's standard design.

1. The fan stacks shall be manufactured of material matching casing (manufacturer's standard design).

2. Fan stack hardware shall be 300 series stainless steel with a wire-mesh, stainless-steel screen; complying with OSHA regulations.

M. 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.

N. Gear-Drive, Oil-Level Switch: Low-oil-level warning switch.

1. Switch shall, on reaching a low-oil-level set point recommended by cooling tower manufacturer, signal an alarm through the plant controls system.

O. Davit Sleeve, Jib and Crane: A removable davit crane shall be mounted on the fan deck or casing wall of the tower and shall be capable of lifting, extending, and lowering the heaviest mechanical component up to 1000 lb over the fan deck and catwalk to an accessible on-grade location beside the tower. The davit crane system shall include a weatherproof cover, winch, cable, and load hook on each tower.

P. Controls: Comply with requirements in Section 23 09 00 "HVAC Instrumentation and Controls."

Q. 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.
2. External Stair and Landings: Within each grouping of towers, a separate galvanized steel stairway, with minimum stair width of 30 inches (762 mm) and 12" tread

with a 6.75" maximum stair riser, with Code/OSHA compliant hand rails, shall be coordinated with the cooling tower catwalk system. Upper landing elevation to match access to tower motor and door. Stair and landings shall be independently supported and not be attached to the cooling tower. Comply with 29 CFR 1910.24.

3. External Ladder with Safety Cage: FRP, Aluminum or 304 stainless-steel, fixed ladder with ladder extension to access external platform and top of cooling tower from adjacent grade without the need for portable ladders. Ladders to be installed on opposite end of towers from stair. Comply with 29 CFR 1910.27. Provide self-closing ladder safety gate at guardrail level of ladder.
4. External Platform with Handrails: Each tower shall be provided with a catwalk to access the plenum level of tower and motor. The catwalk shall be provided with Code/OSHA compliant hand rail. FRP, Aluminum or 304 stainless-steel, fixed ladder to access top of cooling tower catwalk. Comply with 29 CFR 1910.24.
5. Handrail: Aluminum or 304 stainless steel posts, complete with kneerail and toeboard, around top of cooling tower to safeguard personnel while accessing components located on top of cooling tower. Comply with 29 CFR 1910.23.

R. Capacities and Characteristics: Refer to Mechanical Equipment Schedule on Drawings.

2.2 OPEN CIRCUIT, INDUCED DRAFT, CROSSFLOW COOLING TOWERS

A. Known Acceptable Source: Subject to compliance with requirements, provide product indicated on Drawings by the following:

1. Marley Cooling Technologies; an SPX Corporation – NC series.

B. Fabricate cooling tower mounting base with reinforcement strong enough to resist cooling tower movement during a wind force event when cooling tower is anchored to field support structure.

C. Casing and Frame:
1. Casing and Frame Material: Fiberglass or 304 stainless steel casing panels. 304 stainless steel casing frame. Stainless steel casing panels to be factory or field wire brushed with orbital sander to reduce glare/reflectance.
2. Frame Material: 304 Stainless steel.
3. Fasteners: 304 or 316 Stainless steel.
4. Joints and Seams: Sealed watertight.
5. Welded Connections: Continuous and watertight.

D. Collection Basin:

1. Material: 304 Stainless steel.
2. Strainer: Removable 304 or 316 stainless steel strainer with openings smaller than nozzle orifices.
3. Overflow connection.
4. Outlet Connection: ASME B16.5, Class 150 flange.
5. Isolation plate between adjacent cells of multiple-cell towers.

E. Gravity Water Distribution Basin: Nonpressurized design with head of water level in basin adequate to overcome spray nozzle losses and designed to evenly distribute water over fill throughout the flow range indicated.

1. Basin Material: 304 or 316 Stainless steel with easily replaceable plastic spray nozzles mounted in bottom of basin.
2. Basin Location: Over each bank of fill.
3. Pipe Material: Schedule 10, 304 or 316 stainless steel.
4. Piping Supports: 304 or 316 stainless steel hangers and supports to resist movement during operation and shipment.
5. Valves: Manufacturer's standard valve installed at each basin inlet connection to balance or shut off flow to each gravity distribution basin.
6. Inlet Connection: ASME B16.5, Class 150 flange.
7. Joints and Seams: Sealed watertight.
8. Flow control: nozzles or cups designed to distribute water over the fill to minimize icing while operating throughout the flow range indicated. Basin/nozzle design shall accommodate a maximum tower transitional flow of +140% of design flow range shown.
9. Removable Panels: Same material as basin to completely cover top of basin. Secure panels to basin with removable stainless-steel hardware.
10. Single-Inlet, Field Pipe Connection: Stainless-steel or PVC pipe arranged to provide balancing of flow within cooling tower cell without the need for additional balancing valves. Pipe each cooling tower cell internally to a single, field connection suitable for mating to ASME B16.5, Class 150 flange and located on the side unless otherwise indicated.
11. Point of connection to field piping shall be flanged.

F. Fill:

1. Materials: PVC, with maximum flame-spread index of 5 according to ASTM E 84.
2. Minimum Thickness: 20 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. Drift Eliminator:

1. Material: FRP or PVC; 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: Multipass, designed and tested to reduce water carryover to achieve performance indicated.
4. Location: Separate and removable from fill.

H. Air-Intake Louvers:

1. Material: FRP or Stainless Steel.
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.

4. Location: Integral to fill.

I. Removable Air-Intake Screens: 304 or 316 stainless-steel wire mesh.

J. Axial Fan: Balanced at the factory after assembly.

1. Blade Material: FRP, Aluminum or Stainless steel.
2. Hub Material: 304 or 316 Stainless steel.
3. Blade Pitch: Field adjustable.
4. Protective Enclosure: Removable, 304 stainless-steel, wire-mesh screens complying with OSHA regulations.
5. Fan Shaft Bearings: Self-aligning ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F. Bearings designed for an L-10 life of 50,000 hours.
6. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.

K. Gear Drive: Right angle, reduced speed, and designed for cooling tower applications according to CTI STD 111. Motor and gear drive shall be aligned before shipment for factory testing, and again onsite during tower installation and startup.

1. Gear Drive and Coupling Service Factor: 2.0 based on motor nameplate horsepower.
2. Housing: Cast iron, with epoxy or polyurethane finish, beveled high-strength steel gears continuously bathed in oil, and with lubrication to other internal parts at all operating speeds.
3. Mounting: Directly mounted to fan hub and connected to motor so motor shaft is in horizontal position.
4. Operation: Able to operate both forward and in reverse.
5. Drive-to-Motor Connection: Connected to motor located outside of cooling tower casing by a full-floating drive shaft.
6. Drive Shaft Material: Stainless steel, and fitted with flexible couplings on both ends. Provide exposed shaft and couplings with guards according to OSHA regulations.
7. Extend oil fill, drain, and vent to outside of cooling tower casing using stainless-steel piping. Provide installation with oil-level sight glass. Oil shall be extended service (min 5 years), synthetic.

L. Fan Motor:

1. General Requirements for Fan Motors: Comply with NEMA designation and temperature-rating requirements specified in Division 23 Section "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 casing and cooling tower discharge airstream.
9. Motor Base: Adjustable, or other suitable provision for adjusting shaft alignment.

M. Fan Discharge Stack:

1. The fan stacks shall be manufactured of material matching casing (manufacturer's standard design).
2. Fan stack hardware shall be 300 series stainless steel with a wire-mesh, stainless-steel screen; complying with OSHA regulations.

N. 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.

O. Gear-Drive, Oil-Level Switch: Low-oil-level warning switch.

1. Switch shall, on reaching a low-oil-level set point recommended by cooling tower manufacturer, signal an alarm through the plant controls system.

P. Davit Sleeve, Jib and Crane: A removable davit crane shall be mounted on the fan deck or casing wall of the tower and shall be capable of lifting, extending, and lowering the heaviest mechanical component up to 1000 lb over the fan deck and catwalk to an accessible on-grade location beside the tower. The davit crane system shall include a weatherproof cover, winch, cable, and load hook on each tower.

Q. Controls: Comply with requirements in Section 23 09 00 "HVAC Instrumentation and Controls."

R. 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.
2. External Stair and Landings: Within each grouping of towers, a galvanized steel stairway, with minimum stair width of 30 inches (762 mm) and 12" tread with a 6.75" maximum stair riser, with Code/OSHA compliant hand rails, shall be coordinated with the cooling tower access points. Stair and landings shall be independently supported and not be attached to the cooling tower. Comply with 29 CFR 1910.24.
3. External Ladder with Safety Cages: Aluminum or 304 stainless-steel, fixed ladders with ladder extensions to access external platforms and top of cooling tower from adjacent grade without the need for portable ladders. Ladders to be installed on opposite end of towers from stair tower. Comply with 29 CFR 1910.27. Provide self-closing ladder safety gate at guardrail level of ladder.
4. External Platforms with Handrails: Aluminum, FRP, or 304 stainless-steel bar grating at cooling tower access doors when cooling towers are elevated and not accessible from grade. Platform and ladder shall be provided for access to motor.
5. Handrail: Aluminum or 304 stainless steel posts, complete with kneerail and toeboard, around top perimeter of cooling tower to safeguard personnel while accessing components located on the fan deck of the cooling tower. Comply with 29 CFR 1910.23.
6. Internal Platforms: Aluminum, FRP, or 304 stainless-steel bar grating.

    a. Spanning the collection basin from one end of cooling tower to the other and positioned to form a path between the access doors. Platform shall be elevated so that all parts are above the high water level of the collection basin.
    b. Elevated internal platforms with handrails accessible from fixed vertical ladders to access the fan drive assembly when out of reach from collection basin platform.

2.3 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. Provide a minimum of 2 sessions, with each session a minimum of 4 hours.

END OF SECTION 23 65 00

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SECTION 23 73 13 - MODULAR INDOOR CENTRAL STATION AIR HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Constant-air-volume, single-zone air-handling units.

1.2 PERFORMANCE REQUIREMENTS

A. Structural Performance: Casing panels shall be self-supporting and capable of withstanding 133 percent of internal static pressures indicated, without panel joints exceeding a deflection of L/200 where "L" is the unsupported span length within completed casings.

1.3 SUBMITTALS

A. Product Data: For each air-handling unit indicated.

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.

B. 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.
4. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

C. Source quality-control reports.

D. Field quality-control reports.

E. Operation and Maintenance Data: For air-handling units 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, 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. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.

D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

E. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

F. Comply with NFPA 70.

1.5 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.

1.6 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. Gaskets: One set(s) for each access door.
2. Fan Belts: One set(s) for each air-handling unit fan.

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:

1. Carrier Corporation; a member of the United Technologies Corporation Family.
2. McQuay
3. Temtrol
4. Trane; American Standard Inc.
5. YORK International Corporation.

2.2 DOUBLE WALL 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.

2.3 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.

2.4 COIL SECTION

A. General Requirements for Coil Section:

1. Comply with ARI 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.

2.5 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.

2.6 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.

2.7 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.

2.8 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. Reject 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 23 73 13

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SECTION 23 81 23 - COMPUTER-ROOM AIR CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Floor-mounted computer-room air conditioners, 6 tons and larger.

1.2 DEFINITION

A. BAS: Building automation system.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For computer-room air conditioners. 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. Field quality-control reports.

D. Operation and Maintenance Data: For computer-room air conditioners to include in emergency, operation, and maintenance manuals.

E. Warranty: Sample of special warranty.

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. 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 62.1-2004, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004.

D. ASME Compliance: Fabricate and label water-cooled condenser shell to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

1.5 COORDINATION

A. Coordinate layout and installation of computer-room air conditioners and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.6 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: Manufacturer's standard, but not less than 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. Fan Belts: One set for each belt-driven fan.
2. Filters: One set of filters for each unit.

PART 2 - PRODUCTS

2.1 FLOOR-MOUNTED UNITS

A. Known Acceptable Sources, AHU-105 & AHU-106:

1. Data Aire Inc.
2. Liebert Corporation. – Basis of Design
3. Stulz-ATS.

B. Known Acceptable Sources, AHU-21: Unit shall match existing units AHU-22, 23, & 24.

1. Compu-Aire, System 2000 model CAC-5034.

C. Description: Packaged, factory assembled, prewired, and prepiped; consisting of cabinet, fans, filters, humidifier, and controls.

D. 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 62.1-2004.
4. Finish of Exterior Surfaces: Baked-on, textured vinyl enamel; color as selected from manufacturer's standard colors

E. Supply-Air Fan(s):

1. Double-inlet, forward-curved centrifugal fan(s); statically and dynamically balanced.
2. Drive: V-belt, with steel shaft with self-aligning ball bearings and cast-iron or steel sheaves, variable- and adjustable-pitch motor sheave, minimum of two matched belts, with drive rated at a minimum of two times the nameplate rating of motor.

F. Hydronic Cooling Coil: Seamless copper tubes expanded into aluminum fins with modulating two-way control valve.

1. Cooling Medium: Water.
2. Control Valve: Class 125 body.

a. Maximum Pressure Drop: 5 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 62.1-2004 and having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir.

G. Extended-Surface, Disposable, Panel Filter: Pleated, lofted, nonwoven, reinforced cotton fabric; supported and bonded to welded-wire grid; enclosed in cardboard frame.

1. Thickness: 4 inches.
2. Initial Resistance: 0.25 inches wg.
3. Recommended Final Resistance: 1.00 inches wg.
4. Arrestance (ASHRAE 52.1): 80-90 percent.
5. MERV (ASHRAE 52.2): MERV 7 (30 percent)

H. 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. HOA switch for fan control

I. Disconnect Switch: Nonautomatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

J. 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. Smoke/fire.
   g. Supply fan overload.

2. Digital Display:

   a. Control power on.
   b. Dehumidifying.

3. Push buttons shall stop and start process cooling system, silence audible alarm, test indicators, and display room's relative humidity.
4. Control Interface: Factory- and/or field-installed hardware and software to enable the Direct Digital Control System (DDCS) to monitor, control, and display unit status and alarms.

   a. Hardwired Points:

      1) Monitoring: On-off status, common trouble alarm, and space temperature.
      2) Control: On-off operation, and space temperature set-point adjustment.

   b. Network/Software Points: Refer to "DDCS Point Function Schedule" on the mechanical plans for a complete list of control and monitoring points.

   c. Provide a network interface between the unit control panel and the DDCS that is fully compatible with the DDCS to allow remote control and monitoring of unit. If a remote panel is required for the interface, provide conduit and wiring between unit 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."

2.2 FAN MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "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, HOA Switch and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 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.

B. Computer-Room Air-Conditioner Mounting: Install using elastomeric pads. Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

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 machine to allow service and maintenance.

C. Drainage Connections: Comply with applicable requirements in Division 23 Section "Domestic Water Piping." Provide adequate connections for condensate drain.

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 FAA's maintenance personnel to adjust, operate, and maintain computer-room air conditioners. Provide two shifts of training 4 hours each session. Refer to Section 01 79 00 "Demonstration and Training."

END OF SECTION 23 81 23

SECTION 23 82 39 - 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 electric-resistance heating coils.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. CWP: Cold working pressure.

C. PTFE: Polytetrafluoroethylene plastic.

D. 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. Suspended ceiling components.
2. Structural members to which propeller unit heaters will be attached.
3. Method of attaching hangers to building structure.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:

a. Lighting fixtures.
b. Air outlets and inlets.
c. Speakers.
d. Sprinklers.
e. Access panels.

B. Seismic Qualification Certificates: Submit certification that propeller unit heaters, accessories, and components will withstand seismic forces defined in Section 23 05 48 "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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Airtherm; a Mestek company.
2. Engineered Air.
3. McQuay International.
4. Rosemex Products.

5. Ruffneck Heaters; a division of Lexa Corporation.
6. Trane Inc.

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 propeller unit-heater coils according to ASHRAE 33.

B. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in steel or corrosion-resistant

metallic sheath with fins no closer than 0.16 inch. Element ends shall be enclosed in terminal box. Fin surface temperature shall not exceed 550 deg F at any point during normal operation.

1. Circuit Protection: One-time fuses in terminal box for overcurrent protection and limit controls for high-temperature protection of heaters.
2. Wiring Terminations: Stainless-steel or corrosion-resistant material.

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, multispeed. 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 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 spring hangers with vertical-limit stop. Hanger rods and attachments to structure are specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment." Vibration hangers are specified in Section 23 05 48 "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. Comply with safety requirements in UL 1995.

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 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.

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 23 82 39

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SECTION 23 84 13 - HUMIDIFIERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following humidifiers:

1. Self-contained electronic.

1.2 DEFINITION

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.

1.3 SUBMITTALS

A. Product Data: 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, manifolds, and attachments to other work.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For humidifiers to include in 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. Comply with ARI 640, "Commercial and Industrial Humidifiers."

1.5 COORDINATION

A. Coordinate location and installation of humidifiers with manifolds in ducts and air-handling units or occupied space. Revise locations and elevations to suit field conditions and to ensure proper humidifier operation.

1.6 WARRANTY

A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace equipment that fails in materials or workmanship within specified warranty period.

1. Warranty Period: 1 year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SELF-CONTAINED HUMIDIFIERS

A. Known Acceptable Source:

1. Dri-Steem Corp.
2. Herrmidifier.
3. Nortec Industries Inc.

B. Electric Steam Generating Humidifiers

1. General: Electronic electrode type UL listed steam generator, designed to operate with potable untreated water. Incorporate an automatic control system to monitor the contained water conductivity, and control the fill and drain rates to maximize container life and minimize energy consumption. The automatic control system shall allow and compensate for varying entering water conditions without having to change electrode spacing. The unit shall have a minimum capacity as indicated and shall be adjusted to compensate for any condensate losses. Humidifier shall include modulating control to automatically provide 10 percent to 100 percent of rated capacity.
2. Humidifier Cabinet: The humidifier cabinet shall be steel. Cabinet shall have separate removable control compartment. The cabinet shall house the steam generator and related appurtenances and the microprocessor control system.
3. Humidifier Tank: The humidifier tank shall be stainless steel with heli-arc welded seams and quick removal cover. Provide evaporating chamber insulation, minimum ¾" thick rigid foil faced external fiberglass insulation. The tanks can be taken apart for inspection, cleaning, and repair, or disposed of and replaced. Humidifier shall include tray to catch and hold minerals to facilitate periodic clean-out. Heating elements shall be Incoloy alloy sheathed resistance type heaters designed of no more than 95 watts per square inch with manual reset thermal overload protection. The humidifier monitor shall indicate when the tank is dirty. Humidifiers with disposable cylinders will not be accepted.
4. Steam distribution: Humidifier shall discharge pure steam, with no mineral dust carry over, through factory built steam distribution panels. Distribution panels shall be manufacturer's standard type suitable for application with the specified humidifier. Distribution panels shall incorporate a condensate separator and condensate drain to remove condensate from the distribution panel.

a. Steam piping: Provide copper insulated piping between humidifier and dispersion panel in accordance with Section 23 31 13 "Hydronic Piping" and Section 23 07 13 "HVAC Insulation."

5. Controls: The microprocessor control system with keypad interface and LCD display shall provide monitoring and control for unit operation. The electronic water level control shall provide automatic refill, low water cut-off and periodic flush cycles. System shall consist of: A microprocessor control system with step down transformer, water level sensing unit, a solenoid operated fill valve mounted in the evaporator compartment, electronic level control and timer flush control integral to the unit, motor driven brass bodied drain valve mounted in the evaporator compartment, and full SCR modulating control for operation range of 20 percent to 80 percent R.H.
6. Humidifier shall have a disconnect switch in accordance with NEC 430.

C. Accessories: Include the following:

1. Water tempering device: Stainless steel mixing chamber with water tempering valve designed to mix cold water with condensate from the humidifier to limit the temperature of the discharged condensate below 140 degrees F. Provide separate support for water tempering device; unit shall not be supported by piping. Unit shall not require electricity. Unit shall include vacuum breaker to prevent backflow into cold water supply.
2. Humidistat: Refer to Section 23 09 00 "HVAC Instrumentation and Controls".
3. Duct-mounting, high-limit humidistat: Refer to Section 23 09 00 "HVAC Instrumentation and Controls".
4. Airflow switch for preventing humidifier operation without airflow.

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 62.1-2004.

B. Seal humidifier manifold duct or plenum penetrations with flange.

C. Install humidifier manifolds in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

D. Install stainless-steel drain pan under each manifold mounted in duct.

1. Construct drain pans with connection for drain; insulated and complying with ASHRAE 62.1-2004.
2. Connect to condensate trap and drainage piping.
3. Extend drain pan upstream and downstream from manifold a minimum distance recommended by manufacturer but not less than required by ASHRAE 62.1-2004.

E. Install manifold supply piping pitched to drain condensate back to humidifier.

F. Install drip leg upstream from steam trap a minimum of 12 inches tall for proper operation of trap.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 and 23 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 electrical devices and piping specialties furnished by manufacturer but not factory mounted.

C. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 26 05 19 "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. Perform tests and inspections and prepare test reports.

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, 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.

D. Remove and replace malfunctioning units and retest as specified above.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train FAA's maintenance personnel to adjust, operate, and maintain humidifiers. Provide two shifts of training 4 hours each session. Refer to Section 01 79 00 "Demonstration and Training."

END OF SECTION 23 84 13

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SECTION 26 05 00 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 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 equipment.
2. Indoor and outdoor lighting systems.
3. Raceways and wiring 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. Touchup painting.
11. All other work indicated on drawings or specification or necessary for the operation of the complex.

C. This Section includes limited general scope of general construction materials for application with electrical installations 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.

1.2 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 relieve the contractor from furnishing and installing higher grades of materials and workmanship when so required by this specification. Adherence to this specification shall not relieve 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. Institute of Electrical and Electronic Engineers (IEEE)

1. 519: Recommended practices and requirements for harmonic control and electrical power systems.

C. National Electrical Manufacturers Association (NEMA)

1. WC5: Thermoplastic insulated wire and cable for transmission and distribution of electrical energy.
2. WC7: Cross-linked thermosetting polyethylene insulated wire and cable for the transmission and distribution of electrical energy.

D. National Fire Protection Association (NFPA)

1. 70: National Electrical Code (NEC), 2014 edition.

E. National Electrical Contractors Association (NECA)

1. Standard of installation.

F. Occupational Safety and Health Administration (OSHA)

1. 29 CFR 1910.7: Description and Requirements for a Nationally Recognized Testing Laboratory (NRTL).

G. Underwriters Laboratories (UL)

1. 486A: Wire connectors and soldering lugs for use with copper conductors.

1.3 SUBMITTALS

A. Contractor Provided Electrical Equipment Reference Material: 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 system or systems to be furnished.

2. Repair instructions shall include equipment disassembly, repair, replacement, and re-assembly. Checkout or test data shall also be provided. Reprogramming instructions shall be provided for equipment having a programmable memory. Re-packing 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 capability 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 burial 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 wire and terminal block numbers, conductor color coding, device designations, locations, and shall indicate identifications established at the site; and;
3. Cable and conduit schedule for cables and conduits actually installed; include the type, size, origin, destination, and approximate length for each cable 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 a 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 deviations from requirements listed below:

1. Maximum plus or minus five percent 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 ten percent 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 COR to ensure minimal impact to existing utilities and areas known to contain hazardous materials.

F. Submit short circuit and overcurrent protective device coordination study, and arc-flash analysis.

1.4 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.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Contractor Provided Equipment: 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; and the batteries shall be charged.

1.6 SEQUENCING AND SCHEDULING

A. Coordinate electrical equipment installation with other building components.

B. Arrange for chases, slots, and openings in building structure during progress of construction to allow for electrical installations.

C. Coordinate installing required supporting devices and set sleeves in poured-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 requirements for access panels and doors where electrical items requiring access are concealed by finished surfaces. Access panels and doors are specified in Section 08 11 13 "Metal Doors and Frames."

G. Coordinate installing electrical identification after completion of finishing where identification is applied to field-finished surfaces.

H. Coordinate installing electrical identifying devices and markings prior to installing acoustical ceilings and similar finishes that conceal such items.

I. 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 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 30 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 not 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, Raceway Supports, Sleeves, and Fasteners: As specified in Section 26 05 29 "Hangers and Supports 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 1217f "Electrical Work, Interior."

B. Where manufacturers 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 the 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. Connect for ease of disconnecting, with minimum interference with other installations.

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 will be inspected by 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. Firestopping: Apply to cable and raceway penetrations of fire-rated floor and wall assemblies. Perform firestopping as specified in Section 07 84 13 "Penetration Firestopping" to reestablish the original fire-resistance rating of the assembly at the penetration.

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."

D. Install identification devices where required in accordance with the requirements of Section 26 05 53 "Identification for Electrical Systems."

E. 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 cables with equivalent conductor insulation rating and of less than 600 volts may be installed in the same duct.
    b. Power cables shall not be installed in the same duct with control, telephone, or signal type cables.

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 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for electrical installations. Perform cutting by skilled mechanics of the trades involved.

B. Repair disturbed surfaces to match adjacent undisturbed surfaces.

3.4 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. Abandoned Work: For buried raceway and wiring, indicated to be abandoned in place, remove all wires and cables in their entirety. Cut and remove buried raceway 2 inches below the surface of adjacent construction. Permanently cap raceways and structurally patch surface to match existing finish.

D. Remove demolished material from Project site.

E. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

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 COR at least 21 calendar days prior to conducting tests. Unless otherwise indicated, the contractor shall furnish all test instruments, materials and labor necessary to perform tests designated in Division 26 Sections. All tests shall be performed in the presence of the COR. All instruments shall have been calibrated within a period of 1 year preceding testing. Calibrations shall be traceable to applicable industry recognized standards.

B. 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 be limited to, flow and pressure controls, temperature controls and system interlocks and alarms.

C. 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 system as installed.

D. Complete the Electrical Test Report included as Attachment No. 1. Provide the requested information for each panelboard and its power supply conductors. 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. Notify the COR in writing 21 days prior to conducting tests.

E. Insulation Resistance Tests: Insulation tests shall be performed for all feeder and branch circuit conductors (new or re-used) prior to 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 500-volt 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 megohmmeter form located at the end of this Section (Attachment 2).
3. In Lighting, Power, Miscellaneous Power and Receptacle single pole (1P) branch circuit Panelboards, test any random four (4) branch circuits (consisting of a phase conductor, a neutral and a grounding conductor) within a 42 pole Panelboard or test one branch circuit per every ten (10) branch circuits. If more than ten (10) test points are above the specified value, then all branch circuit wiring for both 120 volts and 277 volts 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 conductor, 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 (1P), 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 (HP) supply and exhaust fan motors, close circuit the switch.
    b. Perform a continuity test and then an insulation 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 Overcurrent Circuit Protective Device (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 Overcurrent Circuit Protective Device (OCPD), which will be a single pole (1P), 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 circuit conductors from the first High Intensity Discharge (HID) or Fluorescent lighting fixture in the circuit. Failure to do so can damage all lighting fixture ballasts in the circuit and will also give false, very poor and very low readings. High Intensity Discharge (HID) lamps consist of Mercury Vapor (MV), Metal Halide (MH), Super Metal Halide (SMH), High Pressure Sodium (HPS), High Color Rendering Index High Pressure Sodium (High CRI HPS) and Low Pressure Sodium (SOX) lamps. A continuity test can be performed with all of the HID and Fluorescent 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 be 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 or 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 Overcurrent Circuit Protective Device (OCPD)/ Molded Case Branch Circuit Breaker.

F. No 120 volt, single pole (1P) 100 amp, E-frame nor any 277 volt, single pole (1P), 150 amp, EH frame, molded case circuit breaker is required to be tested. All two pole (2P) and all three pole (3P), molded case, insulated case and draw out power circuit breakers in both 208 volt and 480 volt 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 manufacturers 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.

G. Load Balancing: After Substantial Completion of electrical systems, redistribute the loads where there is a greater than a twenty percent difference between readings in two or more phases, in accordance with Section 26 24 18 "Panelboards".

END OF SECTION 26 05 00

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 SWITCHBOARD			
LOCATION			
MANUFACTURER			
TYPE			
FEEDER OC PROTECTION			
FEEDER CONDUCTOR SIZE			
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 GROUND									
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 _____
Project No._____

Date _____ Sheet No. ____ of ____
Address_____

NOTE: 500 VOLT MEGOHMETER, MEGGER ALL PHASES, RECORD MINIMUM READING

Panel No. Ckt. No. Feeder No.	VOLTS	A-B	A-C	B-C	A-N	B-N	C-N	A-G	B-G	C-G	N-G	SUPERVISOR O.K.

DISTRIBUTION: CENTRAL RECORDS
RE/ENGINEER
CONTRACTOR

_____
RE/ENG/DATE

_____
Contractor Supervisor/Date

SECTION 26 05 19 - LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes building wires and cables and associated splices, connectors, and terminations for wiring systems rated 600 volts and less.

1.2 REFERENCE STANDARDS

A. National Electrical Manufacturers Association (NEMA)

1. WC3: Rubber insulated wire and cable for the transmission and distribution of electrical energy.
2. WC5: Thermoplastic insulated wire and cable for the transmission and distribution of electrical energy.
3. WC26: Wire and cable packaging.

B. Federal Standards (FS)

1. W-S-610: Splice connectors
2. QQ-W-343: Wire, electrical, copper, uninsulated.

C. National Electrical Contractors Association (NECA)

1. Standard of Installation.

D. InterNational Electrical Testing Association (NETA)

1. ATS: Acceptance testing specification for electric power distribution equipment and systems.

E. National Fire Protection Association (NFPA)

1. 70: National Electrical Code (NEC), 2014 edition.

F. Occupational Safety and Health Administration (OSHA)

1. 29 CFR 1910.7: Definitions and requirements for a Nationally Recognized Testing Laboratory (NRTL).

G. Underwriters Laboratories (UL)

1. 486A: Wire connectors and soldering lugs for use with copper conductors.
2. 486C: Splicing wire connectors.
3. 486E: Equipment wiring terminal for use with aluminum and/or copper conductors.

1.3 SUBMITTALS

A. Product data for wires and cables. Field test reports indicating and interpreting test results relative to compliance with performance requirements of testing standard.

1.4 QUALITY ASSURANCE

A. Testing Firm Qualifications: An independent testing firm shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1910.7, or shall be a full member company of the International Electrical Testing Association (NETA).

1. Testing Firm's Field Supervisor Qualifications: A person currently certified by the NETA National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Comply with NFPA 70 for components and installation.

C. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms "Listed and Labeled": As defined in the NEC, Article 100.
2. Listing and Labeling Agency Qualifications: A NRTL as defined in OSHA Regulation 1910.7.

D. Installer Qualifications: Cable splices shall be performed by experienced and qualified cable splicers. The workmen shall be licensed if required by the authority having jurisdiction.

1.5 SEQUENCING AND SCHEDULING

A. Coordination: Coordinate layout and installation of cable with other installations.

1. Revise locations and elevations from those indicated as required to suit field conditions and as approved by the COR.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver wire and cable according to NEMA WC-26.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

1. Wires and Cables:

a. American Insulated Wire Corporation, Leviton Manufacturing Co.
b. Senator Wire & Cable Co.
c. Southwire Co.

2. Connectors for Wires and Cables:

a. Anderson, Square D Co.
b. Electrical Products Division, 3M Co.
c. O-Z/Gedney Unit, General Signal.

2.2 BUILDING WIRES AND CABLES

A. UL-listed building wires and cables with conductor material, insulation type, cable construction, and rating as specified in Part 3 "Applications" Article.

B. Rubber Insulation: Conform to NEMA WC 3.

C. Thermoplastic Insulation: Conform to NEMA WC 5.

D. Solid conductor for 10 AWG and smaller; stranded conductor for larger than 10 AWG.

E. All wire and conduit sizes are based on copper conductors with 75 degrees insulation.

F. Size: Minimum 12 AWG. Wires size shall be dictated by voltage drop calculations. As a guideline, minimum 10 AWG for 120 volt circuits where circuit length (one way) exceeds 75 feet from source, and 8 AWG for 120 volt circuits where circuit length (one way) exceeds 150 feet from source. CCTV and door access systems wiring size shall be per drawings. Communication systems wiring size shall be in accordance with Manufacturer's requirements.

1. Stranded conductors may be used with wire compression connectors or a pressure washer type lug.
2. Stranded conductors smaller than 10 AWG are allowed in applications where vibration and flexing may be encountered.

G. Material: Copper only.

H. Conductor Color Codes: Refer to Section 26 05 53 "Identification for Electrical Systems," for conductors No. 4 AWG and larger, where factory color coding is not available.

1. Feeder conductors to panels and three phase circuits shall be factory color coded as indicated:

a. 208/120 (240) 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.

2. Single-phase branch circuits shall be factory color coded as stated above, or identified in accordance with Section 26 05 53 "Identification for Electrical Systems."

I. Uninsulated conductors shall be copper and comply with F.S. QQW-343.

2.3 CONNECTORS AND SPLICES

A. UL-listed factory-fabricated wiring connectors of size, ampacity rating, material, and type and class for application and for service indicated. Select to comply with Project's installation requirements and as specified in Part 3 "Applications" Article.

B. Connectors, Splice Sleeves and Terminal Lugs: Wire and cable connectors, lugs, and sleeves shall be in compliance with UL 486A, and the following:

1. 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; and
2. Use ring tongue compression type terminators with insulated barrel on all stranded conductors used in control wiring.
3. Crimp type connectors are not permitted on solid conductors.

C. Insulating Tape: ASTM D1000. As a minimum, rate equal to conductor insulation. Rubber tape shall be silicon rubber with silicon pressure sensitive adhesive.

D. 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 APPLICATIONS

A. Feeders: Type THHN/THWN, copper conductor, in raceway.

B. Indoor Branch Circuits: Type THHN/THWN, copper conductor, 75 degree C wet conditions and 90 degree C dry conditions insulation in raceway.

C. Exterior Branch Circuits: Type THHN/THWN, copper conductor, 75 degree C wet conditions and 90 degree C dry conditions insulation in raceway.

3.3 INSTALLATION

A. Install wires and cables as indicated, according to manufacturer's written instructions and the NECA "Standard of Installation."

B. Pull conductors into raceway simultaneously where more than one is being installed in same raceway.

1. Use pulling compound or lubricant where necessary; compound used must not deteriorate conductor nor insulation, and must be non-flammable.
2. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.

C. Cable shall be installed in a manner to prevent harmful stretching of the conductor, injury to the insulation or damage to the outer protective covering.

D. Install exposed cable, parallel and perpendicular to surfaces or exposed structural members, and follow surface contours where possible.

E. The ends of cables shall be sealed with moisture-seal tape before pulling, and shall be left sealed until connections are made.

F. Conductor Splices:Conductors in critical power systems shall not be spliced.

1. Splices shall be made only at outlets, junction boxes, or accessible raceways.
2. Splices shall be made with solderless connectors conforming to FS W-S-610.
3. Wire nuts may only be used to splice conductors sized No. 10 AWG and smaller.
4. Compression connectors shall be used to splice conductors No. 8 and larger. Only hydraulic crimps are acceptable.
5. All splices, including those made with insulated wire nuts, shall be insulated with electrical tape or heat-shrink tubing to a level equal to that of the factory insulated conductors.
6. Splicing of ungrounded conductors in panelboards is not permitted.
7. Splices shall be made with solderless connectors conforming to UL 486A, UL 486C, and UL 486E.
8. Install splices and insulating tapes that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.
9. Use splice and tap connectors that are compatible with conductor material.
10. Splicing methods and material shall be of a type recommended by the manufacturer of the splicing material for the particular type of cable being spliced and shall be approved by the COR prior to installation.

G. Wiring at Outlets: Install with at least 6 inches of slack conductor at each outlet.

H. Connect outlets and components to wiring and to ground as indicated. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL Standard 486A.

I. Conductors for critical circuits, emergency lighting, and security systems shall be kept completely independent from any other system as well as each other.

J. Cables/conductors sizes 250 kcmil and greater shall be installed with the use of a hydraulic cable bender. Cable supports shall be required for stress relief.

K. A splice shall not be pulled into a duct or conduit under any circumstance.

L. Separate neutral and ground wires shall be provided for each overcurrent protection device. Each branch circuit shall have its own neutral and ground conductor. Common neutral or ground conductors are not acceptable. System furniture shall be procured with dedicated neutrals and grounds.

M. Install electrical identification devices specified in Section 26 05 23 "Identification for Electrical Systems" at terminations, immediately after installing wires and cables.

N. Install conductors only after the raceway system is complete.

3.4 FIELD QUALITY CONTROL

A. Testing, General: Cables shall be tested prior to installation and again upon completion of the installation. Testing shall be accomplished before connection is made. Tests shall be performed in the presence of the COR.

1. Upon installation of wires and cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

    a. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA Standard ATS, Section 7.3.1. Certify compliance with test parameters.
    b. Test wire and cable for continuity or circuitry, and also for short circuits.

B. Insulation Resistance Tests: Insulation tests shall be performed for all feeder and branch circuit conductors (new or re-used) prior to 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 500-volt DC insulation resistance. The contractor shall submit a letter type test report to the COR 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. Contractor shall use Megger Test Report Form located at the end of Section 26 05 00 "Common Work Results for Electrical".

C. Correct malfunctioning products at site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units, and retest.

END OF SECTION 26 05 19

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SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes solid grounding of electrical systems and equipment and basic requirements for grounding for protection of life, equipment, circuits, and systems. Grounding requirements specified in this Section may be supplemented in other Sections of these Specifications.

1.2 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. B3: Soft or Annealed Copper Wire.
2. B8: Concentric-Lay-Stranded Copper Conductors, Hard, Medium Hard, or Soft.
3. B33: Tinned Soft or Annealed Copper Wire for Electrical Purposes.

B. Federal Aviation Administration (FAA)

1. FAA-C-1217f Electrical Work, Interior.
2. FAA-STD-019e Lightning and Surge Protection, Grounding Bonding and Shielding Requirements for Facilities and Electronic Equipment.

C. Institute of Electrical and Electronic Engineers (IEEE)

1. 81: Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
2. 1100: Powering and grounding sensitive electronic equipment.

D. InterNational Electrical Testing Association (NETA)

E. National Fire Protection Association (NFPA)

1. 70: National Electrical Code (NEC), 2011 edition.
2. 780: Standard for Installation of Lightning Protection System.

F. Occupational Safety and Health Administration (OSHA)

1. 29CFR 1910.7: Definitions and requirements for Nationally Recognized Testing Laboratories (NRTL).

G. Underwriters Laboratories (UL)

1. 486A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.
2. 467: Grounding and Bonding Equipment.

1.3 SUBMITTALS

A. Product data for connectors and connection materials, and grounding fittings.

B. Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

C. Field tests and observation reports certified by the testing organization and indicating and interpreting the test reports for compliance with performance requirements.

D. Provide operation and maintenance information. Refer to Section 01 78 23 "Operation and Maintenance Data."

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: A NRTL as defined in OSHA Regulation 1910.7, or a full member company of NETA.

1. Testing Agency Field Supervision: Use persons currently certified by NETA or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Comply with NFPA 70 and 780.

C. Comply with UL 467.

D. 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: A NRTL as defined in OSHA Regulation 1910.7.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Erico Inc.; Electrical Products Group.
2. Kearney.
3. Thomas & Betts, Electrical.

2.2 WIRE AND CABLE GROUNDING CONDUCTORS

A. Comply with Section 26 05 19 "Low Voltage Electrical Power Conductors and Cables." Conform to NEC Table 8, except as otherwise indicated, for conductor properties, including stranding.

1. Material: Copper. Use only copper wire for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.
2. Size: Minimum allowable size shall not be less than #12 AWG, in addition to compliance with NEC.

B. Equipment Grounding Conductors: Insulated with green color insulation and shall be sized per NEC 250.122.

C. Bare Copper Conductors: Conform to the following:

1. Solid Conductors: ASTM B3.
2. Assembly of Stranded Conductors: ASTM B8.
3. Tinned Conductors: ASTM B33.

2.3 MISCELLANEOUS CONDUCTORS

A. Braided Bonding Jumpers: Where electrical continuity across the shock mounts is necessary, bonding jumpers shall be installed across each shock mount. Jumpers of this application should have a maximum thickness of 0.025 inch, so that the damping efficiency of the mount is not impaired. In severe shock and vibration environments, solid straps may be corrugated, or flexible wire braid may be used. Braids are to be terminated with copper ferrules.

B. Raceway Bonding Jumpers: Copper, minimum size #6 AWG unless otherwise noted.

C. Cable Tray Bonding Jumpers: Copper, minimum size #6 AWG unless otherwise noted. Provide bonding jumpers between sections, joints, fittings, etc.

2.4 CONNECTOR PRODUCTS

A. Exothermic-Welded Connections: Provided in kit form and selected per manufacturers written instructions for specific types, sizes, and combinations of conductors and connected items. Exothermic welds in the FAA occupied areas shall be low odor and smokeless products.

2.5 POWER DISTRIBUTION SYSTEM GROUNDING

A. The facility electrical grounding shall comply with the National Electric Code (NEC). The Electronic Grounding Systems shall not replace or be used in lieu of the Power Distribution System grounding conductors.

2.6 TRANSIENT SUPPRESSION GROUND

A. Each critical panel shall be connected to a transient suppression plate. The copper plate size and method of installation shall be as indicated on Drawings.

2.7 GROUND STRAP

A. Provide a flexible ground strap, #6 AWG or braided equal, for electrical continuity at each flexible duct connection of each air handler, and fan.

PART 3 – EXECUTION

3.1 APPLICATION

A. General: FAA grounding requirements often exceed those of NEC; therefore, grounding system shall be as indicated in Contract Drawings, and as specified herein.

B. Equipment Grounding Conductors: All metallic non-current carrying parts of electrical equipment shall be grounded with equipment grounding conductors whether or not shown on the drawings. Equipment grounding conductors shall be green insulated copper conductors unless otherwise indicated. Minimum size equipment grounding conductors shall be sized per NEC 250.122. In no case, however, shall these conductors be smaller than No. 12 AWG.

1. Install green, equipment grounding conductor with all feeder and branch circuit conductors.
2. Busway Supply Circuits: Install separate green, equipment grounding conductor from the grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding-bar terminal on busway.
3. Computer Outlet Circuits: Install separate equipment grounding conductor in branch circuit runs from power panels serving computer loads or power distribution units.

4. Air-Duct Equipment Circuits: Install an equipment grounding conductor to duct-mounted electrical devices operating at 120 V and above, including air cleaners and heaters. Bond conductor to each unit and to air duct.

C. Conduit or cable shields shall not be used as the equipment grounding conductor.

3.2 INSTALLATION

A. General: The grounding requirements exceed those of the NEC. Grounding system shall be as indicated on the contract drawings and as specified herein. Reference IEEE-1100-1999, "Recommended Practice for Powering and Grounding Sensitive Electronic Equipment," when installing equipment. In no case shall the NEC be violated.

B. Grounding Conductor: Use of a shared/common ground is not permitted. Each overcurrent protection device shall have its own separate grounding conductor.

C. Route grounding conductors along the shortest and straightest paths possible, except as otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

D. Equipment Enclosure Grounding: Bare wire, wrapped around connecting screws or mounting bolts and screws is not acceptable as a grounding connection. All ground lugs shall be double-hole, of a noncorrosive material suitable for use as a grounding connection, and must be compatible with the type of metal being grounded. Ground lugs shall be mounted on clean, bare metal surfaces that are free of paint, rust, etc.

E. Raceway Grounding: Surface metal raceways, wireways, or cable rack systems shall be installed in a manner that ensures electrical continuity, or short bare copper bonding jumpers shall be installed between adjacent raceway sections to ensure proper bonding. Unless otherwise indicated, the minimum size for these bonding jumpers shall be No. 6 AWG.

F. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.

G. Fault Protection: Prevent equipment parts subject to human contact during operation and maintenance from being electrically energized when powering faults or components fail. Ground parts with a low impedance path to the chassis or cabinets in which they are mounted.

3.3 CONNECTIONS

A. General: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to assure high conductivity and to make contact points closer in order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells. Comply with manufacturers written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable. Indoor exothermic welds shall be low odor and smokeless type.

C. Terminate insulated equipment grounding conductors for feeders with pressure-type grounding lugs. Where metallic raceways terminate at non-metallic or non-conductive housings, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to the ground bus in the housing. Bond electrically non-continuous conduits at both entrances and exits with grounding bushings and bare grounding conductors .

D. Raceway Grounding: Surface metal raceways, wireways, or cable rack systems shall be installed in a manner that assures electrical continuity. Insulated copper bonding jumpers shall be installed between adjacent raceway sections to assure proper bonding. Uninsulated conductors shall not be used. Unless otherwise indicated, the minimum size for these bonding jumpers shall be No. 6 AWG. Where aluminum raceways are used, the jumpers shall be bonded with approved connectors for the dissimilar metals. All metallic raceway penetrations into a facility structure shall be bonded to the earth electrode system.

E. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with torque tightening values specified in UL 486A.

F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Mechanical connections using a Burndy "Hyground Connector" or equipment when operated at a force of 24,000 pounds are acceptable as FAA approved pressure connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on ground conductor. Hydraulically crimped connectors are not acceptable in a lightning protection system.

3.4 SYSTEM AND EQUIPMENT GROUNDING

A. Install a grounding conductor for each overcurrent device. The equipment grounding conductor shall be installed in the same conduit as the branch or feeder conductors. Grounding conductor shall have insulation rating equivalent to phase conductor insulation. Insulated grounding conductors shall be connected to the ground terminal at both ends and to junction, transition, pull and fixtures boxes along the route. Under no circumstances shall this conductor be

omitted from the electrical system, nor shall a separate grounding system, such as the signal grounding, be used as a substitute.

B. Metallic raceway housing the equipment grounding conductor shall be mechanically and electrically continuous.

C. Where there are parallel conductors of a feeder installed in more than one raceway, install an equipment grounding conductor in each raceway.

D. Ground the ends of all conduit runs using grounding bushings, except for receptacle and lighting branch circuits.

E. Splices of grounding conductors inside conduits are not acceptable.

F. Control wiring conduits, raceways without a separate equipment grounding conductor shall be bonded to the multi-point grounding system at every fifty feet intervals.

3.5 FIELD QUALITY CONTROL

A. Independent Testing Agency: Arrange and pay for the services of a qualified independent electrical testing organization to perform tests described below. Ensure no connection to utility power is made during testing.

B. Tests:

1. Subject the completed grounding system to a megger test at each location where a maximum ground resistance level is specified.
2. Refer to Section 09 69 00 "Access Flooring" for access flooring resistance testing.

C. Earth Electrode System Ground shall not exceed 10 ohms.

D. Bolting Resistance: Spot test to verify that ground cable bolted connections have a 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 enclosure, metallic enclosures, and lighting fixtures for continuity to grounding system.

F. Deficiencies: Where ground resistances exceed specified values, modify the grounding system to reduce resistance values.

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 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 structure 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, then test every tenth connection thereafter.
3. If any test point is higher than specified in these electrical specifications, then test the next ten consecutive connections and/or as many points as required to get satisfactory reading below the specified rating.
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.
5. All mechanical equipment grounding points in the attic shall be tested to ascertain that they are within the specified resistance values.

END OF SECTION 26 05 26

SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.

1.2 REFERENCE STANDARDS

A. National Fire Protection Association (NFPA)

1. 70: National Electrical Code (NEC), 2014 edition.

B. International Building Code (IBC)

C. Underwriters Laboratories (UL)

1.3 SUBMITTALS

A. Product data for each type of product specified.

B. Shop drawings of supports shall meet seismic requirements to withstand the IBC Seismic Design Category "D".

1.4 QUALITY ASSURANCE

A. Electrical Component Standard: Components and installation shall 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 COATINGS

A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors shall be hot-dip galvanized.

2.2 MANUFACTURED SUPPORTING DEVICES

A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.

B. Fasteners: Types, materials, and construction features as indicated:

1. Expansion Anchors: Carbon steel wedge or sleeve type.
2. Toggle Bolts: All steel springhead type.

C. U-Channel Systems: 16-gage steel channels, with 9/16-inch-diameter holes, at a minimum of 8 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacture.

D. Conduit Sealing Bushings: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for non-armored electrical cables in conduits subject to exposure to water and/or oil penetration at conduit joints. Provide plugs with number and size of conductor gripping holes as required to suit installation. Construct body of malleable iron casting with hot-dipped galvanized finish.

E. Support systems shall be capable of carrying the weight of the box and its contents.

2.3 FABRICATED SUPPORTING DEVICES

A. General: Shop- or field-fabricated supports or manufactured supports assembled from U-channel components.

B. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.

C. Pipe Sleeves: Provide pipe sleeves for steel pipe to be fabricated from Schedule 40 galvanized steel pipe.

D. Supporting devices shall meet the seismic requirements of withstand IBC Seismic Design Category "D".

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install supporting devices to fasten electrical components securely and permanently in accordance with NEC requirements.

B. Coordinate with the building structural system and with other electrical installation.
C. Raceway Supports: Comply with the NEC and the following requirements:

1. Conform to manufacturers recommendations for selection and installation of supports.
2. Strength of each support shall be adequate to carry design load plus 25 percent for future use, multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 lb., provide additional strength until there is a minimum of 200 lb. safety allowance in the strength of each support.
3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
4. Support parallel runs of horizontal raceways together on trapeze-type hangers.
5. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1-1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use 1/4-inch-diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.
6. Space supports for raceways in accordance with Table I of this section. Space supports for raceway types not covered by the above in accordance with NEC.
7. Support exposed and concealed raceway within 1 foot of an unsupported box and access fittings. In horizontal runs, support at the box and access fittings may be omitted where box or access fittings are independently supported and raceway terminals are not made with chase nipples or threadless box connectors.
8. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.
9. Neither raceways nor boxes shall be fastened to suspended ceiling supports.

D. Miscellaneous Supports: Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.

E. In open overhead spaces, cast boxes threaded to raceways need not be supported separately except where used for fixture support; support sheet metal boxes directly from the building structure.

1. Cast metal boxes having threadless connectors and sheet-metal boxes shall be supported directly from the building structure.

F. 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 firestopping sealant in gaps between sleeves and enclosed conduits and cables in accordance with the requirements of Section 07 84 13 "Penetration Firestopping." For sleeves through non-fire rated-wall or floor construction, apply UL- listed firestopping sealant in gaps between sleeves and enclosed conduits and cables in accordance with the requirements of Section 07 92 00 "Joint Sealants."

G. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, busways, cabinets, panelboards, transformers, boxes, disconnect switches, lighting fixtures, and control components in accordance with the following:

1. Fasten by means of wood screws, carriage bolts, or lag screws of equal holding strength on wood; toggle bolts on hollow masonry units; concrete inserts or expansion bolts on concrete or solid masonry; and machine screws, welded threaded studs, or spring-tension clamps on steel. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.
2. Holes cut to a depth of more than 1-1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used with like and kind, or better, materials.
3. Coordinate any cutting or boring of structural beams with Structural Engineer prior to any work being done.
4. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration- and shock- resistant fasteners for attachments to concrete slabs.
5. Coordinate with structural engineer on expansion joints used to support raceways.

H. Tests: Test pull-out resistance of one of each type, size, and anchorage material for the following fastener types:

1. Expansion anchors.
2. Toggle bolts.

I. Provide all jacks, jigs, fixtures, and calibrated indicating scales required for reliable testing. Obtain the structural Engineer's approval before transmitting loads to the structure. Test to 90 percent of rated proof load for fastener. If fastening fails test, revise all similar fastener installations and retest until satisfactory results are achieved.

3.2 TABLE I: SPACING FOR RACEWAY SUPPORTS

A. Horizontal Runs:

Raceway Size (inches)	No. of Conduits in Run	Location	RGS & IMC (1)	EMT (1)
1/2,3/4	1 or 2	Flat ceiling or wall.	5	5
1/2,3/4	1 or 2	Where it is difficult to provide supports except at intervals fixed by the building construction.	7	7
1/2,3/4	3 or more	Any location.	7	7
1/2-1	3 or more	Any location.		
1 & larger	1 or 2	Flat ceiling or wall	6	6
1 & larger	1 or 2	Where it is difficult to provide supports except at intervals fixed by the building construction.	10	10
1 & larger	3 or more	Any location	10	10

Raceway Size (inches)	No. of Conduits in Run	Location	RGS & IMC (1)	EMT (1)
Any	.....	Concealed	10	10

B. Vertical Runs:

Raceway Size (inches)	No. of Conduits in Run	Location	RGS & IMC (1)	EMT (1)
1/2,3/4	....	Exposed	7	7
1,1-1/4	.....	Exposed	8	8
1-1/2 and larger	.....	Exposed	10	10
Up to 2	.....	Shaftway	14	10
2-1/2	....	Shaftway	16	10
3 & larger	....	Shaftway.	20	10
Any	.....	Concealed	10	10

C. Notes:

1. Maximum spacing of support (feet).
2. Maximum spacings for IMC above apply to straight runs only.
3. Otherwise, the maximums for EMT apply.

D. Abbreviations:

1. EMT: Electrical metallic tubing.
2. IMC: Intermediate metallic conduit.
3. RGS: Rigid galvanized steel conduit, zinc coated.

END OF SECTION 26 05 29

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SECTION 26 05 33 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Raceways include the following:

1. Rigid galvanized steel (RGS) conduit, zinc coated.
2. Electrical metallic tubing (EMT).
3. Flexible metal conduit.
4. PVC-Coated RGS.

C. Boxes, enclosures, and cabinets include the following:

1. Device boxes.
2. Outlet boxes.
3. Pull and junction boxes.
4. Cabinets and hinged cover enclosures.
5. Cable access box
6. Conduit Bodies

1.2 REFERENCE STANDARDS

A. American National Standards Institute (ANSI)

1. C80.1: Rigid steel conduit, zinc-coated RGS.
2. C80.3: Electrical metallic tubing, zinc-coated (EMT).

B. Federal Standards (FS)

1. W-C-586: Conduit outlet boxes, bodies, and entrance caps.

C. National Electrical Contractors Association (NECA)

D. National Electrical Manufacturers Association (NEMA)

1. FB1: Fitting, cast metal Boxes, and conduit bodies, and cable assemblies.
2. OS1: Sheet-steel outlet boxes, device boxes, covers, and box supports.
3. 250: Enclosures for electrical equipment (1000 volts and below).

4. TC2: Rigid nonmetallic conduit
5. ICS-6: Industrial control system enclosure.
6. RN1: Polyvinyl chloride (PVC) externally coated galvanized rigid steel conduit.

E. National Fire Protection Association (NFPA)

1. 70: National Electrical Code (NEC), 2014 edition.

F. Occupational Safety and Health Administration (OSHA)

1. 29 CFR 1910.7 - Definitions and requirements for a Nationally Recognized Testing Laboratory (NRTL).

G. Underwriters Laboratories (UL)

1. 1: Flexible metal conduit.
2. 6: Rigid metal conduit.
3. 50: Enclosures for electrical equipment.
4 360: Liquid-tight flexible metal conduit.
5. 486A: Wire connectors and soldering lugs for use with copper conductors.
6. 514A: Metallic outlet boxes.
7. 514B: Fittings for conduit and outlet boxes.
8. 797: Electric metallic tubing
9. 870: Wireways, auxiliary gutter, and associated gittings.
10. 1242: Intermediate metal conduits.

H. Steel Structures Painting Council (SSPC)

1. PS-10.01: Hot-applied coal tar enamel painting system.

1.3 SUBMITTALS

A. Product data for wireway and fittings, floor boxes, hinged cover enclosures, and cabinets.

1.4 QUALITY ASSURANCE

A. Comply with latest edition of the NFPA 70 "National Electrical Code" for components and installation.

1. Boxes shall be sized in accordance with NEC Article 370.

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: A NRTL as defined in OSHA Regulation 1910.7.

C. Comply with NECA "Standard of Installation."

D. Coordinate layout and installation of raceway and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

PART 2 - PRODUCTS

2.1 GENERAL

A. Enclosures shall conform to NEMA standards.

2.2 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

1. Metal Conduit and Tubing:

a. Allied Tube and Conduit, Grinnell Co.
b. Triangle PWC, Inc.
c. Thomas & Betts Corp.

2. Conduit Bodies and Fittings:

a. Emerson Electric Co., Appleton Electric Co.
b. Hubbell, Inc., Killark Electric Manufacturing Co.
c. Thomas & Betts Corp.

3. Boxes, Enclosures, and Cabinets:

a. Cooper Industries, Midwest Electric.
b. Hoffman Engineering Co., Federal-Hoffman, Inc.
c. Thomas & Betts Corp.

2.3 METAL CONDUIT AND TUBING

A. Rigid Steel Conduit: ANSI C80.1 and UL 6.

B. Galvanized Rigid Steel Conduit: ANSI C80.1

C. Electrical Metallic Tubing and Fittings: UL 797, and ANSI C80.3 with compression-type fittings (screw type fittings are not acceptable). Use for lighting and receptacle branch circuits, fire alarm, environmental, security and communication controls in concealed areas, such as: suspended ceilings, furred walls and where these circuits are not subject to physical damage.

1. Connectors shall have insulated-throat, smooth bell shaped end or a bushing.

D. Flexible Metal Conduit; Zinc-coated steel: UL 1 and Federal Specification WW-C-566.

1. Liquid-tight Flexible Metal Conduit: Flexible metal conduit with PVC jacket: UL 360
2. Provide flexible metal conduit in minimum 24 inches or 10 diameter lengths for connection to motors and equipment subject to vibration and movement.
3. Conduit and fittings shall be type listed for grounding.
4. Use of flexible metal conduit shall not exceed 6 feet length.

E. Fittings: UL 514B and NEMA FB 1, compatible with conduit and of the threaded type. Set screw fittings are not allowed. Conduit expansion and deflection fittings shall be watertight. Fabricate from material compatible with conduit to be used. Exapansion and deflection fittings shall be equipped with bonding jumper cable to provide electrical continuity. Lock-nut and bushings inside boxes or enclosures shall be grounding type.

2.4 OUTLET AND DEVICE BOXES

A. Sheet Metal Boxes: NEMA OS 1 and UL 514A.

B. Cast Metal Boxes: NEMA FB 1, type FD, cast ferroalloy box with threaded hubs, and with gasketed cover.

C. Cast Metal Boxes: NEMA FB 1, type FD, cast ferroalloy box with threaded hubs, and with gasketed cover.

D. Exposed Outlet Boxes for junction boxes and wall switch boxes: UL 514A steel, malleable iron or cast iron boxes with threaded conduit entry for surface mounting in areas having exposed conduit systems.

E. Flush Outlet Boxes: UL 514A hot-dip galvanized steel, square or rectangular, 2-1/8 inches deep by four inches high, with extension ring where necessary.

F. Boxes for lighting fixtures: Flush mounted or in concealed areas: octagonal, four inches by 2-1/8 inches deep, galvanized steel, with fixture stud supports and attachments to properly support ceiling and bracket type lighting fixtures. Surface mounted: malleable or cast iron boxes with threaded conduit hub.

G. Gangable Outlet Boxes: 2-1/2 inches deep by four inches high with partitions as required.

H. Fittings: UL 514B

2.5 PULL AND JUNCTION BOXES

A. Small Sheet Metal Boxes: NEMA OS 1 and UL 514A.

B. Cast Metal Boxes:

1. Threaded-hub type conforming to UL 514A and UL 514B.
2. Galvanized steel conforming to UL 514A and UL 514BB

2.6 CABINETS AND ENCLOSURES

A. Hinged Cover Enclosures: NEMA 250, steel enclosure with continuous hinge cover and flush latch. Finish inside and out with manufacturer's standard enamel.

B. Cabinets: NEMA 250, type 1, code gauge galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Include metal barriers to separate wiring of different systems and voltage, and include accessory feet where required for freestanding equipment.

1. Cabinets shall be constructed with interior dimensions not less than those indicated on the Drawings.
2. Provide 3/4 inch plywood backboard unless otherwise indicated.
3. Key latch to match panelboards. Provide two keys with each cabinet unless otherwise notified.

C. Safety: UL 50

D. Control Enclosures: NEMA ICS-6 and NEMA 250.

E. Telephone and Signal Cabinets shall be constructed in accordance with NEC Article 312.10.

F. All locks in project shall be keyed alike.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of the raceway system. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Examine raceways prior to installation. No crushed or deformed raceway shall be installed.

3.2 WIRING METHODS

A. Outdoors: Use the following wiring methods:

1. Exposed: PVC coated rigid galvanized steel conduit and fittings.
2. Concealed: PVC coated rigid galvanized steel conduit and fittings.
3. Underground, Single Run: PVC coated rigid galvanized steel conduit and fittings.
4. Underground, Grouped: PVC coated rigid galvanized steel conduit and fittings.
5. Connection to Vibrating Equipment (including transformers and hydraulic, pneumatic, or electric solenoid or motor-driven equipment): Liquidtight flexible metal conduit.
6. Boxes and Enclosures: NEMA Type 4X.

B. Indoors: Use the following wiring methods:

1. Connection to Vibrating Equipment (including transformers and hydraulic, pneumatic, or electric solenoid or motor-driven equipment): Flexible metal conduit, except in wet or damp locations use liquidtight flexible metal conduit.
2. Damp or Wet Locations: Rigid steel conduit.
3. Exposed: Rigid metal conduit. Rigid metal conduit shall be used in the electrical/mechanical room to a height of 8 feet above finished floor.
4. Concealed: RMC (EMT shall only be used for lighting branch circuits, receptacle branch circuits, communications, fire alarm, security and environmental controls, and only where these conduits are run in concealed locations indoors).
5. Boxes and Enclosures: NEMA Type 1, except in damp or wet locations use NEMA Type 4X, stainless steel.

C. Conduit Use:

1. Install rigid galvanized steel (RGS) conduit for all distribution panelboard feeders, panelboard feeders, and transformer feeders.
2. Install electrical metallic tubing (EMT) for communication/signal, lighting and power branch circuits.
3. Use rigid galvanized steel (RGS) conduit for all exposed conduit systems within electrical and mechanical equipment rooms and electrical closets from floor level to a height of 8 feet above finished floor. Conduit for communication/signal, lighting and branch circuits may be transitioned to EMT above 8 feet above finished floor.
4. Use polyvinyl chloride (PVC) conduit for lightning protection or grounding system as indicated on drawings.

3.3 INSTALLATION

A. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions. Install to withstand forces for the Seismic forces indicated in Section 26 05 29 "Hangers and Supports for Electrical Systems."

B. Minimum size raceway shall be 3/4 inch, unless otherwise noted. Conduit for security and signal systems shall be as follows:

1. 3/4-inch conduit may be used for lengths not exceeding 50 feet.
2. 1-inch or larger conduit shall be used for lengths not exceeding 100 feet.

3. No run shall contain more than two (2) 90 degree bends, or the equivalent.
4. Provide pull and junction boxes required to meet the above criteria.
5. Bends in conduit, 1-inch and larger, shall have minimum inside radii of 12 times the nominal conduit diameter.

C. Conceal conduit including EMT, unless otherwise indicated, within finished walls, ceilings, and floors.

1. Raceways shall not be attached to the ceiling suspension system.
2. Raceways shall not be attached to or supported by roof decks.
3. Do not anchor or strap raceways to wall furring channels or to other raceways.

D. Keep raceways at least 6 inches away from parallel runs of fully insulated flues and fully insulated 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.

E. Install raceways level and square and at proper elevations. Install raceways at elevations which maintain headroom and at locations which avoid interference with other work requiring grading of pipe, the structure, finished ceiling, walls, etc.

1. Install conduit to drain moisture to nearest outlet or pull box.
2. Inside radii of bends in conduits shall not be less than six times the nominal diameter.
3. No run shall contain more than two 90 deg bends, or the equivalent between conduit terminations.
4. Telephone and signal raceway 2 inches and smaller: no run of 3/4 inch shall exceed 50 ft; or 100 ft for 1 inch or larger and a maximum of two 90 deg bends, or the equivalent. Install pullboxes or junction boxes where necessary to comply with these requirements.
5. Provide conduit bodies, pull and junction boxes required to meet the bends criteria.
6. No pullboxes shall be used for critical power circuits unless otherwise specifically shown on the contract drawings. Conduit bodies shall be used for all critical power circuits.
7. Install a pull wire in all empty tubing and conduit systems. Pull wire shall be No. 14 AWG zinc-coated steel or plastic with a minimum 200 pound tensile strength. Provide ten inches of slack at each end of the pull wire.

F. Complete raceway installation before starting conductor installation. Raceways shall be fished and swabbed before conductors are pulled.

G. Support raceways and boxes as specified in Section 26 05 29 "Hangers and Supports for Electrical Systems."

1. Boxes for fixtures on suspended ceilings shall be supported independently of the ceiling supports.
2. Boxes shall not be supported from sheet-metal roof decks.

H. Use temporary closures to prevent foreign matter from entering raceway.

I. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab.

J. Make bends and offsets so the inside diameter is not reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel.

1. Bends in conduit, for telephone and signal systems, that is 1 inch and larger shall have a minimum inside radii 12 times the nominal conduit diameter.
2. No run shall contain more than two (2) 90 degree bends, or the equivalent. Provide pullboxes, junction boxes, and conduit bodies as required to meet the bends criteria.

K. Use raceway fittings compatible with raceway and suitable for use and location.

L. Run concealed raceways with a minimum of bends in the shortest practical distance considering the type of building construction and obstructions, except as otherwise indicated.

M. Raceways or sections of raceways which pass through to damp, concealed, or underground location shall be of a type allowed for such locations by the NEC, and shall extend a minimum of 12 inches beyond the damp, concealed, or underground area.

N. Floor and Wall Penetrations:

1. Penetrations through walls or floors shall be sealed to prevent moisture and rodent entry and to deter air transfer.
2. Seal penetrations of walls which separate individually temperature or humidity controlled areas, to prevent air circulation.

O. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much as practical.

1. Run parallel or banked raceways together, on common supports where practical.
2. Make bends in concentric or banked runs from same center line to make bends concentric. Use factory elbows only where they can be installed parallel; otherwise, provide field bends for parallel raceways.

P. Join raceways with fittings designed and approved for the purpose and make joints tight.

1. Use bonding locknuts and bushings at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
2. Use insulating bushings for all conduits to protect conductors.
3. Provide expansion fittings for all raceways passing through the building expansion joints.

Q. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely, and install the locknuts with dished part against the box. Where terminations cannot be made secure with one locknut, or where conduits enter enclosures without threaded hubs, use two locknuts, one inside and one outside the box to securely bond the conduit to the

enclosure. In addition a bushing shall be installed on the interior threaded end of the conduit to protect conductor insulation.

R. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed. In addition a bushing shall be installed on the interior threaded end of the chase nipple to protect conductor insulation.

S. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200-lb tensile strength. Leave not less than 12 inches of slack at each end of the pull wire.

T. Stub-Up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs, and set flush with the finished floor. Extend conductors to equipment with rigid steel conduit. When required for vibration, flexible metal conduit may be installed from 6 inches above the floor to the equipment. Where equipment connections are not made under this Contract, install screwdriver-operated threaded flush plugs flush with floor.

U. Flexible Connections: Use maximum of 6 feet of flexible conduit for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquidtight flexible conduit in wet or damp locations.

V. Metal conduits shall be mechanically and electrically continuous between outlets, junction and pull boxes, panels, cabinets and similar equipment. Conduits shall enter and be secured to enclosures so that each system is electrically continuous throughout.

W. Install hinged cover enclosures and cabinets plumb. Support at each corner at a minimum, or as directed by the COR.

X. Provide grounding connections for raceway, boxes, and components. Tighten connectors and terminals, including screws and bolts according to equipment manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL Standard 486A.

1. Provide ground bushings for all feeder and RGS conduits at panelboards, transformers, pull boxes, and all other termination points.
2. Where knockouts are used, provide double locknuts, one on each side with a grounding bushing or grounding locknut, predrilled or field drilled holes used on the inside (use grounding bushings on conduit 1 inch and larger).

Y. Field Cut Conduit: Where conduit has to be cut in the field, it shall be cut square using a hand or power hacksaw or approved pipe cutter using cutting knives. The cut ends of the field-cut conduit shall be reamed to remove burrs and sharp edges.

Z. Field Threaded Conduit: Where threads have to be cut on conduit, the threads shall have the same effective length and shall have the same thread dimensions and taper as specified for factory-cut threads on conduit.

AA. Boxes: Shall be provided in the wiring or raceway system for pulling wires, making connections, and mounting devices or fixtures. Each box shall have the volume required by NFPA 70 for the number and size of conductors in the box.

1. Outlet boxes: Each outlet box shall have a machine screw which fits into a tapped hole in the box for the ground connection.
2. Mounting light fixtures: Boxes for mounting fixtures shall be not less than 4 inches square.
3. Concealed wiring: Boxes installed for concealed wiring shall be provided with extension rings or plaster covers. The front edge of the box shall be flush or recessed not more than 1/4 inch from the finished wall surface (whether the finished surface is drywall, or drywall and a sound-absorbing material).
4. Boxes in masonry block, gypsum-wall board or tile walls: Shall be square-cornered tile-type, or standard boxes shall have square-cornered tile-type covers.
5. Wet locations: Cast metal boxes installed in wet locations and boxes installed flush with exterior surfaces shall be gasketed.

BB. EMT entering an enclosure without threaded hubs: Provide a connector with threads and cast or machined locknut. The connector body and locknut shall be installed so that firm contact is made on each side of the enclosure.

3.4 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, to ensure that coatings, finishes, and cabinets are without damage or deterioration at 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 touch-up coating recommended by the manufacturer.

B. Cap stubbed up raceways, including raceways in cabinets, immediately upon installation. The use of paper or rag wads is not acceptable.

C. Galvanic corrosion protection: Avoid dissimilar metals in contact anywhere in conduit runs. Where contact cannot be avoided at conduit terminations, treat the connection with joint compound that eliminates galvanic corrosion. Where dissimilar metals are in contact, such as at aluminum cable tray or enclosures and steel supports, separate contact surfaces by using gaskets, nonabsorptive tape, or coating to prevent galvanic corrosion.

3.5 CLEANING

A. Upon completion of installation of system, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

END OF SECTION 26 05 33

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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. Component Importance Factor, Ip = 1.5.
3. Design Spectral Response Acceleration at Short Periods, Sds = 1.189g
4. Design Spectral Response Acceleration at 1.0 second period, Sd1 = 0.711g
5. 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.*
6. Seismic Design Category: D.

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.

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 53 "Miscellaneous 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 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. 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 26 05 48

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SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes identification of electrical materials, equipment, and installations.

1.2 REFERENCE STANDARDS

A. American National Standards Institute (ANSI)

1. A 13.1: Scheme for the Identification of Piping Systems.
2. C2: National Electrical Safety Code.

B. National Fire Protection Association (NFPA)

1. 70: National Electrical Code (NEC), 2014 edition.

1.3 QUALITY ASSURANCE

A. Components and installation shall comply with NFPA 70.

B. Comply with the requirements of ANSI A13.1 with regard to type and size of lettering for raceway and cable labels.

1.4 SEQUENCING AND SCHEDULING

A. Coordinate installing electrical identification after completion of finishing where identification is applied to field-finished surfaces.

B. Coordinate installing electrical identifying devices and markings prior to installing acoustical ceilings and similar finishes that conceal such items.

PART 2 - PRODUCTS

2.1 RACEWAY AND CABLE LABELS

A. Manufacturer's Standard Products: Where more than one type is listed for a specified application, selection is Installer's option, but provide single type for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, and these Specifications.

B. Conform to ANSI A13.1, Table 3, for minimum size of letters for legend and minimum length of color field for each raceway or cable size.

1. Color: Black legend on orange field.
2. Legend: Indicates voltage and service.

C. Adhesive Labels: Preprinted, flexible, self-adhesive vinyl. Legend overlaminated with clear, weather- and chemical-resistant coating.

D. Heat Shrink Tubing: Preprinted, embossed, permatized, 20-year life. Size to suit conductors; lettering shall be legible after heat shrinking.

E. Pretensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color-coded, acrylic bands sized to suit the diameter of the line it identifies and arranged to stay in place by pretensioned gripping action when placed in position.

F. Colored Adhesive Tape: Self-adhesive vinyl tape not less than 3 mils thick by 1 inch wide.

G. Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound type with pre-printed numbers and letters.

H. Plasticized Card-stock Tags: Vinyl cloth with pre-printed legends. Orange background, except as otherwise indicated, with eyelet for fasteners.

I. Brass Tags: Metal tags with stamped legend, punched for fasteners. Dimensions: 2 inches by 2 inches by 0.05 inch.

2.2 ENGRAVED NAMEPLATES AND SIGNS

A. Manufacturer's Standard Products: Where more than one type is listed for a specified application, selection is Installer's option, but provide single type for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, and these Specifications.

B. Engraving Stock: melamine plastic laminate, 1/16-inch minimum thick for signs up to 20-sq. in., 1/8 inch thick for larger sizes.

1. Engraved Legend: White letters on black field.
2. Punched for mechanical fasteners.

C. Interior Warning and Caution Signs: Pre-printed aluminum, baked enamel finish with 1/4-inch grommets in corners for mounting.

1. Color, size and legend: appropriate to the application.
2. Punched for fasteners.

D. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, non-fading, preprinted, cellulose acetate butyrate signs with 0.0396-inch, galvanized steel backing, with colors, legend, and size appropriate to the application. 1/4-inch grommets in corners for mounting.

E. Fasteners for Plastic-Laminated and Metal Signs: Self-tapping stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.

2.3 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6-nylon cable ties with the following features:

1. Minimum Width: 3/16 inch.
2. Tensile Strength: 50-lb. minimum.
3. Temperature Range: Minus 40 to 185 deg F.
4. Color: As indicated where used for color-coding.

B. Paint: Alkyd-urethane enamel over primer as recommended by enamel manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install identification devices according to manufacturer's written instructions.

B. Install labels where indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

C. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations used for electrical identification with corresponding designations used in the Contract Documents or required by codes and standards. Use consistent designations throughout the Project.

D. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.

E. Self-Adhesive Identification Products: Clean surfaces of dust, loose material, and oily films before applying.

F. Install painted identification as follows:

1. Clean surfaces of dust, loose material, and oily films before painting.
2. Prime Surfaces: For galvanized metal, use single-component, acrylic vehicle coating formulated for galvanized surfaces. For concrete masonry units, use heavy-duty, acrylic-resin block filler. For concrete surfaces, use clear, alkali-resistant, alkyd binder-type sealer.
3. Apply one intermediate and one finish coat of silicone alkyd enamel.
4. Apply primer and finish materials according to manufacturer's instructions.

G. Refer to Section 28 31 00 "Fire Detection and Alarm" for identification painting for fire alarm conduit and associated systems.

H. Identify Raceways with Color Banding: Band exposed and accessible raceways of the systems listed below for identification.

1. Bands: Pretensioned, snap-around, colored plastic sleeves; colored adhesive tape; or a combination of both. Make each color band 2 inches wide, completely encircling conduit, and place adjacent bands of 2-color markings in contact, side by side.
2. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25 feet in congested areas.
3. Colors: As follows:

    a. Fire-Suppression Supervisory and Control System: Red and yellow
    b. Security System: Blue and yellow.
    c. Mechanical and Electrical Supervisory System: Green and blue.
    d. Telecommunications System: Green and yellow.

I. Install Circuit Identification Labels on Boxes: Label externally as follows:

1. Exposed Boxes: Pressure-sensitive, self-adhesive plastic label on cover.
2. Concealed Boxes: Plasticized card-stock tags.
3. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.

J. Color-Code Conductors: The following field-applied color-coding methods may be used in lieu of factory-coded wire listed in Section 26 05 19 "Low Voltage Electrical Power Conductors and Cables" for sizes larger than No. 4 AWG. Contractor shall demonstrate non-availability of factory colored wire before using this application.

1. Colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply the last 2 turns of tape with no tension to prevent possible unwinding. Use 1-inch-wide tape in colors as specified. Adjust tape bands to avoid obscuring cable identification markings.

    a. Where conductors are color coded by this method, they shall be color coded in accessible raceways, panelboards, outlets, and switches, as well as at all terminations. Conductors in accessible raceways shall be color coded so that by removing or opening any cover, the coding will be visible.
    b. Phase, ground, and neutral conductors shall be color coded in accordance with Section 26 05 19 "Low Voltage Electrical Power Conductors and Cables".

2. Green insulated conductors shall not be re-identified for purposes other than grounding.
3. White or neutral gray conductors shall not be re-identified for purposes other than grounded neutrals.

K. Apply identification to conductors as follows:

1. Conduits and Conductors to Be Extended in the Future: Indicate source and circuit numbers.
2. Power and Lighting Circuits at Enclosure and at terminations: Identify each conductor with panel designation, circuit number, voltage, and phase.

3. Control and Communications Circuits at Enclosure and at terminations: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color-coding, or cable marking tape.

L. Apply warning, caution, and instruction signs and stencils as follows:

1. Install warning, caution, and instruction signs where indicated or required to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation.
2. Emergency-Operating Signs: Install engraved laminate signs with white legend on red background with minimum 3/8-inch-high lettering for emergency instructions on power transfer, and other emergency operations.

M. Install identification as follows:

1. Apply equipment identification labels of engraved plastic laminate on each major unit of equipment, including central or master unit of each system. This includes communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Provide equipment, required under Division 16, as follows: with nameplate indicating equipment name, system voltage(s) and phase. Except as otherwise indicated, provide a single line of text with 1/2-inch-high lettering on 1-1/2-inch-high label; where 2 lines of text are required, use 2-inch-high label. Apply labels for each unit of the following categories of equipment:

    a. Panelboards, electrical cabinets, and enclosures.
    b. Access doors and panels for concealed electrical items.
    c. Motor starters.
    d. Control devices.

2. Label conduit at each end and at pull boxes with characters a minimum 1/4-inch high.
3. Apply designation labels of engraved plastic laminate for disconnect switches, breakers, push buttons, pilot lights, and similar items for power distribution and control components above, except panelboards and alarm/signal components where labeling is specified elsewhere. For panelboards, provide framed, typed circuit schedules with explicit description and identification of items controlled by each individual breaker.

END OF SECTION 26 05 53

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SECTION 26 09 23 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Photoelectric switches.
2. Indoor occupancy sensors.

B. Related Requirements:

1. Section 26 27 26 "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and 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 INDOOR OCCUPANCY SENSORS

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. Hubbell Building Automation, Inc.
3. Watt Stopper.

B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.
3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
4. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.

5. Mounting:

   a. Sensor: Suitable for mounting in any position on a standard outlet box.
   b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
   c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
7. Bypass Switch: Override the "on" function in case of sensor failure.

C. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.

2.3 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

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. Hubbell Building Automation, Inc.
3. Watt Stopper.

B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.

C. Wall-Switch Sensor:

1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 2100 sq. ft.
2. Sensing Technology: Dual technology - PIR and ultrasonic.
3. Switch Type: Manual "on," automatic "off."
4. Voltage: Match the circuit voltage; dual-technology type.

5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
7. Concealed "off" time-delay selector at 30 seconds, and 5, 10, 20, and 30 minutes.
8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

2.4 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 260519 "Low-Voltage Electrical Power Conductors and Cables."

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 3/4 inch.

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-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 FAA's operations.
2. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.7 DEMONSTRATION

A. Train FAA's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 26 09 23

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SECTION 26 18 39 – LOW VOLTAGE MOTOR CONTROLLER

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes AC motor control devices rated 600 V and below that are supplied as an integral part of motor/controller packages.

1.2 REFERENCE STANDARDS

A. Reference standards noted are applicable only to the extent specified.

B. American Society of Testing and Materials (ASTM)

1. E699: Practice for Criteria For Evaluation of Agencies Involved Testing Quality Assurance, and Evaluating Building Components in Accordance with Test Methods Promulgated by ASTM Committee.

C. International Electrical Testing Association (NETA)

1. ATS: Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems.

D. National Electrical Manufacturer Association (NEMA)

1. ICS2: Standard for industrial control devices, controllers and assemblies.
2. 250: Enclosures for electrical equipment (1000 Volts Maximum).
3. FCS2: Industrial control and systems controllers, Contractors, and overload relays rated not more than 2000 Volts AC or 750 Volts DC.

E. National Fire Protection Association (NFPA)

1. 70: National Electrical Code (NEC), 2014 edition.

F. Occupational Safety and Health Administration (OSHA)

1. 29CFR 1910.7: Definitions and requirements for a Nationally Recognized Testing Laboratory (NRTL).

G. Underwriters Laboratories (UL)

1. 486A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.
2. 489: Molded-Case Circuit Breakers and Circuit-Breaker Enclosures.
3. 508: Electrical Industrial Control Equipment.

1.3 DEFINITIONS

A. Motor Controller: A device that controls, protects, and energizes an electric motor, and where required, controls its speed or the torque or power delivered by it.

1.4 SUBMITTALS

A. Product data for products specified in this Section. Include dimensions, ratings, and data on features and components.

B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

C. Maintenance data for products to be included in Operating and Maintenance Manual specified in Section 01 78 23, "Operation and Maintenance Data" and Section 26 05 00, "Common Work Results for Electrical."

D. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suit actual motor nameplate full-load currents.

E. Qualification Data for Field Testing Agency: Certificates, signed by Contractor, certifying that agency complies with requirements specified in "Quality Assurance" Article below.

F. Coordinated control wiring diagram.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Provide solid-state, reduced-voltage and solid-state, variable-speed controllers from manufacturers regularly engaged in the manufacture of equipment of the types and capacities indicated, with such products in satisfactory use in similar service for not less than 5 years. Manufacturer must also maintain, within 100 miles of the project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Field Testing Agency Qualifications: An independent testing agency with experience and capability to satisfactorily conduct testing indicated without delaying the Work. Evaluation criteria shall be according to ASTM E699.

C. Components and Installation: NFPA 70 "National Electrical Code."

D. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The terms "listed" and "labeled" shall be defined as they are in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: A NRTL as defined in OSHA Regulation 1910.7.

E. NEMA Compliance: NEMA ICS 2, "Industrial Control Devices, Controllers and Assemblies."

F. UL Compliance: UL 508, "Electric Industrial Control Equipment."

G. Single-Source Responsibility: Obtain similar motor-control devices from a single manufacturer.

1.6 COORDINATION

A. General: Coordinate features of controllers and control devices with pilot devices and control circuits provided in Section 23 09 00 "HVAC Instrumentation and Controls."

1.7 EXTRA MATERIALS

A. Spare Fuses and Pilot Light Indicating Lamps: Furnish one spare for every 5 installed units, but not less than one set of 3 of each kind.

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:

1. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.
2. Eaton Corporation; Cutler-Hammer Products.
3. General Electrical Company; GE Industrial Systems.
4. Square D.

2.2 MOTOR CONTROLLERS, GENERAL

A. Coordinate the features of each motor controller with the ratings and characteristics of the supply circuit, the motor, the required control sequence, the duty cycle of the motor, drive, and load, and the pilot device, and control circuit affecting controller functions. Provide controllers that are horsepower rated to suit the motor controlled and are of the manual reset type.

B. Contacts shall open each ungrounded connection to the motor.

C. Overload Relays: Motors, 1/8 horsepower or larger, shall have overload protection in each phase, or other equally rated method in accordance with NFPA 70. Ambient-compensated type with inverse-time- current characteristic. Provide with heaters or sensors matched to nameplate full-load current of the specific motor to which connected with appropriate adjustment for duty cycle.

1. Provide with reset button in an accessible location.

D. Enclosures: For individually mounted motor controllers and control devices, comply with NEMA Standard 250, "Enclosures for Electrical Equipment (1000 Volts Maximum)." Provide enclosures suitable for the environmental conditions at the controller location. Provide NEMA Type 1 enclosures except as otherwise indicated.

2.3 MAGNETIC MOTOR CONTROLLERS

A. Description: Provide full-voltage, non-reversing, across-the-line, magnetic controller, horsepower rated, tested and labeled at NEMA size indicated on the drawings, with field replaceable main contacts, external manual resets, ambient compensated melting-alloy overload protection in all phases and low voltage release and the following accessories.

1. Auxiliary contacts: Two normally open and two normally closed contacts;
2. Pilot lights: Start-stop; and
3. Three position "Hand-Off-Automatic" switch.

B. Each 3-phase magnetic motor controller shall provide reversal and phase loss protection. Protective device shall cause controller to open upon loss of any one phase or reversal of phases.

C. Control Circuit: Provide with integral control power transformer with 120 volt AC secondary holding coil with fused primary and secondary integral with controller where no other supply of 120 V control power to controller is indicated. Provide control power transformer with adequate capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.

D. Combination Controller: Provide combination motor controller complete with enclosure, disconnect operator with external handle, motor circuit protector, controller, controls, and wiring. Fabricated by one manufacturer and factory assembled, wired, and tested. Provide motor circuit protector in accordance with UL 489; molded-case circuit-breaker type with magnetic-only trip element calibrated to coordinate with the actual locked-rotor current of the connected motor and the controller overload relays. Provide breakers that are factory assembled with the controller, interlocked with unit cover or door, and arranged to disconnect the controller. Provide motor-circuit protectors with field-adjustable trip elements. Controller shall be UL 508 tested. Controllers operating at 240 volts and below shall be listed to withstand 22,000 amperes RMS symmetrical fault current unless a larger rating is shown on the drawings, and controllers operating at 480 volts shall be listed to withstand 25,000 amperes RMS symmetrical fault current unless a larger rating is shown on the drawings.

2.4 AUXILIARY CONTROL DEVICES

A. General: Factory installed in controller enclosure except as otherwise indicated. Where separately mounted, provide NEMA 1 enclosure except as otherwise indicated.

B. Push-button Stations, Pilot Lights, and Selector Switches: Heavy- duty type.

C. Stop and Lockout Push-button Station: Momentary-break push-button station with a factory-applied hasp arranged so a padlock can be used to lock the push-button in the depressed position with the control circuit open.

D. Control Relays: Auxiliary and adjustable time-delay relays.

E. Elapsed Time Meters: Heavy duty with digital readout in hours.

F. Current Sensors: Rated to suit application.

G. Phase-Failure and Undervoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection. Provide adjustable undervoltage setting.

H. Current-Sensing, Phase-Failure Relay: Solid-state sensing circuit with isolated contacts for hard-wired connection. Arranged to operate on phase failure, phase reversal, current unbalance of from 30 to 40 percent, or loss of supply voltage. Provide adjustable response delay.

PART 3 - EXECUTION

3.1 GENERAL

A. Comply with manufacturer's requirements in accordance with the direction of the COR.

3.2 APPLICATIONS

A. Select features of each motor controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, drive, and load; and configuration of pilot device and control circuit affecting controller functions.

B. Select horsepower rating of controllers to suit motor controlled.

C. Use fractional-horsepower manual controllers for single-phase motors, unless otherwise indicated.

D. Use magnetic starters for 3-phase motors, unless otherwise indicated.

E. Push-button Stations: In covers of magnetic controllers for manually started motors where indicated, start contact connected in parallel with sealing auxiliary contact for low-voltage protection.

F. Hand-Off-Automatic Selector Switches: In covers of manual and magnetic controllers of motors started and stopped by automatic controls or interlocks with other equipment.

3.3 INSTALLATION

A. Install independently mounted motor-control devices according to manufacturer's written instructions.

B. Manufacturers Field Services: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components, including the pre-testing and adjustment of solid-state controllers.

C. Location: Locate controllers within sight of motors controlled, unless otherwise indicated.

D. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks conforming to Section 26 05 00 "Common Work Results for Electrical."

3.4 IDENTIFICATION

A. Identify motor-control components and control wiring according to Section 26 05 53, "Identification for Electrical Systems."

3.5 CONTROL WIRING INSTALLATION

A. Install wiring between motor-control devices according to Section 26 05 19, "Low Voltage Electrical Power Conductors and Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect Hand-Off-Automatic (HOA) switch and other automatic control devices where available.

1. Connect selector switches to bypass only the manual and automatic control devices that have no safety functions when switch is in the hand position.
2. Connect selector switches with motor-control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

D. Provide a composite coordinated wiring diagram. Include an interlock wiring diagram for HOA switches, controls, and fire alarm.

3.6 CONNECTIONS

A. Tighten connectors, terminals, bus joints, and mountings. Tighten field-connected connectors and terminals, including screws and bolts, according to manufacturers published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A.

B. Conduit and Wiring connecting equipment to motor controller shall be same size as associated homerun.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Provide services of a qualified independent testing agency to perform specified testing.

B. Testing: After installing motor controllers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Sections 7.5, 7.6, and 7.16. Certify compliance with test parameters.
2. Testing Equipment: Use instruments bearing records of calibration within 3 months of testing.
3. Provide two (2) weeks advance notice to the COR prior to testing and schedule test at least one (1) week in advance of the test commencement.

C. Pretesting: On completing installation of the system, perform the following preparations for tests:

1. Make insulation resistance tests of conducting parts of motor control components; and of connecting supply, feeder, and control circuits. For devices containing solid-state components, use test equipment and methods recommended by the manufacturer.
2. Make continuity tests of circuits.
3. Provide set of Contract Documents to test personnel. Include full updating on final system configuration and parameters where they supplement or differ from those indicated in original Contract Documents.
4. Provide manufacturer's instructions for installation and testing of motor control devices to test personnel.

D. Visual and mechanical inspection: Include the following inspections and related work.

1. Motor-Control Device Ratings and Settings: Verify that ratings and settings as installed are appropriate for final loads and final system arrangement and parameters. Recommend final protective-device ratings and settings where differences are found. Use accepted revised ratings or settings to make the final system adjustments. Prepare and submit the load current and overload relay heater list.
2. Inspect for defects and physical damage, NRTL labeling, and nameplate compliance with current project drawings.
3. Exercise and perform operational tests of mechanical components and other operable devices in accordance with manufacturer's instructions.
4. Check tightness of electrical connections of devices with calibrated torque wrench. Use manufacturer's recommended torque values.
5. Clean devices using manufacturer's approved methods and materials.
6. Verify proper fuse types and ratings in fusible devices.

E. Electrical Tests: Perform the following in accordance with manufacturers instructions:

1. Insulation resistance test of motor control devices conducting parts to the extent permitted by the manufacturer's instructions. Insulation resistance less than 100 megohms is not acceptable.
2. Use primary current injection to check performance characteristics of motor-circuit protectors and for overload relays of controllers for motors 15 horsepower and larger. Trip characteristics not within manufacturer's published time-current tolerances are not acceptable.
3. Make adjustments for final settings of adjustable-trip devices.
4. Test auxiliary protective features such as loss of phase, phase unbalance and undervoltage to verify operation.
5. Check for improper voltages at terminals in controllers that have external control wiring when controller disconnect is opened. Any voltage over 30 V is unacceptable.

F. Remove and replace malfunctioning units with new units, and retest.

3.8 CLEANING

A. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean devices internally, using methods and materials recommended by manufacturer.

END OF SECTION 26 18 39

SECTION 26 22 00 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 REFERENCES

A. 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.

B. American National Standards Institute (ANSI)

1. ANSI C57.12.20 Overhead-Type Distribution Transformers, 500 kVA and Smaller: High-Voltage, 34 500 Volts and Below; Low Voltage, 7970/13 800 Y Volts and Below
2. ANSI C57.12.25 Standard for Pad-Mounted, Compartmental-Type, Self-Cooled, Single-Phase Distribution Transformers with Separable Insulated High-Voltage Connectors (34 500-Grd Y/19 920 Volts and Below; Low Voltage, 240/120; 167 kVA and Smaller)
3. ANSI C57.12.26 Transformers - Pad-Mounted Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers for Use with Separable Insulated High-Voltage Connectors, High Voltage, (34 500 Grd Y/19 920 and Below; 2500 kVA and Smaller)

C. ASTM International (ASTM)

1. ASTM D 877 Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes
2. ASTM D 924 Standard Test Method for Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids

D. Institute of Electrical and Electronics Engineers (IEEE)

1. IEEE C57.12.00 Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
2. IEEE C57.12.80 Standard Terminology for Power and Distribution Transformers
3. IEEE C57.12.90 Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers
4. IEEE Std 62 Guide for Diagnostic Field Testing of Electric Power Apparatus-Part 1: Oil Filled Power Transformers, Regulators, and Reactors

E. National Electrical Manufacturers Association (NEMA)

1. NEMA ST 1 Specialty Transformers (Except General Purpose Type)
2. NEMA ST 20 Dry-Type Transformers for General Applications

F. Underwriters Laboratories (UL)

1. UL 506 Standard for Specialty Transformers

1.2 GENERAL REQUIREMENTS

A. Section 26 05 00, "Common Work Results for Electrical" applies to work specified in this section.

B. Certification of previous tests on similar units under actual conditions may be submitted for impulse tests, temperature rise tests, sound tests, power-factory tests, bushing tests, and short-circuit tests in lieu of factory tests on actual units furnished.

C. Equipment and performance data shall be submitted for distribution transformers including resistance measurements, impedance, efficiencies and voltage and load losses at rated currents.

D. Equipment foundation data for distribution transformers shall include plan dimensions of foundations and relative elevations, equipment weight and operating loads, horizontal and vertical loads, horizontal and vertical clearances for installation, and size and location of anchor bolts.

1.3 SUBMITTALS

A. Product data for each product specified, including dimensioned plans, sections, and elevations. Show minimum clearances and installed features and devices.

B. Shop Drawings for wall brackets and platforms for transformers.

C. Wiring diagrams of products differentiating between manufacturer-installed and field-installed wiring.

D. Product certificates signed by manufacturers certifying that their products comply with the specified requirements.

E. Qualification data for firms and persons specified in the "Quality Assurance" Article.

F. Operation and maintenance data for materials and products to include in the "Operating and Maintenance Manual."

G. Field test reports of tests and inspection conducted according to Part 3 of this Section.

H. Product Test Reports: Certified copies of manufacturer's design and routine factory tests required by the referenced standards.

I. Sound Level Test Reports: Certified copies of manufacturer's sound level tests applicable to equipment for this Project.

1.4 FACTORY TESTING

A. Tests on transformers shall comprise the manufacturer's standard tests including resistance measurements of all windings; ratio tests; polarity and phase-relation tests; no-load loss at rated

voltage; impedance; voltage and load loss at rated current; insulation power factor (Doble) tests, insulation oil tests, and dielectric tests. For oil-filled units manufacturer shall certify that the oil contains no PCB's and shall affix a label to that effect on the transformer tank and on each oil drum containing the insulating oil.

1.5 DRAWINGS

A. Connection diagrams shall be submitted for distribution transformers indicating the relations and connections of devices and apparatus by showing the general physical layout of all controls, the interconnection of one system or portion of system with another, and internal tubing, wiring, and other devices.

B. Fabrication drawings shall be submitted for distribution transformers consisting of fabrication and assembly details to be performed in the factory.

C. Installation drawings shall be submitted for distribution transformers in accordance with the paragraph entitled, Installation, of this Section.

PART 2 - PRODUCTS

2.1 TRANSFORMERS, GENERAL

A. Transformers: Factory-assembled and -tested, air-cooled (Class AA) units of types specified, designed for 60-Hz service in accordance with IEEE C57.12.80. Unless otherwise indicated, minimum Basic Impulse Insulation Levels (BIL) shall be in accordance with IEEE 141.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.

D. Internal Coil Connections: Brazed type.

2.2 GENERAL-PURPOSE, DRY-TYPE TRANSFORMERS

A. Comply with NEMA Standard ST 20 "Dry-Type Transformers for General Applications."

B. Transformers: Two-winding type, 3-phase units using 1 coil per phase in primary and secondary.

C. Windings: All copper.

D. Low Sound Level Units: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE Standard C57.12.91 or the following, whichever is more stringent:

1. 45 dB for transformers rated over 9 KVA but not over 50 KVA.

E. Features and Ratings: As follows:

1. Enclosure: Indoor, ventilated, drip-proof.

a. Three phase transformer larger than 15 KVA shall be fully encased in steel enclosures.
b. Enclosures shall be bonded to the grounding system.
c. Surface temperature shall not exceed 65 degrees C when the transformer is operating continuously at rated load with an ambient temperature of 40 degrees C.

F. Insulation Class: 220 deg C class for transformers larger than 25 KVA.

1. Insulation Temperature Rise: 115 deg C maximum rise above 40 deg C.

G. Taps: For transformers 3 KVA and larger, full capacity taps in high-voltage winding are as follows:

1. 15 KVA through 500 KVA: Six 2.5-percent taps, 2 above and 4 below rated high voltage.

H. Electrostatic Shielding: Each winding is independently single shielded with a full-width copper electrostatic shield arranged to minimize interwinding capacitance.

1. Coil leads and terminal strips are arranged to minimize capacitive coupling between input and output connections.
2. Shield Terminal: Separate; marked "Shield" for grounding connection.
3. Capacitance: Shield limits capacitance between primary and secondary to a maximum of 33 picofarads over a frequency range of 20 Hz to 1 MHz.
4. Common-Mode Noise Attenuation: Minus 120 dB minimum, 0.5 to 1.5 kHz; minus 65 dB minimum, 1.5 to 100 kHz.
5. Normal-Mode Noise Attenuation: Minus 52 dB minimum, 1.5 to 10 kHz.

I. Wall-Mounting Brackets: Manufacturer's standard brackets for transformers up to 30 kVA.

J. Terminal Compartments: Dry type transformers shall be provided with a suitable terminal compartment to accommodate the required primary and secondary wiring connections, and a side or bottom conduit entrance. Transformers rated greater than 25 KVA shall have terminal boards equipped with factory installed clamp-type connectors. The terminal compartment temperature shall not exceed 75 degrees C when the transformer is operating continuously at rated load with an ambient temperature of 40 degrees C.

2.3 FINISHES

A. Indoor Units: Manufacturer's standard paint over corrosion-resistant pretreatment and primer.

PART 3 - EXECUTION

3.1 GENERAL

A. Comply with manufacturer's requirements in accordance with the direction of the COR.

3.2 INSTALLATION

A. Arrange equipment to provide adequate spacing for access and for cooling air circulation. Examine walls and floors for suitable mounting conditions where transformers will be installed.

B. Dry type transformers shall be installed on resilient vibration-isolating mountings and connected with flexible metallic conduit to prevent transmission and amplification of sound.

C. Pad-mounted distribution transformers shall be installed on precast or poured-in-place concrete pads and shall be grounded to a ground grid. Construct concrete bases not less than four inches larger in both directions than supported unit and four inches high.

D. Identify transformers and install warning signs according to Division 26 Section 26 05 53 "Identification for Electrical Systems".

E. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not furnished, use those specified in UL 486A and UL 486B.

F. Final electrical connections to transformer shall be with flexible metal conduit (except service transformers).

G. Transformer secondary winding neutral, core and enclosure shall be grounded in accordance with the latest National Electrical Code requirements.

H. Install to withstand forces for the IBC seismic design category indicated in Section 260529, "Hangers and Supports for Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Tests: The Contractor shall perform testing under this Section. Include the following minimum inspections and tests according to the manufacturer's instructions. Conform to IEEE Standard Test Code C57.12.91 for dry-type units, test method, and data correction factors.

1. Inspect accessible components for cleanliness, mechanical, and electrical integrity, for presence of damage or deterioration, and to ensure removal of temporary shipping bracing. Do not proceed with tests until deficiencies are corrected.

    a. Include internal inspection through access panels and covers.
    b. Inspect bolted electrical connections for tightness according to manufacturer's published torque values or, where not available, those of UL standard 486A.

2. Insulation Resistance: Perform megohmmeter test of primary and secondary winding-to-winding and winding-to-ground. Use a minimum test voltage of 1,000 VDC. Minimum insulation resistance shall be 500 megohms.
3. Duration of Each Test: 10 minutes.
4. Temperature Correction: Correct results for test temperature deviation from 20 deg C standard.

B. Test Failures: Correct deficiencies identified by tests and retest. Verify that equipment meets the specified requirements at no additional cost to the FAA. If substantial deficiencies are recognized, replace transformer at the sole discretion of the COR, and retest at no additional cost to the Government.

3.4 ADJUSTING

A. After completing installation, cleaning, and testing, touch up scratches and mars on finish to match original finish.

B. Adjust transformer taps to provide optimum voltage conditions at utilization equipment throughout the normal operating cycle of the facility. Record voltages and tap settings to submit with test results.

END OF SECTION 26 22 00

SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes lighting and power panelboards and associated auxiliary equipment rated 600 V and less.

1.2 REFERENCE STANDARDS

A. Federal Standards (FS)

1. W-P-115: Panel, power distribution.

B. Institute of Electrical and Electronic Engineers (IEEE)

1. C62.41: Recommended practice on surge voltage in low-voltage AC power circuits.

C. National Electrical Manufacturers Association (NEMA)

1. 250: Enclosures for electrical equipment (1000 volts or less).
2. PB1: Panelboards
3. AB1: Molded case circuit breakers and molded case switches.

D. InterNational Electrical Testing Association (NETA)

1. ATS: Acceptance Testing Specification for Electric Power Distribution Equipment and Systems.

E. National Fire Protection Association (NFPA).

1. 70: National Electrical Code (NEC), 2014 edition.

F. Occupational Safety and Health Administration (OSHA)

1. 29CFR 1910.7 Definitions and Requirements for a Nationally Recognized Testing Laboratory (NRTL).

G. Underwriters Laboratories (UL)

1. 50: Electrical cabinets and boxes.
2. 67: Panelboards.
3. 486A: Wire connectors and soldering lugs for use with copper conductors.
4. 489: Molded case circuit breakers and circuit breaker enclosures.

1.3 SUBMITTALS

A. Product Data: For each type of panelboard, accessory item, and component specified.

B. Shop Drawings: For panelboards include dimensioned plans, sections, and elevations. Show tabulations of installed devices, major features, and voltage rating. Include the following:

1. Enclosure type with details for types other than NEMA 250, Type 1.
2. Bus configuration and current ratings.
3. Short-circuit current rating of panelboard.
4. Features, characteristics, ratings, and factory settings of individual protective devices and auxiliary components.

C. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements. Include certified infrared scanning reports.

E. Panelboard Schedules: For installation in panelboards. Submit final typed versions after load balancing.

F. Maintenance Data: For panelboard components included in the maintenance manuals specified in Section 26 05 00 "Common Work Results for Electrical". Include manufacturer's written instructions for testing circuit breakers.

G. Short-circuit study report and arc-flash study report; signed, dated, and sealed by a qualified professional engineer. Contractor shall perform an entirely new study or to update the Jacobs' preliminary study using electrical ratings from the actual installed equipment.

1. One-line diagram, showing the following:
   a. Protective device designations and ampere ratings.
   b. Cable size and lengths.
   c. Transformer kilovolt ampere (kVA) and voltage ratings.
   d. Motor and generator designations and kVA ratings.
   e. Switchgear, switchboard, motor-control center and panelboard designations.
2. Short-Circuit Study Output:

a. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
   1) Voltage.
   2) Calculated symmetrical fault-current magnitude and angle.
   3) Fault-point X/R ratio.
   4) No AC Decrement (NACD) ratio.
   5) Equivalent impedance.
   6) Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
   7) Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

3. Incident Energy and Flash Protection Boundary Calculations:
   a. Arcing fault magnitude.
   b. Protective device clearing time.
   c. Duration of arc.
   d. Arc-flash boundary.
   e. Working distance.
   f. Incident energy.
   g. Hazard risk category.
   h. Recommendations for arc-flash energy reduction.
4. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of the computer printout.
5. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: Independent testing agency shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1910.7, or shall be a full member company of NRTL.

1. Testing Agency's Field Supervision: Person currently certified by the InterNational Electrical Testing Association or National Institute for Certification in Engineering Technologies, to supervise on-site testing specified in Part 3 of this section.

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: A NRTL as defined in OSHA Regulation 1910.7.

C. Comply with NFPA 70 for components and installation.

D. Comply with NEMA PB 1, "Panelboards."

E. Single Source Responsibility: Panelboards and circuit breakers located in the panelboards shall be the product of a single manufacturer.

1.5 EXTRA MATERIALS

A. Keys: 6 spares of each type for panelboard cabinet lock.

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:

1. Eaton Corp.; Westinghouse & Cutler-Hammer Products.
2. Siemens Energy and Automation, Inc.
3. Square D Co.

2.2 PANELBOARD FABRICATION

A. Panelboards shall be circuit breaker equipped, dead-front type, and shall conform to Federal Specification W-P-115, Type I, Class 1.

B. Enclosures: UL 50, galvanized steel, flush- or surface-mounted cabinets as indicated. Panelboards shall be listed and labeled by Underwriters Laboratories, Inc. in accordance with UL Standard 67, and shall conform to the latest requirements of the National Electric Code and of NEMA Standard PB 1, Type 1, Class 1, unless otherwise indicated to meet environmental conditions at installed locations.

C. Directory Frame: Metal, mounted inside each panelboard door.

D. Bus: Hard drawn copper of 98 percent conductivity meet UL 67 temperature rise limits, and have a current density of 1000 amperes per square inch. Bus bars shall be sequence-phased, and rigidly supported by high impact resistant, insulated bus supporting assemblies to prevent vibration or short circuits. Solderless terminations shall be suitable for copper UL listed wire or cable and shall be tested and listed in conjunction with appropriate UL standards.

1. Phase bus bars shall be copper or plated copper.
2. Neutral bus bar shall be copper or plated copper, and insulated from panelboard.

3. Capacity as indicated on Drawings, or equal to or greater than the panelboard OCPD.

E. Main and Neutral Lugs: Compression type.

1. The neutral bar shall be fully rated and capable of being located in either corner of the enclosure at the line end to facilitate conductor termination, and shall be insulated from panelboard.

F. Equipment Ground Bus: Ground bus shall be copper, and adequate for feeder and branch-circuit equipment ground conductors with 25% additional space for future conditions. Lugs shall be sized to accommodate grounding conductors shown on plans.

1. The ground bus shall be securely bonded to the cabinet and shall be separate from the neutral bus.
2. The number of terminations shall be equal to the number of poles in the panelboard.
3. The ground bus bar shall be structurally integral to the panelboard, or attached to the panelboard with a bolt, nut, and lockwasher.

a. If ground bus bar is mounted to enclosure with screw threads only, (i.e. tapped blind hole), a separate bolted ground lug shall be installed on the panelboard enclosure and bonded to the ground bus bar.

1) Bond conductor shall have same current carrying capacity as the largest equipment grounding conductor terminated to the ground bus bar.

G. Short circuit rating: Panelboards shall be fully rated in AIC. See Drawings for AIC rating.

H. Future Devices: Equip with mounting brackets, bus connections, and necessary appurtenances, for the overcurrent protective device ampere ratings indicated for future installation of devices.

I. Include the following special features for panelboards.

1. Hinged Front Door in Door Construction: Entire front trim hinged to box with standard door within hinged trim cover. (One piece front with two doors). The smaller door, when open, provides access to device handles and rating labels and shall be lockable. The larger door, when open, provides access to conductors and wiring terminals and shall also be lockable. Consult with COR for keying requirements. Door hinges shall be continuous piano hinges which are welded to the door(s) and bolt on front.

a. All door hinges shall be concealed.

2. Channel/Wiring Space: Shall be four (4) inches wide for panelboards with 100 ampere bus, six (6) inches wide for power feeders over 100 amperes and up to and including 225 ampere bus, and eight (8) inches wide for power feeders over 225 amperes and up to 600 ampere bus.
3. Subfeed: Overcurrent protective device or lug provision.

J. Doors shall have flush type cylinder locks and catches. All locks in a project shall be keyed alike, and 2 keys shall be furnished with each lock.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units. Branch circuit breakers shall be molded case, quick-make, quick-break with short circuit interrupting current rating equal to or greater than the rating indicated on the Drawings.

1. Branch circuits shall be connected to the individual circuit breakers as indicated on the Drawings.

B. Plug-in type load centers and plug-in type branch or feeder circuit breakers shall not be used.

C. Doors: In panelboard front, with concealed hinges. Secure with flush catch and tumbler lock, keyed alike, and two (2) keys shall be provided with each lock.

2.4 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: NEMA AB 1, UL 489, FS W-C-375 and the following requirements.

1. Molded case
2. Bolt-on breaker type. Stab-in and plug-in types are not acceptable
3. Quick make, quick break connections with mechanical trip free switching mechanism
4. Inverse time, thermal overcurrent trip
5. Instantaneous magnetic trip
6. Thermal trip calibrated for 40 deg C ambient temperature
7. Provide breakers with number of poles, voltage rating, current rating, and frame size as indicated on the drawings
8. Multiple circuit breakers shall have an internal, common trip mechanism;
9. Trip-indicating feature
10. Single-pole breakers shall be full size modules
11. Two and three pole breakers shall be sized in multiples of a single-pole breaker
12. Branch circuits shall be connected to the individual circuit number, as indicated on the Drawings
13. UL marked as suitable for use with 75 deg C wire.

B. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices and interrupting capacity rating as indicated on the Drawings.

C. Circuit Breakers, 200 A and Larger: Trip units interchangeable within frame size.

D. Lugs: Mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.

2.5 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items as required for overcurrent protective device test, inspection, maintenance, and operation.

PART 3 - EXECUTION

3.1 GENERAL

A. Comply with manufacturer's requirements in accordance with the direction of the COR.

3.2 INSTALLATION

A. Install panelboards and accessory items according to NEMA PB 1.1.

B. Mounting Heights, top of trim: 81 inches above finished floor, unless otherwise indicated. Panelboards with a height greater than 90 inches shall be mounted at height required for working clearances.

C. Mounting: Plumb and rigid without distortion of box. Mount flush panelboards uniformly flush with wall finish.

D. Circuit Directory: Type directory to include installed circuit loads after balancing panelboard loads. The directory shall be arranged so that typed entries simulate circuit breaker positions in the panelboard. Obtain approval before installing.

E. Install filler plates in unused spaces.

F. Provision for Future Circuits at Flush Panelboards: Stub four 1-inch GRC (Galvanized Rigid Conduit) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future.

G. Wiring in Panelboard Gutters: Arrange conductors into groups, and bundle and wrap with insulated cable ties after completing load balancing.

3.3 IDENTIFICATION

A. Identify field-installed wiring and components and provide warning signs as specified in, Section 26 05 53 "Identification for Electrical Systems."

B. Panelboard Nameplates: Label each panelboard with engraved laminated-plastic or metal nameplates mounted with corrosion-resistant screws, as specified in Section 26 05 53 "Identification for Electrical Systems."

C. ARC-FLASH WARNING LABELS

1. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems." Produce a 3.5-by-5-inch thermal transfer label of high-adhesion polyester for each work location included in the analysis.
2. Apply one arc-flash label for 600-V ac, 480-V ac, and applicable 208-V ac panelboards and disconnects.
3. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:

    a. Location designation.
    b. Nominal voltage.
    c. Flash protection boundary.
    d. Hazard risk category.
    e. Incident energy.
    f. Working distance.
    g. Engineering report number, revision number, and issue date.

4. Labels shall be machine printed, with no field-applied markings.

3.4 GROUNDING

A. Make equipment grounding connections for panelboards as indicated, and in accordance with, Section 26 05 26 "Grounding and Bonding for Electrical Systems."

B. Provide ground continuity to main electrical ground bus as indicated.

3.5 CONNECTIONS

A. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A.

3.6 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Make insulation-resistance tests of each panelboard bus, component, and connecting supply, feeder, and control circuits.
2. Make continuity tests of each circuit.

B. Testing: After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA, ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units, and retest.

C. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove panel fronts so joints and connections are accessible to portable scanner.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Record of Infrared Scanning: Prepare a certified report that identifies panelboards checked and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.7 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots, dirt and debris. Touch up scratches and marred finishes to match original finish.

END OF SECTION 26 24 16

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SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes various types of receptacles, connectors, multi-outlet assemblies, switches, and finish plates.

1.2 REFERENCE STANDARDS

A. Federal Standards (FS)

1. W-C-596: General and associated detailed specifications: connector, plug receptacle, and cable outlet, electrical power.
2. W-S-896E: Switch, toggle, flush mounted.

B. National Electrical Manufacturer Association (NEMA)

1. WD1: General requirements for wiring devices.
2. 250: Enclosures for Electrical Equipment (1000 Volts and Below).

C. National Fire Protection Association (NFPA)

1. 70: National Electrical Code (NEC), 2014 edition.

D. Occupational Safety and Health Administration (OSHA)

1. 29 CFR 1910.7: Definitions and requirements for a Nationally Recognized Testing Laboratory (NRTL).

E. Underwriters Laboratories (UL)

1. 20: General uses snap switches.
2. 498: Electrical attachment plugs and receptacles.
3. 943: Ground fault circuit interrupters.
4. 1472: Solid-State Dimming Control.

F. Institute of Electrical and Electronics Engineers (IEEE)

1. C62.41 Surge Voltages in Low-Voltage AC Power Circuits.

1.3 SUBMITTALS

A. Product data for each product specified.

B. Operation and maintenance data for materials and products specified in this Section to be included in the "Operating and Maintenance Manual". Refer to Section 01 78 23 "Operation and Maintenance Data."

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70 for components and installation.

B. Listing and Labeling: Provide products that are listed and labeled for their applications and installation conditions and for the environments in which installed.

1. The Terms "Listed" and "Labeled": As defined in the NEC," Article 100.
2. Listing and Labeling Agency Qualifications: A NRTL as defined in OSHA Regulation 1910.7.

1.5 COORDINATION

A. Device plates' color shall match the existing device plate at the facility. Coordinate with COR to finalize the color of the device plate.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Wiring Devices:

a. Hubbell Inc.
b. Leviton Mfg. Co., Inc.
c. Pass & Seymour/Legrand.

2.2 WIRING DEVICES

A. Comply with NEMA Standard WD 1, "General requirements for wiring devices," and UL approved, specification grade.

B. Enclosures: NEMA 250, Type 1 equivalent, except as otherwise indicated. Exterior receptacles shall be mounted in waterproof cast outlet boxes with waterproof covers.

C. Receptacles, General: All receptacles shall be specification grade in accordance with NEMA WD 1. Wiring terminals shall be of the screw-type. Receptacles with push-in connections or a combination of screw-type and push-in connectors are not acceptable.

1 Straight-Blade: Except as otherwise indicated, comply with Federal Specification W-C-596 and heavy-duty grade of UL Standard 498, "Electrical Attachment Plugs and Receptacles." Provide NRTL labeling of devices to verify these compliance's.

2. General Purpose Duplex Receptacle: 125 volt, 20 Ampere, 2 pole, 3 wire grounded, NEMA 5-20R.

a. Outlet grounding shall be accomplished by the installation of a #12 AWG green insulated conductor from the ground bus in the panelboard to the receptacle grounding screw of the receptacle. A pigtail #12 AWG conductor shall also be installed from the receptacle grounding screw to the grounding lug on the outlet box.

D. Receptacles, Straight-Blade, Special Features: Comply with the basic requirements specified above for straight-blade receptacles of the class and type indicted, and with the following additional requirements:

1. Ground-Fault Circuit Interrupter Receptacles: UL Standard 943, "Ground Fault Circuit Interrupters," feed-through type, with integral NEMA 5-20R (UL Group I, Class A), duplex receptacle arranged to protect connected downstream receptacles on the same circuit.

E. Wall Switches:

1. Snap Switches: AC switches, NRTL listed and labeled as complying with UL Standard 20 "General Use Snap Switches", and with Federal Specification W-S-896E.

a. Single-pole and three-way wall switches shall be specification grade, rated 120/277 volts, and shall be fully rated 20 amperes, AC only.
b. Wire terminals shall be of the screw type.
c. Switches with push-in connections or a combination of screw -type and push-in connectors are not acceptable.
d. Switches shall be the quiet-operating rocker types.
e. Switch color shall be ivory.

F. Device Plates:

1. Provide plates of one-piece type for all outlets and fittings to suit the devices installed. Plate screw shall be metal with countersunk heads, in a color to match the finish of the plate.

a. Plates installed in wet locations shall be gasketed.

b. Plates for telephone and intercommunication outlets shall have a 3/8-inch-bushed opening in the center or a dome-shaped grommet on the side. Plates for telephone may be more than one-piece type where required.
c. Telephone and communication outlets shall be provided with a blank cover plate unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install devices and assemblies plumb and secure.

B. Install wall plates after painting is complete.

C. Arrangement of Devices: Except as otherwise indicated, mount flush, with long dimension vertical, and grounding terminal of receptacles on bottom. Group adjacent switches under single, multi-gang wall plates.

D. Wall Switches:

1. Not more than one switch shall be installed in a single gang position.
2. Grounding: Where switches have grounding terminals, they shall be grounded with a green grounding pigtail connected from the switch grounding screw directly to the grounding lug on the outlet box where the green equipment grounding conductor is terminated.

E. Device Plates:

1. Plates shall be installed with all four edges in continuous contact with finished wall surfaces without use of mats or similar devices.
2. Plates installed in wet locations shall be gasketed.
3. Use of sectional type device plates shall not be permitted.

F. The equipment-grounding conductor shall be installed with the receptacle power conductors and shall terminate at the ground bus in the electrical service panel.

G. Receptacles shall be installed 18 inches above finished floor, unless noted otherwise. Wall switches shall be installed 48 inches above finished floor, unless noted otherwise.

H. Protect devices and assemblies during painting.

I. Adjust locations at which floor service outlet are installed to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Comply with Section 26 05 53 "Identification for Electrical Systems."

3.3 GROUNDING

A. Grounded Receptacles: Connect to grounding conductor routed to designated ground terminal of electrical system.

3.4 FIELD QUALITY CONTROL

A. Testing: Test wiring devices for proper polarity and ground continuity. Operate each operable device at least 6 times.

B. Test ground-fault circuit interrupter operation with both local and remote fault simulations according to manufacturer's recommendations.

C. Replace damaged or defective components.

3.5 CLEANING

A. General: Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

END OF SECTION 26 27 26

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SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes individually mounted switches and circuit breakers used for the following:

1. Feeder and equipment disconnect switches.
2. Feeder overcurrent protection.
3. Motor disconnect switches.

1.2 REFERENCE STANDARDS

A. Reference listed in this Section are a applicable only to the extent specified.

B. Federal Specifications

1. W-C-375 Circuit Breakers, Molded Case; Branch Circuit and Service.

C. InterNational Electrical Testing Association (NETA)

1. ATS: Acceptance Testing Specification for Electric Power Distribution Equipment and Systems.

D. National Electrical Manufacturer Association (NEMA)

1. KS 1: Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
2. AB1: Molded Case Circuit Breakers and Molded Case Switches
3. FU 1: Low Voltage Cartridge Fuses

E. National Fire Protection Association (NFPA)

1. 70: National Electrical Code (NEC), 2014 edition.

F. Occupational Safety and Health Administration (OSHA)

1. 29CFR 1910.7: Definitions and requirements for a Nationally Recognized Testing Laboratory (NRTL).

G. Underwriters Laboratories (UL)

1. 98: Standard for Enclosed and Dead Front Switches.
2. 486A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.

1.3 SUBMITTALS

A. Product Data for switches, circuit breakers, and accessories specified in this Section. Include the following:

1. Descriptive data including enclosure types and details, current and voltage ratings, short circuit current ratings (interrupting and withstand, as appropriate).
2. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxilliary components.
3. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.
2. Let-through current curves for circuit breakers with current-limiting characteristics.
3. Coordination charts and tables and related data.
4. Coordination study for new breakers to ensure proper coordination with existing breakers.

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 firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of CORs and owners, and other information specified.

D. Field test reports indicating and interpreting test results.

E. Prepare and distribute operations and maintenance data as specified in Section 01 78 23 "Operation and Maintenance Data."

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: In addition to the requirements specified in Section 01 40 00 "Quality Control," an independent testing agency shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1910.7, or shall be a full member company of the InterNational Electrical Testing Association (NETA).

1. Testing Agency's Field Supervisor: Person currently certified by NETA or the National Institute for Certification in Engineering Technologies, to supervise on-site testing specified in Part 3.

B. Source Limitations: Obtain disconnect switches and circuit breakers from one source and by a single manufacturer.

C. Comply with NFPA 70 for components and installation.

D. Listing and Labeling: Provide disconnect switches and circuit breakers 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: A NRTL as defined in OSHA Regulation 1910.7.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide disconnect switches and circuit breakers by one of the following:

1. Fusible and non-fusible Switches:

a. Eaton Corp.; Cutler-Hammer Products.
b. Siemens Energy & Automation, Inc.
c. Square D Co.
d. General Electric

2. Circuit Breakers:

a. Eaton Corp.; Cutler-Hammer Products.
b. Siemens Energy & Automation, Inc.
c. Square D Co.
d. General Electric

2.2 DISCONNECT SWITCHES

A. General: Switches shall be of the voltage and current ratings indicated on the Drawings, and each shall be capable of interupting the locked rotor current of the motor for which it is to be used. The locked rotor current will be assumed to be ten (10) times the full rated load current. Switches shall be the quick-make, quick-break type. Except for ground lugs which shall be bonded to the housing, parts shall be mounted on insulating bases to permit replacement of any part from the front of the switch. All current carrying parts shall be of high conductivity copper unless otherwise specified, and shall be designed to carry rated current without excessive heating. Switch contacts shall be silver tungsten or plated to minimize corrosion, pitting and oxidation and to assure suitable conductivity.

B. Enclosed, Non-fusible Switch: NEMA KS 1, Type HD, lockable handle, with 2 padlocks.

C. Enclosed, Fusible Switch, below 800 amperes: NEMA KS 1, Type HD, clips to accommodate specified fuses, enclosure consistent with environment where located, handle lockable with 2 padlocks, and interlocked with cover in CLOSED position. Provide rejection type fuse clips with switches.

D. Type HD, Heavy Duty, Double 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.

E. Enclosure: NEMA KS 1, Type 1, unless otherwise specified or required to meet environmental conditions of installed location.

F. Auxiliary Contacts: Provide additional contacts for equipment with variable frequency drives: one (1) normally open, one (1) normally closed.

2.3 MOLDED-CASE CIRCUIT BREAKERS

A. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

B. 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.

C. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

D. 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.

E. 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.

F. Replacement Breaker in Existing MCC: A complete plug in unit for adding/replacing to an existing MCC includes the plug-in unit, isolating divider pan, and all necessary installation hardware.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install disconnect switches and circuit breakers in locations as indicated, according to manufacturer's written instructions.

B. Install disconnect switches and circuit breakers level and plumb.

C. Install wiring between disconnect switches, circuit breakers, control, and indication devices.

D. Connect disconnect switches and circuit breakers and components to wiring system and to ground as indicated and instructed by manufacturer.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A.

E. Identify each disconnect switch and circuit breaker according to requirements specified in Section 26 05 53 "Identification For Electrical Systems.".

3.2 FIELD QUALITY CONTROL

A. Testing: After installing disconnect switches and circuit breakers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.5 for disconnect switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.

B. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

3.3 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, and abrasions.

END OF SECTION 26 28 16

SECTION 26 29 23 - VARIABLE-FREQUENCY DRIVE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes separately enclosed, pre-assembled, combination VFDs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

1.2 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. VFD: Variable-frequency drive.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: VFDs 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.

1.4 ACTION SUBMITTALS

A. Product Data: For each type and rating of VFD indicated. Include features, performance, electrical ratings, operating characteristics, shipping and operating weights, and furnished specialties and accessories.

B. Shop Drawings: For each VFD 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 VFD and installed devices.
g. Specified modifications.

2. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFDs. Show VFD 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.

B. Qualification Data: For qualified testing agency.

C. Seismic Qualification Certificates: For VFDs, 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.

D. Product Certificates: For each VFD, from manufacturer.

E. 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 VFD input filtering to limit TDD and THD(V) at the PCC to specified levels.

F. Source quality-control reports.

G. Field quality-control reports.

H. 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.

I. 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 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VFDs to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "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.

1.7 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. 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(s) for each size and type of magnetic controller installed.

5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.8 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.

D. IEEE Compliance: Fabricate and test VFD according to IEEE 344 to withstand seismic forces defined in Section 260548.

1.9 DELIVERY, STORAGE, AND HANDLING

A. 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.

1.10 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 14 deg F and not exceeding 104 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 (noncondensing).
4. Altitude: Not exceeding 3300 feet.

B. Interruption of Existing Electrical Systems: Do not interrupt electrical systems in facilities occupied by FAA or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Construction Manager and FAA no fewer than 30 calendar 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 FAA's written permission.
4. Comply with NFPA 70E.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFDs, including clearances between VFDs, and adjacent surfaces and other items.

1.11 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.

1.12 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace VFDs that fail in materials or workmanship within a specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Danfoss Inc.; Danfoss Drives Div.
2. ABB Inc
3. Square D; a brand of Schneider Electric.

B. General Requirements for VFDs: Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.

C. Application: Constant torque and variable torque.

D. VFD 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 VFD input voltage rating.
2. Input AC Voltage Unbalance: Not exceeding 3 percent.
3. Input Frequency Tolerance: Plus or minus 3 percent of VFD 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: 25 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 VFDs 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. Under- and overvoltage trips.
4. Inverter overcurrent trips.
5. VFD and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFDs and motor thermal characteristics, and for providing VFD overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
6. Critical frequency rejection, with three selectable, adjustable deadbands.
7. Instantaneous line-to-line and line-to-ground overcurrent trips.
8. Loss-of-phase protection.
9. Reverse-phase protection.
10. Short-circuit protection.
11. Motor overtemperature 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 VFD 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 VFD input current rating.
2. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFD input current rating, whichever is larger.
3. Auxiliary Contacts: NO/NC, arranged to activate before switch blades open.
4. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
5. 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, and LOCAL and REMOTE 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 VFD, local automatic control at VFD, 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 VFD door and connected to display VFD 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. 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.

3. Output Signal Interface: A minimum of one programmable analog output signal (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).

4. 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 (overtemperature or overcurrent).
d. PID high- or low-speed limits reached.

F. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.

1. Number of Loops: One.

G. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display VFD status and alarms. Allows VFD to be used with an external system within a multidrop LAN configuration; settings retained within VFD's nonvolatile memory.

1. Network Communications Ports: Ethernet and RS-422/485.
Network Communications: Provide BACnet compatible network interface card or embedded network module to communicate with the BAS. Interface shall be factory-installed and integral to the drive and it shall communicate using either BACnet protocol via BACnet MS/TP or BACnet/IP. Interface shall allow the following data values of VFD to be monitored from the BAS:
a. Analog Value:
1) Output Speed (RPM)
2) Output Frequency (Hz)
3) Output Power (kW)
4) Energy Usage (kW/h)
5) Run Time (Hrs)
b. Binary Value:
1) Run Status
2) Rotation Direction (FWD/REV)
3) Drive Fault Status
4) Hand/Auto Indication
5) Drive Alarm

2.3 LINE CONDITIONING AND FILTERING

A. Power line noise generated by the VFDs shall be individually and cumulatively limited to a voltage distortion factor and line notch depth as defined in IEEE Standard 519-1992, Recommended Practices and Requirements for Harmonic Control in Electric Power systems. Comply with the requirements for special applications, as listed in Table 10.2 of Standard 519-1992 with the point of common coupling (PCC) defined as the "ESSENTIAL BUS SWITCHGEAR." The THD(V) shall not exceed 3 percent. The TDD shall comply with IEEE-519 requirement. Ensure that voltage distortion, current distortion, line notching and zero crossings are kept within allowable levels on both utility power and generator power. Provide line reactors, isolation transformers, filters and chokes as required.

B. Input Line Conditioning: Based on the harmonic analysis study and report, provide input filtering, as required, to limit THD(V) to 3 percent and TDD to comply with 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: Manual operation only; requires local operator selection at VFD. Transfer between power converter and bypass contactor and retransfer shall only be allowed with the motor at zero speed.

C. 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.

D. Bypass Controller: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller.

E. In "Bypass Contactor" Subparagraph below, IEC-rated contactors are most often used for the bypass contactor in HVAC applications and for smaller motors, and they are usually smaller and less costly than equivalent NEMA-rated contactors. NEMA-rated contactors are most often used in industrial applications and for larger motors, where they must carry high motor inrush and full-load running currents. IEC-rated contactors are most often used in all applications for the isolating contactors, because they are only used to isolate the power converter and normally do not carry any current. Consult manufacturers for the types used for each.

1. Bypass Contactor: Load-break, NEMA-rated contactor.
2. Output Isolating Contactor: Non-load-break, NEMA-rated contactor.
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.

F. Bypass Controller: Three-contactor-style bypass allows motor operation via the power converter or the bypass controller 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.

G. Bypass Contactor Configuration: Full-voltage (across-the-line) type.

1. NORMAL/BYPASS selector switch.
2. HAND/OFF/AUTO selector switch.
3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFD 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: 150 VA.

6. Overload Relays: NEMA ICS 2.

    a. Melting-Alloy Overload Relays:

        1) Inverse-time-current characteristic.
        2) Class 10 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 10 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 10 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. Multiple-Motor Capability: VFD suitable for variable-speed service to multiple motors. Overload protection shuts down VFD and motors served by it, and generates fault indications, when overload protection activates.

1. Configure to allow two or more motors to operate simultaneously at the same speed; separate overload relay for each controlled motor.
2. Configure to allow two motors to operate separately; operator selectable via local or remote switch or contact closures; single overload relay for both motors; separate output magnetic contactors for each motor.
3. Configure to allow two motors to operate simultaneously and in a lead/lag mode, with one motor operated at variable speed via the power converter and the other at constant speed via the bypass controller; separate overload relay for each controlled motor.

B. Damper control circuit with end of travel feedback capability.

C. Sleep Function: Senses a minimal deviation of a feedback signal and stops the motor. On an increase in speed-command signal deviation, VFD resumes normal operation.

D. Motor Preheat Function: Preheats motor when idle to prevent moisture accumulation in the motor.

E. 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 VFD to operate motor, without any other run or speed command, at a field-adjustable, preset speed.
3. Forces VFD to transfer to Bypass Mode and operate motor at full speed.
4. Causes display of Override Mode on the VFD display.
5. Reset VFD to normal operation on removal of override signal automatically.

F. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.

G. Remote digital operator kit.

H. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer and a notebook computer.

2.6 ENCLOSURES

A. VFD 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 VFD as "Plenum Rated."

2.7 ACCESSORIES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFD enclosure cover unless otherwise indicated.

1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty type.

a. Push Buttons: Covered types.
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. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

G. Space heaters, with NC auxiliary contacts, to mitigate condensation in NEMA 250, Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

H. 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.

I. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

J. Spare control-wiring terminal blocks; unwired.

2.8 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFDs according to requirements in NEMA ICS 61800-2.

1. Test each VFD while connected to its specified motor.
2. Verification of Performance: Rate VFDs according to operation of functions and features specified.

B. VFDs 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 VFDs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance.

B. Examine VFD before installation. Reject VFDs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFD 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 VFD input filtering to limit TDD and THD(V) at each VFD to specified levels.

B. Prepare a harmonic analysis study and report complying with IEEE 399 and NETA Acceptance Testing Specification.

3.3 INSTALLATION

A. Coordinate layout and installation of VFDs 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 VFDs 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 Section 260529 "Hangers and Supports for Electrical Systems."

C. Floor-Mounting Controllers: Install VFDs on 4-inch nominal thickness concrete base. Comply with requirements for concrete base specified in Section 033000 "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 seismic design category requirements specified in Section 260548.

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 VFD.

G. Install fuses in control circuits if not factory installed.

H. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

I. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

J. Comply with NECA 1.

3.4 IDENTIFICATION

A. Identify VFDs, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each VFD with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

B. Operating Instructions: Frame printed operating instructions for VFDs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFD units.

3.5 CONTROL WIRING INSTALLATION

A. Install wiring between VFDs and remote devices.

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 VFD element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

E. Tests and Inspections:

1. Inspect VFD, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Test insulation resistance for each VFD element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at VFD locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify FAA 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 VFD. 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 VFD 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. VFDs 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 VFD 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 FAA before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

E. Set field-adjustable circuit-breaker trip ranges as specified in Overcurrent Protective Device Coordination Study.

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 VFDs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative shall provide two 4-hour sessions of training and training material to train FAA maintenance personnel to adjust, operate, reprogram, and maintain VFDs.

END OF SECTION 26 29 23

SECTION 26 41 13 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes lightning protection for buildings and associated structures and requirements for lightning protection system components.

1.2 REFERENCE STANDARDS

Applicable only to the extent specified.

A. National Fire Protection Association (NFPA)

1. 780: Standard for Installation of Lightning Protection Systems.
2. 70: National Electrical Code (NEC), 2014 edition

B. National Institute of Standards and Technology (NIST)

C. Occupational Safety and Health Administration (OSHA)

1. 29 CFR 1910.7: Definitions and Requirements for a Nationally Recognized Testing Laboratory (NRTL).

D. Underwriters Laboratories (UL)

1. 96: Lightning Protection Components
1. 96A: Installation Requirements for Lightning Protection Systems

E. Federal Aviation Administration (FAA)

1. FAA-STD-019e: Lightning and Surge Protection, Grounding Bonding and Shielding Requirements for Facilities and Electronic Equipment.

1.3 SUBMITTALS

A. Product Data for each component specified. Include the following:

1. Roof adhesive data.
2. Air terminal illustrations.
3. Cable termination components.

B. Shop Drawings detailing lightning protection system, including but not limited to air terminal locations, conductor routing and connections, bonding and grounding provisions. Include indications for use of raceway and data on how concealment requirements will be met.

C. Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include data on listing or certification by nationally recognized testing laboratory (NRTL) or trade association. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

D. Certification, signed by Contractor, that roof adhesive for air terminals is approved by manufacturers of both the terminal assembly and the single-ply membrane roofing material.

E. Field inspection reports indicating compliance with specified requirements.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer who is certified by the Lightning Protection Institute as a Master Installer/Designer to install lightning protection system.

B. Listing and Labeling: Provide products specified in this Section that are listed and labeled by an organization concerned with product evaluations and that can determine compliance with appropriate standards for the current production of listed items.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: A NRTL as defined in OSHA Regulation 1910.7.

C. Conform to NFPA 780.

D. Conform to UL 96A.

E. Conform to the most stringent requirements of the following standards.

1. LPI certification of system.
2. ETL Master Label indicating system complies with specified requirements.

1.5 SEQUENCING AND SCHEDULING

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, in accordance with FAA Order 6950.19 and 6950.20.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Approved Lightning Protection Co., Inc.
2. Harger Lightning Protection, Inc.
3. Heary Bros. Lightning Protection Co.
4. Thompson Lightning Protection Co.

2.2 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. Materials: All equipment shall be UL approved and marked in accordance with UL procedures. All equipment shall be new and of a design and construction to suit the application in accordance with UL 96A requirements. Bronze and stainless steel may be used for some components. Aluminum material shall not be contact with copper material and bimetal connector shall be used for interconnecting copper and aluminum.

B. Air Terminals:

1. Air terminals shall be UL approved and shall be solid copper, aluminum or bronze. Copper air terminals may be nickel plated. The minimum sizes are 1/2 inch in diameter for solid copper or bronze air terminals, and 5/8 inch in diameter for solid aluminum air terminals. Air terminals shall be a minimum of 12 inches in height, and shall have a rounded or "bullet" tip.
2. Air terminals shall be located in accordance with the requirements of NFPA 780 and UL 96A.
3. Air terminals shall extend at least 36 inches above the object or area they are designed to protect and 5 feet above walking surface.

C. Conductors: All lightning protection conductors shall be sized in accordance with FAA Std 19e, minimum Class II material.

D. Hardware: Hardware shall meet the following requirements:

1. Fasteners: Roof and down conductors shall be fastened at intervals not exceeding 3 feet. Fasteners shall be of the same material as the conductor base material or bracket being fastened, or other equally corrosion resistant material. Galvanized or plated materials shall not be used.
2. Fittings: Bonding devices, cable splices, and miscellaneous connectors shall be suitable for use with the installed conductor with exothermic weld. Bolt pressure connections of secondary conductors may be acceptable where indicated on drawings. Cast or stamped crimp type fittings shall not be used.

E. Guards: Guards shall be provided for down conductors located in or next to driveways, walkways or other areas where they may be displaced or damaged. Guards shall extend to 6 feet above grade level, and 1 foot below grade level. Guards shall be schedule 40 PVC.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and conditions, with Installer present, for compliance with installation tolerances and other conditions affecting performance of lightning protection System. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Installation shall conform to UL standard 96A.

B. Comply with UL 96A, NFPA 780.

C. Conform to the most stringent requirements when more than one standard is specified.

D. Conductor and conduit routing: Roof and down conductors shall maintain a horizontal or downward course. No bend in a roof or down conductor shall form an included angle of less than 90 degrees, nor shall it have a bend radius of less than 8 inches. Conductors shall be routed external to buildings and 6 feet or more from power or signal conductors.

E. Down conductor terminations: Down conductors used to ground air terminals and roof conductors shall terminate on buried ground rods eighteen (18) inches vertically below ground level, and from 2 feet to 6 feet outside the foundation or exterior footing of the building. Down conductors shall be connected to the ground rods by exothermic welding. Provide number of down conductors indicated on drawings.

F. Route down conductors outside of building facade in PVC conduit. Submit system plan which indicates exact location of down conductors, as well as intended equipment locations, to COR for approval prior to installation.

G. Notify COR at least 24 hours before concealing lightning protection system components.

H. Air Terminal attachment: All air terminals shall be secured against overturning either by attachment to the object to be protected, or by means of braces that are permanently and rigidly attached to the building.

I. Metallic bodies subject to induced charges: Metallic bodies, on or below roof level, that are subject to induced charges from lightning include roof drains, plumbing vents, metal coping, metal flashing, gutters, downspouts, small metal wall vents, door and window frames, metal balcony railings, and generally, any isolated metallic body within 6 feet of an exposed lightning protection system element. These metallic bodies shall be bonded to the lightning protection system using UL approved splicers, fittings, and conductors. Conductors used for bonding these metallic bodies shall be Class II secondary conductors in accordance with FAA Std 19e.

J. Metallic bodies subject to direct lightning discharge: Metallic bodies on roofs subject to direct lightning discharge are generally any large metallic body whose size causes it to protrude beyond

the zone of protection of the installed air terminals. This includes antenna support structures, exhaust fans, flues, ladders, railings, and roof hatches. When these metallic bodies have a metal thickness of 3/16 inches or greater, they shall be bonded to the nearest main lightning protection system conductor with UL approved fittings and conductors meeting the requirements of NFPA 780. These bonding fittings shall provide surfaces of not less than 3 square inches. Provisions shall be made to prevent corrosive effects introduced by galvanic action of dissimilar metals at bonding points. If the metal parts of these units are less than 3/16 inches thick, additional approved air terminals, conductors, and fittings, providing a two-way path to ground from the air terminals, shall be installed.

K. Hydraulically crimped connections are not acceptable. Only exothermic welds are acceptable.

3.3 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 the junction of such materials.

B. Use conductors with suitable protective coatings where conditions would cause deterioration or corrosion of conductors.

3.4 FIELD QUALITY CONTROL

A. Periodic Inspections: Provide the services of a qualified inspector to perform periodic inspections during construction and at its completion, according to LPI-175.

B. ETL Inspection: Provide the services of ETL to inspect completed system for conformance with specified requirements.

3.5. TESTING

A. Upon completion of installation of lightning protection system, test resistance-to-ground with resistance tester. Where tests show resistance-to-ground is over 10 ohms, take appropriate action to reduce resistance to 10 ohms, or less, by treating soil proximity to ground rods with sodium chloride, copper sulfate, or magnesium. Then retest to demonstrate compliance. Submit results to COR.

B. Make a visual inspection to verify that all connections have been made firm (i.e. not loose causing high resistance).

END OF SECTION 26 41 13

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SECTION 26 43 13 - SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes field-mounted SPDs for low-voltage (120 to 600 V) power distribution and control equipment.

1.2 DEFINITIONS

A. Inominal: Nominal discharge current.

B. MCOV: Maximum continuous operating voltage.

C. Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.

D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.

E. OCPD: Overcurrent protective device.

F. SCCR: Short-circuit current rating.

G. SPD: Surge protective device.

H. VPR: Voltage protection rating.

1.3 REFERENCE STANDARDS

A. American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE)
   1. C62.41: Guide for Surge Voltages in Low Voltage AC Power Circuits.
   2. C62.45: Standard for Testing Procedures and Practices.
   3. C62.1: Standard for Surge Arrestors for AC Power Circuits.
   4. C62.33: Standard for Test Specification for Varistor Surge Protection Devices.
   5. 81: Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Ground System.

B. National Fire Protection Association (NFPA)
   1. 70: National Electrical Code (NEC), 2014 edition.

C. Underwriters Laboratory (UL)

1. 1449: Transient Voltage Surge Suppressors.
2. 1283: Electromagnetic Interference Filters.
3. 486A: Wire Connectors and Soldering Lugs for use with Copper Conductors.

D. Federal Aviation Administration (FAA)
1. C-1217f: Electrical Work, Interior.
2. Std-019e: Lightning Protection, Grounding, Bonding and Shielding Requirements for Facilities.
3. Std-020b: Transient Protection, Grounding and Shielding for Electronic Equipment.

E. Occupational Safety and Health Administration (OSHA)
1. 29CFR 1910.7: Definitions and Requirements for a Nationally Recognized Testing Laboratory (NRTL).

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Dimensions for each suppressor type and indicate mounting arrangement with required hardware and conductor.
3. Manufacturer's UL certified test data derived from test results conducted on a completed unit indicating the ability of the product to meet or exceed the requirements of this work. Include confirmation of a fail short failure mode.
4. Provide documentation certifying UL 1449 2nd Edition listing.
5. Submit electrical one-line diagram layout showing location of each unit installation point.
6. Wiring diagrams, elementary or schematic: Single line diagram of TVSS showing connections between TVSS and power source.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For SPDs to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Listing and Labeling: Provide electrically operated equipment specified in this Section that is listed and labeled.

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" as defined in OSHA Regulation 1910.7.

B. Perform work to meet or exceed the requirements of NFPA 70 and other applicable statutes, ordinances, codes and regulations of governmental authorities having jurisdiction. Notify the COR of known or probable code violations discovered during contractor performance. Do not proceed with the work until violations have been resolved.

C. Manufacturer's Qualifications:
1. Surge suppression devices manufactured by a company engaged in the design, development and manufacture of surge suppression devices for the protection of electrical circuits and electronic equipment with such products in satisfactory use in similar service for not less than 5 years.
2. Regulatory Requirements:
   a. For purposes of this specification, IEEE Category C and B locations, assume maximum voltage amplitude of twenty kilovolts and a maximum current amplitude to ten kiloamperes.
   b. UL Standard 1449 2nd Edition.

1.8 WARRANTY

A. Special Warranty: A written warranty, executed by manufacturer, agreeing to repair or replace components of transient voltage surge suppressors that fail in materials or workmanship within the specified warranty period.
1. Warranty Period: 5 years from date of Final Acceptance by COR.
2. Should suppressor be destroyed by surge(s) or transients, free replacement shall apply during the warranty period.

PART 2 - PRODUCTS

2.1 GENERAL SPD REQUIREMENTS

A. Materials procured and installed in this section shall be in accordance with FAA C-1217f, FAA Std. 019e, and FAA Std. 020b.

2.2 SUPPRESSOR CRITERIA: CATEGORY C DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Current Technology, Inc.
2. Advanced Protection Technologies Inc. (APT).
3. Eaton Corporation.

B. Location: Distribution, lighting, and branch circuit panels serving exterior equipment, IEEE C62.41, Category C, unless otherwise shown on the Drawings.

C. Three-Phase, Three-Wire Configuration: Provide independent suppression elements between each phase conductor providing a total of three suppression element paths.

D. Three-Phase, Four-Wire Configuration: Provide independent suppression elements between each phase conductor and the system neutral, between each phase conductor and the system ground, and between the system ground and the system neutral conductors, providing a total of seven suppression element paths.

E. If MOV's are used as suppression elements, each individual MOV must be rated for a minimum of 115 percent of nominal operating voltage.

F. Suppressors shall have a turn-on and turn-off time of less than one nanosecond, less than 5 nanoseconds for system, 1 nanosecond for each element.

G. Suppressors shall utilize solid-state componentry that operates bi-directionally.

H. 480 Volt Delta Connected Suppressors shall meet the following criteria:
1. Line-to-Line. Maximum single impulse current rating: 160,000 amps (8 x 20 μs waveform).
2. Pulse Life Rating: 10,000 amperes (8 x 20 μs waveform) with 1,000 occurrences in accordance with ANSI C62.45.
3. Maximum clamping voltage and current rating when subjected to waveform with the following characteristics: 1.2 by 50 μs, 20 KV open circuit voltage and 8.0 by 20 μs, 10 KA short circuit current:

SYSTEM VOLTAGE DELTA CONNECTED	CLAMPING VOLTAGE L - L
480 Volts	1,500 Volts

I. 480Y/277 Volt Wye Connected Suppressors shall meet the following criteria:
1. Line-to-Neutral. Maximum single impulse current rating: 160,000 amps (8 x 20 μs waveform).
2. Line-to-Ground. Maximum single impulse current rating: 160,000 amps (8 x 20 μs waveform).
3. Neutral-to-Ground. Maximum single impulse current rating: 160,000 amps (8 x 20 μs waveform).
4. Pulse Life Rating: 10,000 amperes (8 x 20 μs waveform) with 1,000 occurrences in accordance with ANSI C62.45.2.
5. Maximum clamping voltage and current rating when subjected to waveform with the following characteristics: 1.2 by 50 μs, 20 KV open circuit voltage and 8.0 by 20 μs, 10 KA short circuit current:

SYSTEM VOLTAGE WYE CONNECTED	CLAMPING VOLTAGES		
	L - N	L-G	N-G
480Y/277 Volts	900	900	900

J. 208Y/120 Volt Wye Connected Suppressors shall meet the following criteria:
1. Line-to-Neutral. Maximum single impulse current rating: 160,000 amps (8 x 20 μs waveform).
2. Line-to-Ground. Maximum single impulse current rating: 160,000 amps (8 x 20 μs waveform).
3. Neutral-to-Ground. Maximum single impulse current rating: 160,000 amps (8 x 20 μs waveform).
4. Pulse Life Rating: 10,000 amperes (8 x 20 μs waveform) with 1,000 occurrences in accordance with ANSI C62.45.2.
5. Maximum clamping voltage and current rating when subjected to a waveform with the following characteristics: 1.2 by 50 μs, 6 KV open circuit voltage, and 8.0 by 20 μs, 3 KA short circuit current:

SYSTEM VOLTAGE WYE CONNECTED	CLAMPING VOLTAGES		
	L - N	L-G	N-G
208Y/120 Volts	400	400	400

K. Provide visible indication of proper suppressor connection and operation without having to disconnect or disassemble the unit.

2.3 SUPPRESSOR CRITERIA: CATEGORY B LOCATIONS

A. Locations: As shown on the drawings, conforming to IEEE C62.41, Category B.

B. Three-Phase, Four-Wire Configuration: Provide independent suppression elements between each phase conductor and the system neutral, between each phase conductor and the system ground, and between the system ground and the system neutral conductors, providing a total of seven suppression element paths.

C. If MOV's are used as suppression elements, each individual MOV must be rated for a minimum of 115 percent of nominal operating voltage.

D. Suppressors shall have turn-on and turn-off times of less than one nanosecond for each element, less than 5 nanoseconds for each system.

E. Suppressors shall utilize solid-state componentry that operates bi-directionally.

F. Suppressors shall meet or exceed the following criteria (100,000 ampere surge current per phase):
1. Line-to-Neutral. Maximum single impulse current rating: 50,000 amps (8 x 20 μs waveform).

2. Line-to-Ground. Maximum single impulse current rating: 50,000 amps (8 x 20 μs waveform).
3. Neutral-to-Ground. Maximum single impulse current rating: 50,000 amps (8 x 20 μs waveform).
4. Pulse Life Rating: 10,000 amperes (8 x 20 μs waveform) with 1,000 occurrences in accordance with ANSI C62.45.2.
5. Maximum clamping voltage and current rating when subjected to a waveform with the following characteristics: 1.2 by 50 μs, 6 KV open circuit voltage, and 8.0 by 20 μs, 3 KA short circuit current.

SYSTEM VOLTAGE WYE CONNECTED	CLAMPING VOLTAGES		
	L - N	L-G	N-G
208Y/120 Volts	400	400	400

2.4 ANNUNCIATION (COVER MOUNTED)

A. Diagnostic and Monitor Panel:
   a. Provide visual status indicators, one for each suppression module.
   b. Status Alarm Monitor: Provide one normally open and one normally closed dry contacts interlocked with the status alarm monitoring.
   c. Provide a transient counter.

2.5 FILTERING

A. Electromagnetic Interference and Radio Frequency Filters: Provide per UL 1283 and UL 1449, for all suppressors.

B. The filtering circuit shall provide a minimum insertion loss as indicated below. Note: Standardized insertion loss data obtained utilizing MIL-STD-B220A 50 ohm insertion loss methodology.

Frequency	100 KHZ	1 MHZ	10 MHZ	100 MHZ
Attenuation (dB)	34	51	54	48
Attenuation Ratio	50:1	350:1	500:1	250:1

2.6 ENCLOSURES

A. Indoor Enclosures: NEMA 250, Type 1.

B. Outdoor Enclosures (Permanent): NEMA 250, Type 4X.

C. Outdoor Enclosures (Temporary): NEMA 250, Type 3R

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Materials procured and installed in this Section shall be in accordance with FAA C-1217f, Std-019e and FAA Std-020b.

C. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.

D. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

E. Use crimped connectors and splices only. Wire nuts are unacceptable.

F. Wiring:

1. Power Wiring: Comply with wiring methods in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
2. Controls: Comply with wiring methods in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

G. Connections
1. Ground each transient voltage surge suppressor enclosure.
   a. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A.

3.2 EXAMINATION

A. Examine conditions for compliance with requirements for installation tolerances, power characteristics, and other conditions affecting performance of transient voltage surge suppressors. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.3 COORDINATION

A. Coordinate installation of TVSS system with manufacturers and suppliers of equipment to be protected.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.

1. Compare equipment nameplate data for compliance with Drawings and Specifications.
2. Inspect anchorage, alignment, grounding, and clearances.
3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

B. An SPD will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Complete startup checks according to manufacturer's written instructions.

B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests, and reconnect them immediately after the testing is over.

C. Energize SPDs after power system has been energized, stabilized, and tested.

3.6 DEMONSTRATION

A. Train FAA's maintenance personnel to operate and maintain SPDs.

END OF SECTION 26 43 13

SECTION 26 51 00 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes interior lighting fixtures, lamps, ballasts and accessories.

1.2 REFERENCE STANDARDS

Applicable only to the extent specified.

A. American National Standards Institute (ANSI)

1. C62.41: Recommended Practice on Surge Voltage in Low-Voltage AC Power Circuits
2. C78: Electric Lamps
3. C82.2: Fluorescent Lamp Ballast, Methods of Measurement
4. C82.4: Ballast for High-Intensity-Discharge Sodium Lamps

B. Federal Aviation Administration (FAA)

1. FAA-C-1217f Electrical Work, Interior.

C. Federal Communications Commission (FCC)

1. Part 18.

D. Institute of Electrical and Electronics Engineers (IEEE)+

1. C62.41: IEEE Recommended Practice on Surge Voltage in Low-Voltage AC Power Circuits.

E. Federal Specifications (FS)

1. W-F-414: Fixture, Lighting, Fluorescent
2. J-C-30: Cable and Wire, Electrical

F. Military Standards

1. MIL STD 461: Requirements for Control of Electromagnetic Interference Emissions and Susceptibility User.

G. National Fire Protection Association (NFPA)

1. 70: National Electrical Code (NEC), 2014 edition.

H. Occupational Safety and Health Administration (OSHA)

1. 29CFR 1910.7 Definitions and Requirements for a National Recognized Testing Laboratories (NRTL).

I. Underwriters Laboratories (UL)

1. 486A: Wire Connectors and Soldering Lugs for Use with Copper Conductors
2. 542: Lampholders, Starters, and Starter Holders for Fluorescent Lamps.
3. 924: Emergency Lighting and Power Equipment.
4. 935: Fluorescent Lamps and Ballasts
5. 1570: Fluorescent Lighting Fixtures

1.3 DEFINITIONS

A. Fixture: A complete lighting unit or exit sign. Fixtures include lamps and parts required to distribute light, position and protect lamps, and connect lamps to power supply.

B. Average Life: The time after which 50 percent fails and 50 percent survives under normal conditions.

C. Luminaire: Fixture.

1.4 SUBMITTALS

A. Product Data describing fixtures, lamps, and ballasts. Arrange Product Data for fixtures in order of fixture designation. Include data on features and accessories and the following:

1. Outline drawings indicating dimensions and principal features of fixtures.
2. Electrical Ratings and Photometric Data: Certified results of independent laboratory tests for fixtures and lamps.
3. Manufacturer's suggested maintenance procedure and requirements.

B. Maintenance data for fixtures to include in the operations and maintenance manual.

C. Product certifications signed by manufacturers of lighting fixtures certifying that their fixtures comply with specified requirements.

D. Shop drawings from manufacturers detailing nonstandard fixtures and indicating dimensions, weights, methods of field assemply, components, features, accessories, supports, and seismic bracing.

1.5 QUALITY ASSURANCE

A. Electrical Component Standard: Provide components that comply with NFPA 70 and that are listed and labeled by UL.

B. Listing and Labeling: Provide fixtures and accessory components that are listed and labeled for their indicated use and installation conditions on the Project.

1. Special Listing and Labeling: Provide fixtures for use in damp or wet locations, underwater, and recessed in combustible construction that are specifically listed and labeled for such use.
2. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
3. Listing and Labeling Agency Qualifications: A NRTL as defined in OSHA Regulation 1910.7.

C. Energy Efficiency: Comply with National Energy Policy Act of 2005 requirements for lighting products.

D. Ballast Manufacturer Qualifications: Manufacturer shall have manufactured ballasts for at least ten years, and battery ballasts for at least ten years.

E. Coordinate fixtures, mounting hardware, and trim with ceiling system and other items, including work of other trades, required to be mounted on ceiling or in ceiling space.

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

1. Ballasts: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

1.7 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the FAA of other rights the FAA may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Special Warranty - Ballasts: Provide a written warranty signed by manufacturer and Installer agreeing to replace ballasts against defects in material or workmanship for a period of five years from the date of Substantial Completion. Defective ballasts shall be replaced within the warranty period at no cost to the FAA.

PART 2 - PRODUCTS

2.1 FIXTURE COMPONENTS, GENERAL

A. Electromagnetic Interference (EMI) and Radio Frequency Interference RFI filters.

2.2 FLUORESCENT FIXTURE BALLASTS.

A. Emergency Self-testing/ Self-diagnostic Fluorescent Battery Ballast: 2 lamp, self-contained, modular, battery-inverter unit factory mounted within fixture body. Comply with UL 924.

1. Test Switch and Light-Emitting Diode Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
2. Battery: Sealed, maintenance-free, nickel-cadmium type with minimum 7-year nominal life.
3. Charger: Fully automatic, solid-state, constant-current type.
4. Operation: Relay automatically energizes lamp from unit when normal AC power fails. When normal voltage is restored, relay disconnects lamp, and battery is automatically recharged and floated on charger.
5. Testing: Electronic circuitry shall be self-testing in design and automatically test emergency lighting for a minimum of 30 seconds every 30 days and 90 minutes once a year.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Set units plumb, square, and level with ceiling and walls, and secure according to manufacturer's written instructions and approved Shop Drawings.

B. Support for Recessed and Semi-recessed Grid-Type Fluorescent Fixtures: Units shall not be solely supported from suspended ceiling support system. Install ceiling support system rods or wires at a minimum of 4 rods or wires for each fixture, located not more than 3 inches from fixture corners.

In addition, each fixture shall be supported at each corner, with 12 gage steel drop ceiling hanger wire.

1. Install support clips for recessed fixtures, securely fastened to ceiling grid members, at or near each fixture corner.
2. Fixtures Smaller than Ceiling Grid: Install a minimum of 4 rods or wires for each fixture at corner of ceiling grid where fixture is located. Do not support fixtures by ceiling acoustical panels.
3. Fixtures of Sizes Less than Ceiling Grid: Center in acoustical panel. Support fixtures independently from the building structure with at least two 3/4-inch metal channels.

C. Support for Suspended Fixtures: Provide unistrut support for light fixtures to match existing.

D. Lamping: Lamp units according to manufacturer's instructions.

E. Install fixtures and support system to withstand forces for the IBC Seismic Design Category indicated in Section 26 05 48.

3.2 CONNECTIONS

A. Ground lighting units. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A.

B. External bonding jumpers are not required across lighting fixture flexible conduit.

3.3 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replaced damaged fixtures and components.

B. Give advance notice of dates and times for field tests.

C. Provide instruments to make and record test results.

D. Tests: Verify normal operation of each fixture after fixtures have been installed and circuits have been energized with normal power source. Interrupt electrical energy to demonstrate proper operation of emergency lighting installation. All fixtures shall be energized upon completion of installation for a period of 72 hours, upon which contractor shall replace any lamps or ballasts which are not operating properly.

E. Replace or repair malfunctioning fixtures and components, then retest. Repeat procedure until all units operate properly.

F. Report results of tests.

G. Replace fixtures that show evidence of corrosion during Project warranty period.

3.4 ADJUSTING AND CLEANING

A. Clean fixtures after installation. Use methods and materials recommended by manufacturer.

3.5 DISPOSAL

A. Removing Materials: Remove and dispose of the light tubes/bulbs and ballasts in accordance with applicable State and local rules and regulations.

END OF SECTION 26 51 00

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SECTION 26 56 00 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes exterior lighting fixtures, lamps, ballasts, and accessories.

1.2 REFERENCE STANDARDS

A. American National Standards Institute (ANSI)

1. C2: National Electric Safety Code.
2. C78 Series: Lamps.
3. C78.135X Series: High Pressure Sodium Lanps
4. C78.388: Electric Lamps, High Pressure Sodium lamps, Methods of MeasuringCharacteristics.
5. C82.4: Ballasts for High-Intensity Discharge and Low-Pressure Sodium Lamps.
6. C82.5: Reference Ballasts - High Intensity Discharge and Low Pressure Sodium Lamps.
7. C82.6: Reference Ballasts for High Intensity Discharge Lamps - Methods of Measurement.

B. Federal Communications Commission (FCC)

1. Part 18.
2. Part 15.

C. American Standards for Testing and Materials (ASTM)

1. A500 : Cold Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

D. American Association of State Highway and Transportation Officials (AASHTO)

1. LTS-3: Structural Supports of Highway Signs, Luminaires and Traffic Signals.

E. National Fire Protection Agency (NFPA)

1. 70: National Electrical Code (NEC), 2011 edition.

F. Occupational Safety and Healthe Administration (OSHA)

1. 29CFR1910.7: Description and Requirements for a Nationally Recognized Testing Laboratory (NRTL).

G. Underwriters Laboratories (UL)

1. 773: Plug-In Locking Type Photocontrols for Use with Area Lighting
2. 1029: High-Intensity-Discharge Lamp Ballasts.
3. 1572: High-Intensity-Discharge Lighting Fixtures.
4. 1598: Luminaires.

H. Federal Standards (FS)

1. J-C-30: Cable and Wire, Electrical.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color rendering index.

C. Fixture: A complete lighting device. Fixtures include a lamp or lamps and parts required to distribute light, position and protect lamps and connect lamps to power supply.

D. Lighting Unit: A fixture or an assembly of fixtures with a common support, including a pole or bracket plus mounting and support accessories.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: A fixture.

1.4 SUBMITTALS

A. Product Data describing fixtures, lamps, ballasts, poles and accessories. Arrange Product Data for fixtures in order of fixture designation. Include data on features, poles, accessories, finishes and the following:

1. Outline drawings indicating dimensions and principal features of fixtures and poles.
2. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.
3. Electrical Ratings and Photometric Data: Certified results of independent laboratory tests for fixtures and lamps.

    a. LED fixtures: Manufacturer must provide testing documentation demonstrating that radiated emissions testing has been performed up to 1000MHz for LED lighting products to ensure compliance with the radiated emissions requirements.
4. Photoelectric relays.
5. Means for attaching luminaires to supports and indication that the attachment is suitable for componenets involved.

B. Wind Resistance Calculations: Certified by a registered professional engineer.

C. Shop Drawings detailing nonstandard fixtures and poles and indicating dimensions, weights, method of field assembly, components and accessories.

D. Wiring diagrams detailing wiring for control system showing both factory-installed and field-installed wiring for specific system of this Project and differentiating between factory-installed and field-installed wiring.

E. Anchor-Bolt Templates: Keyed to specific poles and certified by manufacturer.

F. Product certificates signed by manufacturers of lighting units certifying that their products comply with specified requirements.

G. Field test reports indicating and interpreting test results specified in Part 3 of this Section.

H. Prepare and distribute operations and maintenance data as specified in Section 01 78 23 "Operation and Maintenance Data."

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. Listing and Labeling: Provide fixtures and accessories specified in this Section that are listed and labeled for their indicated use and installation conditions on Project.

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.

C. Comply with ANSI C2.

D. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturers' laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

E. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products and complying with applicable IES testing standards.

F. Provide luminaires from a single manufacturer for each luminaire type.

G. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

H. Energy Efficiency: Comply with National Energy Policy Act of 2005 requirements for lighting products.

I. LED lighting fixtures require special consideration for application in Radio communication and low Electromagnetic-Interference Environments per 47 CFR 18, Ch. 1, Subpart C, limitations on electromagnetic and radio-frequency interference for consumer equipment. Light-emitting-diode (LED) lighting products use a different technology. In most cases they employ switching power supplies which operate at RF frequencies similar to those used in digital electronic

products; they do not apply an RF signal to the gas in a lamp. As such, they are subject to the Federal Communications Commission (FCC), Part 15 rules for unitentional radiators and are subject ot the "Verification" equipment authorization procedures with the line-conducted and radiated emissions limitis in §§15.107 and 15.109, respectively. LED fixture manufacturer must provide testing documentation demonstrating that radiated emissions testing has been performed up to 1000 MHz for LED lighting products to ensure compliance with the radiated emissions requirements.

1.6 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Government of other rights the Government may have under other provisions of the Contract Documents and shall be in addition to and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Special Warranty: Submit a written warranty signed by manufacturer and Installer agreeing to replace external parts of lighting fixtures exhibiting a failure of finish as specified below. This warranty is in addition to and not a limitation of, other rights and remedies the Government may have under the Contract Documents.

1. Protection of Metal from Corrosion: Warranty against perforation or erosion of finish due to weathering.
2. Color Retention: Warranty against fading, staining and chalking due to effects of weather and solar radiation.
3. Special Warranty Period: 5 years from date of Substantial Completion.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage and are identified with labels describing contents.

1. Lamps: 1 lamp for each type and rating installed. (For group relamping when lamps have reached 70 percent of rated life.)
2. Glass and Plastic Lenses, Covers and Other Optical Parts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
3. Ballasts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
4. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Comply with the requirements specified in the Articles below and lighting fixture schedule indicated on the drawings.

B. The fixtures specified in the lighting fixture schedule on the Drawings establish a level of quality and appearance that any substituted fixtures must match or exceed. Substitutions for the specified fixtures will be reviewed by the COR for compliance and approval.

C. All lighting fixtures shall be UL approved and shall bear the UL label.

2.2 FIXTURES AND FIXTURE COMPONENTS, GENERAL

A. Metal Parts: Free from burrs, sharp edges and corners.

B. Sheet Metal Components: Corrosion-resistant aluminum,cast metal and steel, except as otherwise indicated. Form and support to prevent warping and sagging.

C. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag or deform in use. Provide filter/breather for enclosed fixtures.

D. Doors, Frames and Other Internal Access: Smooth operating, free from light leakage under operating conditions and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers and other pieces to prevent accidental falling during relamping and when secured in operating position. Provide for door removal for cleaning or replacing lens. Arrange for door opening to disconnect ballast.

E. Exposed Hardware Material: Stainless steel.

F. Reflecting Surfaces: Minimum reflectances as follows, except as otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

G. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat and UV radiation.

H. Lenses and Refractors: Materials as indicated. Use heat- and aging-resistant, resilient gaskets to seal and cushion lens and refractor mounting in fixture doors.

I. Comply with UL 1598.

J. High-Intensity-Discharge (HID) Fixtures: Conform to UL 1572.

K. Fixture wiring shall be thermoplastic insulated copper, rated for 600 volts, in accordance with FS J-C-30 and the NEC.

2.3 LED FIXTURES

A. LED Lamps: Minimum CRI 65 and CCT 5000K,L70 lamp life of 50,000 hours.

B. Internal Driver.

2.4 BALLASTS FOR HID LAMPS

A. Comply with ANSI C82.4 and UL 1029 and capable of open-circuit operation without reduction of average lamp life. Include the following features unless otherwise indicated:

1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.

2. Minimum Starting Temperature: Minus 22 deg F.
3. Normal Ambient Operating Temperature: 104 deg F.
4. Ballast Fuses: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by ballast manufacturer.

B. Auxiliary, Instant-On, Quartz System: Factory-installed feature automatically switches quartz lamp on when fixture is initially energized and when momentary power outages occur. System automatically turns quartz lamp off when HID lamp reaches approximately 60 percent of light output.

2.5 HID LAMPS

A. Metal-Halide Lamps: ANSI C78.43, with minimum CRI 65 and CCT 4000K.

2.6 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS

A. Comply with UL 773 or UL 773A.

B. Factory installed photocell in an electrical compartment with fully gasketed sensor.

C. 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.

1. Relay with locking-type receptacle shall comply with ANSI C136.10.
2. Adjustable window slide for adjusting on-off set points.

2.7 FIXTURE SUPPORT COMPONENTS

A. Wind-load strength of total support assembly, including pole, arms, appurtenances, base and anchorage, is adequate to carry itself plus fixtures indicated at indicated heights above grade without failure, permanent deflection or whipping in steady winds of 90 mi./h with a gust factor of 4.1

B. Arm, Bracket and Tenon Mount Materials: Match poles' finish.

C. Mountings, Fastenings and Appurtenances: Corrosion-resistant items compatible with support components. Use materials that will not cause galvanic action at contact points. Use mountings that correctly position luminaire to provide indicated light distribution.

2.8 FINISHES

A. Metal Parts: Manufacturer's standard finish, except as otherwise indicated, applied over corrosion-resistant primer, free of streaks, runs, holidays, stains, blisters and similar defects.

B. Other Parts: Manufacturer's standard finish, except as otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Set units plumb, square, level and secure according to manufacturer's written instructions and approved Shop Drawings.

B. Fixture Attachment: Fasten to indicated structural supports.

C. Lamp fixtures with indicated lamps according to manufacturer's written instructions. Replace malfunctioning lamps.

3.2 GROUNDING

A. Ground fixtures and metal poles according to Section 26 05 26 "Grounding and Bonding for Electrical Systems".

3.3 FIELD QUALITY CONTROL

A. Inspect each installed unit for damage. Replace damaged fixtures and components.

B. Give advance notice of dates and times for field tests.

C. Provide instruments to make and record test results.

D. Tests and Observations: Verify normal operation of lighting units after installing fixtures and energizing circuits with normal power source. Include the following:

1. Photometric Tests: Measure light intensities at night at locations where specific illumination performance is indicated. Use photometers with calibration referenced to National Institute of Standards and Technology (NIST) standards.
2. Check for intensity of illumination.
3. Check for uniformity of illumination.
4. Check for excessively noisy ballasts or drivers.
5. Prepare written report of tests indicating actual illumination results.

E. Replace or repair damaged and malfunctioning units, make necessary adjustments and retest. Repeat procedure until all units operate properly.

3.4 ADJUSTING AND CLEANING

A. Clean units after installation. Use methods and materials recommended by manufacturer.

B. Adjust aimable fixtures to provide required light intensities.

END OF SECTION 26 56 00

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SECTION 27 15 00 - COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pathways
2. UTP cabling.
3. 62.5/125-micrometer, optical fiber cabling.
4. Multiuser telecommunications outlet assemblies.
5. Cable connecting hardware, patch panels, and cross-connects.
6. Telecommunications outlet/connectors.
7. Cabling system identification products.
8. Cable management system.

1.2 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.

C. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

D. EMI: Electromagnetic interference.

E. IDC: Insulation displacement connector.

F. LAN: Local area network.

G. MUTOA: Multiuser telecommunications outlet assembly, a grouping in one location of several telecommunications outlet/connectors.

H. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.

I. RCDD: Registered Communications Distribution Designer.

J. UTP: Unshielded twisted pair.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordinate layout and installation of telecommunications cabling with Owner's telecommunications and LAN equipment and service suppliers.

B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

1.4 ACTION SUBMITTALS

A. Product Data: For features, ratings and performance of each component specified.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration drawings and printouts.
4. Wiring diagrams to show typical wiring schematics, including the following:

    a. Cross-connects.
    b. Patch panels.
    c. Patch cords.

5. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

6. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
    a. Vertical and horizontal offsets and transitions.
    b. Clearances for access above and to side of cable trays.
    c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
    d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

B. Source quality-control reports.

C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For splices and connectors to include in maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

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. Connecting Blocks: One of each type.
2. Device Plates: One of each type.
3. Multiuser Telecommunications Outlet Assemblies: One of each type.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD 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. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cables to determine the continuity of the strand end to end. Use optical fiber flashlight or optical loss test set.
2. Test optical fiber cables while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; including the loss value of each. Retain test data and include the record in maintenance data.

3. Test each pair of UTP cable for open and short circuits.

PART 2 - PRODUCTS

2.1 HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called a "permanent link," a term that is used in the testing protocols.

1. TIA/EIA-568-B.1 requires that a minimum of two telecommunications outlet/connectors be installed for each work area.
2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
3. Bridged taps and splices shall not be installed in the horizontal cabling.
4. Splitters shall not be installed as part of the optical fiber cabling.

B. A work area is approximately 100 sq. ft., and includes the components that extend from the telecommunications outlet/connectors to the station equipment.

C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-B.1 when tested according to test procedures of this standard.

B. 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: 25 or less.
2. Smoke-Developed Index: 50 or less.

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. Grounding: Comply with J-STD-607-A.

2.3 PATHWAYS

A. General Requirements: Comply with TIA/EIA-569-A.

B. Cable Support: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

1. Support brackets with cable tie slots for fastening cable ties to brackets.
2. Lacing bars, spools, J-hooks, and D-rings.
3. Straps and other devices.

C. Cable Trays:
1. Manufacturers:
   a. Cable Management Solutions, Inc.
   b. Cablofil Inc.
   c. Cooper B-Line, Inc.
   d. Cope - Tyco/Allied Tube & Conduit.
   e. GS Metals Corp.
2. Cable Tray Materials: Metal, suitable for indoors, and protected against corrosion.
   a. Center Spine Cable Trays: 18 inches wide and 4 inches deep. Rung spacing shall not exceed 12 inches.
   b. Ladder Cable Trays: 18 inches wide and 4 inches deep. Rung spacing shall not exceed 12 inches.

2.4 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements in Section 06 10 00 "Rough Carpentry" for plywood backing panels.

2.5 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ADC.
2. Belden Inc.
3. Berk-Tek; a Nexans company.
4. CommScope, Inc.
5. Draka Cableteq USA.
6. Genesis Cable Products; Honeywell International, Inc.
7. Mohawk; a division of Belden Networking, Inc.
8. Superior Essex Inc.
9. SYSTIMAX Solutions; a CommScope, Inc. brand.
10. 3M Communication Markets Division.
11. Tyco Electronics Corporation; AMP Products.

B. Description: 100-ohm, four-pair UTP, formed into 25-pair, binder groups covered with a blue thermoplastic jacket.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
3. Comply with TIA/EIA-568-B.2, Category 5e.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

   a. Communications, General Purpose: Type CM or CMG.

b. Communications, Plenum Rated: Type CMP, complying with NFPA 262.

2.6 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ADC.
2. American Technology Systems Industries, Inc.
3. Belden Inc.
4. Dynacom Inc.
5. Hubbell Premise Wiring.
6. Leviton Commercial Networks Division.
7. Molex Premise Networks; a division of Molex, Inc.
8. Panduit Corp.
9. Siemon Co. (The).
10. Tyco Electronics Corporation; AMP Products.

B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Connecting Blocks: 66-style IDC for Category 5e. Provide separate blocks for LAN and voice systems for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

D. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One for each conductor in assigned cables.

E. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Field: One for each four-pair conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria.

F. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

G. Patch Cords: Factory-made, four-pair cables in 48-inch lengths; terminated with eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
2. Patch cords shall have color-coded boots for circuit identification.

2.7 OPTICAL FIBER CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Belden Inc.
2. Berk-Tek; a Nexans company.
3. CommScope, Inc.
4. Corning Cable Systems.
5. CSI Technologies Inc.
6. General Cable Technologies Corporation.
7. Mohawk; a division of Belden Networking, Inc.
8. Superior Essex Inc.
9. SYSTIMAX Solutions; a CommScope, Inc. brand.
10. 3M Communication Markets Division.
11. Tyco Electronics Corporation; AMP Products.

B. Description: Multimode, 62.5/125-micrometer, 12-fiber, nonconductive, tight buffer, optical fiber cable.

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA/EIA-568-B.3 for performance specifications.
3. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
    a. General Purpose, Nonconductive: Type OFNG.
    b. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
4. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5dB/km at 1300 nm.
5. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

C. Jacket:

1. Jacket Color: Orange for 62.5/125-micrometer cable.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-C.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

2.8 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ADC.
2. American Technology Systems Industries, Inc.
3. Belden Inc.
4. Berk-Tek; a Nexans company.
5. Corning Cable Systems.
6. CSI Technologies Inc.
7. Dynacom Inc.
8. Hubbell Premise Wiring.

9. Molex Premise Networks; a division of Molex, Inc.
10. Siemon Co. (The).

B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

C. Patch Cords: Factory-made, dual-fiber cables in 36-inch lengths.

D. Cable Connecting Hardware:

1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA-604-2-B, TIA-604-3-B, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.
2. Quick-connect, simplex and duplex connectors. Insertion loss not more than 0.75 dB.

2.9 MULTIUSER TELECOMMUNICATIONS OUTLET ASSEMBLY (MUTOA)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Belden Inc.
2. Chatsworth Products, Inc.
3. Hubbell Premise Wiring.
4. Molex Premise Networks; a division of Molex, Inc.
5. Ortronics, Inc.; a subsidiary of Legrand Group.
6. Panduit Corp.
7. Siemon Co. (The).

B. Description: MUTOAs shall meet the requirements for cable connecting hardware.

1. Number of Terminals per Field: One for each conductor in assigned cables.
2. Number of Connectors per Field:

a. One for each four-pair UTP cable indicated.
b. One for each four-pair conductor group of indicated cables, plus 25 percent spare positions.

3. NRTL listed as complying with UL 50 and UL 1863.
4. Label shall include maximum length of work area cords, based on TIA/EIA-568-B.1.
5. When installed in plenums used for environmental air, NRTL listed as complying with UL 2043.

2.10 TELECOMMUNICATIONS OUTLET/CONNECTORS

A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-B.1.

B. Workstation Outlets: Four-port-connector assemblies mounted in single faceplate.

1. Plastic Faceplate: High-impact plastic. Color shall be white.
2. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords.

    a. Flush mounting jacks, positioning the cord at a 45-degree angle.

2.11 GROUNDING

A. Comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Comply with J-STD-607-A.

2.12 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

2.13 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.

C. Factory test UTP cables according to TIA/EIA-568-B.2.

D. Factory test multimode optical fiber cables according to TIA-526-14-A and TIA/EIA-568-B.3.

E. Factory-sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.

F. Cable will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

A. Install cables in pathways and cable trays except within consoles, cabinets, desks, in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used. Conceal pathways and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.

B. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures:

1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 INSTALLATION OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A-7.

B. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.

C. Install manufactured conduit sweeps and long-radius elbows whenever possible.

D. Pathway Installation in Communications Equipment Rooms:
1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits 6 inches above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

E. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.4 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. MUTOA shall not be used as a cross-connect point.

5. Consolidation points may be used only for making a direct connection to telecommunications outlet/connectors:

   a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.

6. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
7. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
8. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
9. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
10. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
11. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
12. In the communications equipment room, install a 10-foot- long service loop on each end of cable.
13. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.
2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

D. Optical Fiber Cable Installation:

1. Comply with TIA/EIA-568-B.3.
2. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 6 feet long not less than 12 inches in diameter below each feed point.

G. Outdoor Coaxial Cable Installation:

1. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.
2. Attach antenna lead-in cable to support structure at intervals not exceeding 36 inches.

H. Group connecting hardware for cables into separate logical fields.

I. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-B for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.5 FIRESTOPPING

A. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

B. Comply with TIA-569-B, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with J-STD-607-A.

C. Locate multipoint grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.7 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

B. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

C. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
    a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
    b. Label each unit and field within distribution racks and frames.
5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
6. Uniquely identify and label work area cables extending from the MUTOA to the work area. These cables may not exceed the length stated on the MUTOA label.

D. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.

1. Cables use flexible vinyl or polyester that flex as cables are bent.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform the following tests and inspections:

1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.
2. Visually confirm Category 5e marking of outlets, cover plates, outlet/connectors, and patch panels.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
4. Test UTP backbone copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

5. Optical Fiber Cable Tests:

    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    b. Link End-to-End Attenuation Tests:

        1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in 1 direction according to TIA-526-14-A, Method B, One Reference Jumper.
        2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.

6. UTP Performance Tests:

    a. Test for each outlet and MUTOA. Perform the following tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.2:

        1) Wire map.
        2) Length (physical vs. electrical, and length requirements).
        3) Insertion loss.
        4) Near-end crosstalk (NEXT) loss.

5) Power sum near-end crosstalk (PSNEXT) loss.
6) Equal-level far-end crosstalk (ELFEXT).
7) Power sum equal-level far-end crosstalk (PSELFEXT).
8) Return loss.
9) Propagation delay.
10) Delay skew.

7. Optical Fiber Cable Performance Tests: Perform optical fiber end-to-end link tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.3.
8. Final Verification Tests: Perform verification tests for UTP and optical fiber systems after the complete communications cabling and workstation outlet/connectors are installed.

a. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.
b. Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

C. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

D. End-to-end cabling will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.9 DEMONSTRATION

A. Train FAA's maintenance personnel in cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and keeping records of cabling assignments and revisions when extending wiring to establish new workstation outlets.

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SECTION 27 51 16 - PUBLIC ADDRESS AND MASS NOTIFICATION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Preamplifiers.
2. Power amplifiers.
3. Transfer to standby amplifier.
4. Volume limiter/compressors.
5. Loudspeakers.
6. Battery backup power unit.
7. Conductors and cables.
8. Raceways.

B. The new system shall be integrated with the existing system and be fully functional as one complete system.

1.2 REFERENCE STANDARDS

A. Electronic Industries Association (EIA)
1. 160-51: Standard for sound systems.
2. SE-103-49: Standard for speakers for sound equipment.

B. National Fire Protection Association (NFPA)
1. 70: National Electrical Code (NEC), 2014 edition.

C. Occupational and Health Administration (OSHA)
1. 29 CFR 1910.7: Definitions and Requirements for a Nationally Recognized Testing Laboratory (NRTL)

D. Underwriters Laboratories (UL)
1. 50: Enclosures for electrical equipment.

1.3 DEFINITIONS

A. Channels: Separate parallel signal paths, from sources to loudspeakers or loudspeaker zones, with separate amplification and switching that permit selection between paths for speaker alternative program signals.

B. VU: Volume unit.

C. Zone: Separate group of loudspeakers and associated supply wiring that may be arranged for selective switching between different channels.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports and seismic restraints for control consoles, equipment cabinets and racks, and components, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Seismic Performance: Supporting devices shall meet the seismic requirements of withstand IBC seismic design category "D".

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."

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Product certificates signed by equipment manufacturers certifying that their products comply with specified requirements.

C. Shop Drawings: For supports and seismic restraints for control consoles, equipment cabinets and racks, and components. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location and size of each field connection.
2. Calculations: For sizing backup battery.
3. Wiring Diagrams: For power, signal, and control wiring.

a. Identify terminals to facilitate installation, operation, and maintenance.
b. Single-line diagram showing interconnection of components.
c. Cabling diagram showing cable routing.

D. Delegated-Design Submittal: For supports and seismic restraints for components 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. Detail fabrication and assembly of supports and seismic restraints for control consoles, equipment cabinets and racks, and components.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and

special moldings are shown and coordinated with each other, using input from installers of the items involved.

B. Qualification Data: For qualified Installer.

C. Seismic Qualification Certificates: For control consoles, equipment cabinets and racks, 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.

D. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For public address and mass notification systems to include in emergency, operation, and maintenance manuals.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

1. Personnel certified by NICET as Audio Systems Level II Technician.

B. Manufacturer Qualifications: Engage a firm experienced in manufacturing public address and music systems complying with the requirements of these Specifications and experienced with at least 5 projects of similar size and scope that have been in operation for 3 years or more.

C. Testing Agency Qualifications: Qualified agency, with the experience and capability to conduct testing indicated.

1. Testing Agency's Field Supervisor: Currently certified by NICET at Level III to supervise on-site testing.

D. Source Limitations: Obtain public address and mass notification systems from single source from single manufacturer.

E. 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.

F. Comply with NFPA 70.

1.9 COORDINATION

A. Coordinate layout and installation of system components and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 GENERAL

A. The Public Address System in this design includes amplifiers, transformers, telephone interface module, zone modules, speakers, volume controllers, and associated system trunk cables and cables for integration with the existing Public Address System (Bogen PCM 2000 Model).

2.2 MANUFACTURERS

A. Available Manufacturers: Due to the compatibility requirements the manufacturer for the public address system shall be 100 percent compatible with the existing system.

2.3 FUNCTIONAL DESCRIPTION OF SYSTEM

A. System Functions:

1. Selectively connect any zone to any available signal channel.
2. Selectively control sound from microphone outlets and other inputs.
3. "All-call" feature shall connect the all-call sound signal simultaneously to all zones regardless of zone or channel switch settings.
4. Telephone paging adapter shall allow paging by dialing an extension from any local telephone instrument and speaking into the telephone.
5. Produce a program-signal tone that is amplified and sounded over all speakers, overriding signals currently being distributed.
6. Reproduce high-quality sound that is free of noise and distortion at all loudspeakers at all times during equipment operation including standby mode with inputs off; output free of non-uniform coverage of amplified sound.

2.4 GENERAL EQUIPMENT AND MATERIAL REQUIREMENTS

A. Compatibility of Components: Coordinate component features to form an integrated system. Match components and interconnections for optimum performance of specified functions.

B. Equipment: Comply with UL 813. Equipment shall be modular, using solid-state components, and fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.

C. Equipment Mounting: Where rack, cabinet, or console mounting is indicated, equipment shall be designed to mount in a 19-inch housing complying with TIA/EIA-310-D.

D. Weather-Resistant Equipment: Listed and labeled by a qualified testing agency for duty outdoors or in damp locations.

2.5 SYSTEM AMPLIFIERS

A. System Amplifiers: Due to the compatibility requirements the manufacturer for the system amplifiers shall be 100 percent compatible with the existing system and shall have sufficient capacity to handle the number of speakers as indicated in the contract documents plus 30 percent spare capacity for future expansion.

2.6 LOUDSPEAKERS

A. Cone-Type Loudspeakers:

1. Minimum Axial Sensitivity: 91 dB at one meter, with 1-W input.
2. Frequency Response: Within plus or minus 3 dB from 50 to 15,000 Hz.
3. Size: 8 inches with 1-inch voice coil and minimum 5-oz. ceramic magnet.
4. Minimum Dispersion Angle: 100 degrees.
5. Rated Output Level: 10 W.
6. Matching Transformer: Full-power rated with four tap values at 0.5, 1, 2, and 8 Watts. Maximum insertion loss of 0.5 dB.
7. Surface-Mounting Units: Ceiling, wall, or pendant mounting, as indicated, in steel back boxes, acoustically dampened. Front face of at least 0.0478-inch steel and whole assembly rust proofed and shop primed for field painting.
8. Flush-Ceiling-Mounting Units: In steel back boxes, acoustically dampened. Metal ceiling grille with white baked enamel.

2.7 VOLUME CONTROLLER

A. Speakers shall be provided with integral volume controller.

B. Remote volume controller shall be provided in the conference rooms and other selected areas as shown on drawings for volume adjustment in those selected areas. 10 steps with 1.5 dB or 3 dB step interval shall be provided.

2.8 CONDUCTORS AND CABLES

A. Jacketed, twisted pair and twisted multi-pair, untinned solid copper.

1. Insulation for Wire in Conduit: Thermoplastic, not less than 1/32 inch thick.
2. Plenum Cable: Listed and labeled for plenum installation.

2.9 RACEWAYS

A. Conduit and Boxes: Comply with Section 26 05 33 "Raceway and Boxes for Electrical Systems." Flexible metal conduit shall not be used.

1. Outlet boxes shall be not less than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Wiring Method: Install cables in raceways except within consoles and cabinets. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Section 26 05 33 "Raceway and Boxes for Electrical Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

D. Control Circuit Wiring: Provide number of conductors as recommended by system manufacturer for control functions indicated.

3.2 INSTALLATION OF RACEWAYS

A. Comply with requirements in Section 26 05 33 "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.

B. Install manufactured conduit sweeps and long-radius elbows whenever possible.

3.3 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Cable Installation Requirements:

1. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.
2. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.

3. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
5. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
6. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used.

C. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.

3.4 INSTALLATION

A. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.

B. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.

C. Conductor Sizing: Trunk cables for the Public Address System shall be 2 pair, #12AWG plenum cable. Cable to connect the speakers, horn, and volume controller shall be 2 pair, #16AWG plenum cable or follow the manufacturer's requirements if larger size of cable is required.

D. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.

E. Speaker transformer tap setting: Based on the Owner's suggestion:, speaker transformer tap setting shall be as indicated:
1. Speakers in hallway: uses 1 watt tap.
2. Speakers in office: use 0.5 watt tap.

F. For speakers and horn to be installed in mechanical rooms, chiller room, other non-office rooms, and outdoor installation, field test and determine proper tap setting.

G. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.5 GROUNDING

A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.

C. Install grounding electrodes as specified in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to supervise the field assembly and connection of components and the testing and adjustment of the system.

B. Tests and Inspections:

1. Schedule tests with at least seven days' advance notice of test performance.
2. After installing public address and mass notification systems and after electrical circuitry has been energized, test for compliance with requirements.
3. Operational Test: Perform tests that include originating program and page messages at microphone outlets, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and that system is free of noise and distortion.
4. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:

    a. Disconnect microphone at connector or jack closest to it and replace it in the circuit with a signal generator using a 1000-Hz signal. Replace all other microphones at corresponding connectors with dummy loads, each equal in impedance to microphone it replaces. Measure signal-to-noise ratio.
    b. Repeat test for each separately controlled zone of loudspeakers.
    c. Minimum acceptance ratio is 50 dB.

5. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 50, 200, 400, 1000, 3000, 8000, and 12,000 Hz into each preamplifier channel. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 3 percent total harmonics.
6. Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at five locations in each zone. For spaces with seated audiences, maximum permissible variation in level is plus or minus 2 dB. In addition, the levels between locations in same zone and between locations in adjacent zones must not vary more than plus or minus 3 dB.
7. Power Output Test: Measure electrical power output of each power amplifier at normal gain settings of 50, 1000, and 12,000 Hz. Maximum variation in power output at these frequencies must not exceed plus or minus 1 dB.
8. Signal Ground Test: Measure and report ground resistance at pubic address equipment signal ground. Comply with testing requirements specified in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

C. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.

D. Public address and mass notification systems will be considered defective if they do not pass tests and inspections.

E. Retesting: Rectify deficiencies indicated by tests and observations. Include revising tap settings of speaker line matching transformers where necessary to optimize volume and uniformity of sound levels. Completely retest work affected by such deficiencies at the Contractor's expense. Verify by the system tests that the total system meets the Specifications and complies with applicable standards. Provide a written record of all retest results.

F. Prepare test and inspection reports.

1. Include a record of final speaker-line matching transformer-tap settings, and signal ground-resistance measurement certified by Installer.

3.7 CLEANING

A. Prior to final acceptance, clean system components and protect from damage and deterioration.

3.8 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions (including, but not limited to adjusting sound levels, resetting matching transformer taps, adjusting controls, and investigating possible need for any system revisions required to meet actual occupancy conditions). Provide up to three visits to Project during other-than-normal occupancy hours for this purpose at intervals and occurrences as determined by COR.

3.9 DEMONSTRATION

A. Train FAA's maintenance personnel to adjust, operate, and maintain the public address and mass notification systems and equipment.

END OF SECTION 27 51 16

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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 Honeywell XLS 1000 addressable fire alarm system serving the Control Wing Basement Area to coordinate with any potential impact of architectural, mechanical or electrical changes in the area.

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, applicable local codes, this Section, and the drawings. The shop drawings and design calculations shall be signed and sealed by a licensed Professional Fire Protection Engineer or certified 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, 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 Control Room.
4. Provide, configure and activate the alarm verification feature for new analog smoke detectors connected to the FACP.
5. FACP shall monitor the automatic on/off sprinkler control panel for the B101 area through addressable interface devices. The points to monitor are trouble, supervisory and alarm. FACP shall monitor the valve tamper switch and waterflow switch through addressable interface devices.
6. 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.
7. 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 minimal 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 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. Government personnel shall accomplish shutdown of equipment.

C. Interruptions of the existing addressable fire alarm system shall be requested in writing to the COR at least ten (10) days prior to the Contractor's needs. The fire alarm 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 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 barrier sealers.

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.

1.4 REFERENCE STANDARDS

A. 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 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), 2012 Edition.
2. International Mechanical Code (IMC), 2012 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.
2. 70: National Electrical Code.
3. 72: National Fire Alarm and Signaling Code.
4. 90A: Installation of Air Conditioning and Ventilating Systems.
5. 101: Safety to Life from Fire in Buildings and Structures.

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 Contracting Officer Representative (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. Smoke detectors;
2. Duct smoke detectors;
3. Addressable control devices;
4. Interconnecting wiring;
5. Conduit; and
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-J is existing and does not require modification.

E. First alarm detection in the main building: When a fire alarm initiating device is activated in the main building, excluding devices from the Power Service Building, the following shall occur:

1. System alarm LED lights on the existing FACP.
2. Sounding of the local alarm sounding device in the existing FACP.
3. Indication of zone, floor, and type of initiating device shall appear on the existing Graphic Annunciator Panel (GAP).
4. Activation of the audible and visual alarm appliances in the ARTCC (except in the Control Room) and the Power Service Building for general evacuation. (Duct smoke detector shall not activate the general evacuation signal.)
5. Activation of the Stage I visual alarm appliances in the Control Room. (Duct smoke detector shall not activate the Stage I visual alarm appliances.)
6. Transmit a fire alarm signal to a U.L. Listed Central Station.
7. FACP shall indicate the pertinent information associated with the alarm on the Liquid Crystal Display (LCD).
8. An appropriate status change message is sent to the existing printer, with the date and time of occurrence.
9. Activation of all other existing fire alarm and control functions currently activated by an alarm condition, unless otherwise modified by the specifications or drawings.

F. Second alarm detection in Control 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 in the existing FACP.
3. Indication of zone, floor, and type of initiating device shall appear on the existing Graphic Annunciator Panel (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 Control Room. Audible and visual alarm appliances in the remainder of the ARTCC and the Power Service Building shall remain activated.
6. Transmit a fire alarm signal to a U.L. Listed Central Station.
7. FACP shall indicate the pertinent information associated with the alarm on the Liquid Crystal Display (LCD).
8. An appropriate status change message is sent to the existing printer, with the date and time of occurrence.
9. 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: When a fire alarm pull station is activated in the DSR Control Room, the following shall occur immediately:

1. System alarm LED lights on the existing addressable FACP.

2. Sounding of the local alarm-sounding device in the existing addressable FACP.
3. Indication of zone, floor, and type of initiating device shall appear on the existing and new Annunciator.
4. The Stage II audible (the chime shall automatically silence after 60 seconds) and visual alarm appliances in the DSR Control Room shall activate.
5. Activation of the audible and visual alarm appliances in all areas of the facility outside of the Control Room (Alarm appliances shall continue, even if previously actuated by a separate initiation device).
6. If already operating, the Stage I visual alarm appliances in the DSR Control Room shall cease to activate.
7. FACP shall indicate the pertinent information associated with the alarm on the Liquid Crystal Display (LCD).
8. An appropriate status change message shall be sent to the existing printer with the date and time of occurrence.
9. DACT will transmit the alarm condition to a UL Listed central station service.
10. Activation of all other existing fire alarm and control functions currently activated by an alarm condition, unless otherwise modified by the specifications or drawings.

H. Alarm detection in Power Service Building: When a fire alarm initiating device is activated in the Power Service Building the following shall occur immediately:

1. System alarm LED lights on the existing addressable FACP.
2. Sounding of the local alarm-sounding device in the existing addressable FACP.
3. Indication of zone, floor, and type of initiating device shall appear on the existing and new Annunciator.
4. Activation of the audible and visual alarm appliances in the Power Service Building. Duct detectors will not initiate notification appliances.
5. FACP shall indicate the pertinent information associated with the alarm on the Liquid Crystal Display (LCD).
6. An appropriate status change message is sent to the existing printer with the date and time of occurrence.
7. DACT will transmit the alarm condition to a UL Listed central station service.
8. Activation of all other existing fire alarm and other control functions currently activated by an alarm condition, unless otherwise modified by the specifications or drawings.

I. 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 in the existing FACP.
3. Indication of system trouble on the existing GAP.
4. Transmit a trouble alarm signal to a UL Listed Central Station.
5. FACP shall indicate the pertinent information associated with the alarm on the LCD.
6. An appropriate status change message is sent to the existing printer in the FACP, with the date and time of occurrence.

J. Supervisory Signals: When an off normal condition is indicated by a water valve tamper switch, sprinkler panel trouble, air sampling smoke detector trouble signal, activation of a duct smoke detector, air sampling system pre-alarm, 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 FACP.
2. Sounding of the local supervisory sounding device in the FACP.
3. Indication of the supervisory condition on the GAP.
4. Transmit a supervisory alarm signal to a U.L. Listed Central Station.
5. FACP shall indicate the pertinent information associated with the alarm on the LCD.
6. An appropriate status change message is sent to the existing printer, with the date and time of occurrence.

K. 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. Smoke detectors;
2. Duct smoke detectors;
3. Addressable control devices;
4. System components to be placed within existing FACP;
5. Conduit, wire and cable;
6. Signs and labels;
7. Manufacturer's wiring guidelines; and
8. 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 licensed Professional Fire Protection Engineer 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 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 5 years of system startup experience.

F. As-Built Drawings: Upon completion of system update existing as-built drawings showing actual installation conditions. Notify COR if existing as-built drawings do not exist. 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 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 24 hour, seven 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 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

2. Duct smoke detectors: 2 percent
3. Detector bases: 2 percent
4. Control devices: 2 percent

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, 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 Honeywell XLS 1000 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. Sampling Tube: Design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions where applied.
   b. Relay Fan Shutdown: DPDT relay contacts rated for 5 amps at 120 VAC or 28 VDC minimum, to interrupt fan motor-control circuit.
   c. Air Velocity Rating: Minimum velocity rating shall be 3000 FPM.
   d. The front of the detector shall have visible alarm and status lights. Where detector is installed more than 10 ft above the finished floor or in a concealed location, such as above a ceiling, provide remote LED status indicator light located in an accessible location.

B. 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.

C. Addressable Interface Device: To monitor and supervise a device, and provide an input signal with a unique address to the existing FACP identifying the status of the device. Distinguish the following input signal conditions: normal (open contact), short circuit (closed contact), and open circuit (field wire break). Provide one addressable interface device for each device to be monitored. Each monitored device shall have a unique address in the FACP software.

D. Tamper and Flow Switch: Provided under Section 21 13 13, "Fire Suppression Systems". Monitor each tamper and flow switch with an addressable interface device and provide each tamper and flow switch with a unique FACP software address.

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.

E. 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, 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 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.

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. Duct smoke detectors: Surface mount housing on the side of the composite air duct. Install remote LED status indicators where the duct smoke detectors are installed more than 10 ft above the finished floor or in concealed locations where the detector's alarm indicator is not readily visible.

C. Addressable Interface and Control Devices: Mount each module within three feet of each device that is being monitored or controlled.

D. Valve Tamper and Flow Switch: Connect addressable interface device to tamper and flow switches for sprinkler valve station required to be supervised. Provide each switch with unique software address in FACP.

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. Install 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 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 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.

3.8 WARRANTY

A. 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 24-hour, 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 TRAINING

A. Engage factory-authorized instructors to demonstrate and train FAA personnel for two training classes each lasting a minimum of 4 hours. Equipment installers are not acceptable instructors. The training shall be based on the final approved Operations and Maintenance manual. At a minimum, training shall cover panel operation, responding to emergencies, trouble shooting. At the conclusion of the training, each participant shall be capable of conducting the annual fire alarm test required by NPFA 72.

END OF SECTION 28 31 00

SECTION 31 20 00 - EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Preparing subgrades for slabs-on-grade, walks, pavement, turf and grass, and plants.
2. Excavating and backfilling for buildings and structures.
3. Excavating and backfilling trenches for utilities and pits for buried utility structures.

1.2 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

G. Fill: Soil materials used to raise existing grades.

H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

I. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

J. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

K. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:

1. Classification according to ASTM D 2487.

1.4 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from FAA and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by FAA or authorities having jurisdiction.

B. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth moving operations.

1. Erection of sheds or structures.
2. Excavation or other digging unless otherwise indicated.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D 2487, or a combination of these groups; free of cobbles, boulders, or gravel larger than 2.5 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487 or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inchsieve and not more than 12 percent passing a No. 200sieve.

E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inchsieve and not more than 8 percent passing a No. 200sieve.

F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inchsieve and not more than 12 percent passing a No. 200sieve.

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inchsieve and not more than 8 percent passing a No. 200sieve.

H. Sand: ASTM C 33; fine aggregate.

I. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 milsthick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inchesdeep; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include cobbles,

boulders, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for cobble or boulder excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and cobbles or boulders, replace with satisfactory soil materials.
2. Remove cobbles and boulders to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:

    a. 6 inchesbeneath pipe in trenches, and 24 incheswider than pipe.

3.3 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.4 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 incheshigher than top of pipe or conduit unless otherwise indicated.

1. Clearance: 12 incheseach side of pipe or conduit.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

1. For pipes and conduit less than 6 inchesin nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
2. For pipes and conduit 6 inchesor larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
3. Excavate trenches 6 inchesdeeper than elevation required in cobbles or boulders or other unyielding bearing material to allow for bedding course.

3.5 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.6 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.7 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches Under Footings: Backfill trenches excavated under footings and within 18 inchesof bottom of footings with satisfactory soil; fill with concrete per specifications to elevation of bottom of footings.

D. Backfill voids with satisfactory soil while removing shoring and bracing.

E. Place and compact initial backfill of subbase material, free of particles larger than 1 inchin any dimension, to a height of 12 inchesover the pipe or conduit.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

F. Place and compact final backfill of satisfactory soil to final subgrade elevation.

G. Controlled Low-Strength Material: Place final backfill of controlled low-strength material to final subgrade elevation.

H. Install warning tape directly above utilities, 12 inchesbelow finished grade, except 6 inchesbelow subgrade under pavements and slabs.

3.8 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use satisfactory soil material.
3. Under steps and ramps, use engineered fill.
4. Under building slabs, use engineered fill.
5. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.9 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inchesin loose depth for material compacted by heavy compaction equipment, and not more than 4 inchesin loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:

1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inchesof existing subgrade and each layer of backfill or fill soil material at 95 percent.
2. Under walkways, scarify and recompact top 6 inchesbelow subgrade and compact each layer of backfill or fill soil material at 92 percent.
3. Under turf or unpaved areas, scarify and recompact top 6 inchesbelow subgrade and compact each layer of backfill or fill soil material at 85 percent.
4. For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.

3.10 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Turf or Unpaved Areas: Plus or minus 1 inch.
2. Walks: Plus or minus 1 inch.
3. Pavements: Plus or minus 1/2 inch.

3.11 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:

1. Place base course material over subbase course under hot-mix asphalt pavement.
2. Shape subbase course to required crown elevations and cross-slope grades.
3. Place subbase course and base course 6 inchesor less in compacted thickness in a single layer.
4. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.12 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified geotechnical engineering testing agency to perform tests and inspections.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

C. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2937, and ASTM D 6938, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 200 sq. ft. or less of paved area or building slab but in no case fewer than three tests.
2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 50 feet or less of wall length but no fewer than two tests.
3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 100 feet or less of trench length but no fewer than two tests.

D. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.13 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by COR; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.14 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off FAA's property.

B. Transport surplus satisfactory soil to designated storage areas on FAA's property. Stockpile or spread soil as directed by COR.

END OF SECTION 31 20 00

SECTION 31 50 00 - EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes temporary excavation support and protection systems.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review existing utilities and subsurface conditions.
2. Review coordination for interruption, shutoff, capping, and continuation of utility services.
3. Review proposed excavations.
4. Review proposed equipment.
5. Review monitoring of excavation support and protection system.
6. Review coordination with waterproofing.
7. Review abandonment or removal of excavation support and protection system.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, performance properties, and dimensions of individual components and profiles, and calculations for excavation support and protection system.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer.

B. Contractor Calculations: For excavation support and protection system. Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Existing Conditions: Using photographs, show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by inadequate performance of excavation support and protection systems. Submit before Work begins.

1.5 FIELD CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied by FAA or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:

1. Notify COR no fewer than two days in advance of proposed interruption of utility.
2. Do not proceed with interruption of utility without COR's written permission.

B. Project-Site Information: No geotechnical report has been prepared for this Project.

1. Make additional test borings as necessary and conduct other exploratory operations necessary for excavation support and protection according to the performance requirements.

C. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting earth and hydrostatic pressures and superimposed and construction loads.

1. Contractor Design: Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer.
2. Prevent surface water from entering excavations by grading, dikes, or other means.
3. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.
4. Continuously monitor vibrations, settlements, and movements to ensure stability of excavations and constructed slopes and to ensure that damage to permanent structures is prevented.

2.2 MATERIALS

A. General: Provide materials that are either new or in serviceable condition.

B. Structural Steel: ASTM A 36/A 36M, ASTM A 690/A 690M, or ASTM A 992/A 992M.

C. Steel Sheet Piling: ASTM A 328/A 328M, ASTM A 572/A 572M, or ASTM A 690/A 690M; with continuous interlocks.

1. Corners: Site-fabricated mechanical interlock.

D. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of size and strength required for application.

E. Shotcrete: Comply with Section 033713 "Shotcrete" for shotcrete materials and mixes, reinforcement, and shotcrete application.

F. Cast-in-Place Concrete: ACI 301, of compressive strength required for application.

G. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

H. Tiebacks: Steel bars, ASTM A 722/A 722M.

I. Tiebacks: Steel strand, ASTM A 416/A 416M.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.

1. Shore, support, and protect utilities encountered.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from FAA and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Locate excavation support and protection systems clear of permanent construction so that construction and finishing of other work is not impeded.

3.2 FIELD QUALITY CONTROL

A. Survey-Work Benchmarks: Resurvey benchmarks regularly during installation of excavation support and protection systems, excavation progress, and for as long as excavation remains open. Maintain an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify COR if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

B. Promptly correct detected bulges, breakage, or other evidence of movement to ensure that excavation support and protection system remains stable.

C. Promptly repair damages to adjacent facilities caused by installation or faulty performance of excavation support and protection systems.

3.3 REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and earth and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils and rock or damaging structures, pavements, facilities, and utilities.

1. Remove excavation support and protection systems to a minimum depth of 48 inches below overlying construction and abandon remainder.
2. Fill voids immediately with approved backfill compacted to density specified in Section 31 20 00 "Earth Moving."
3. Repair or replace, as approved by COR, adjacent work damaged or displaced by removing excavation support and protection systems.

B. Leave excavation support and protection systems permanently in place.

END OF SECTION 31 50 00

SECTION 32 12 16 - ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hot-mix asphalt patching.
2. Hot-mix asphalt paving.
3. Hot-mix asphalt overlay.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:

a. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
b. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include technical data and tested physical and performance properties.
2. Job-Mix Designs: Certification by California Department of Transportation of approval of each job mix proposed for the Work.
3. Job-Mix Designs: For each job mix proposed for the Work.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer and testing agency.

B. Material Certificates: For each paving material. Include statement that mixes containing recycled materials will perform equal to mixes produced from all new materials.

C. Material Test Reports: For each paving material, by a qualified testing agency.

D. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of state in which Project is located.

B. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.

C. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of California Department of Transportation for asphalt paving work. State of California, Department of Transportation (CDOT) - Construction and Material Specifications.

1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:

1. Prime Coat: Minimum surface temperature of 60 deg F.
2. Tack Coat: Minimum surface temperature of 60 deg F.
3. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
4. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations and meet CDOT standards.

B. Coarse Aggregate: Sound; washed gravel, CCS, or crushed ACBFS meeting Section 703.04A of CDOT specifications.

C. Fine Aggregate: Natural sand or sand manufactured from stone, gravel, or ACBFS meeting Section 703.04B of CDOT specifications.

1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

D. Crushed Steel Slag (OH, EAF or BOF) conforming to 703.01.E and 401.03 may be used for coarse and fine aggregate in asphalt concrete base used in flexible pavements.

E. Mineral Filler: Rock or slag dust, hydraulic cement, or other inert material shall meet CDOT specifications.

2.2 ASPHALT MATERIALS

A. Asphalt Binder: AASHTO M 320, and additional requirements set forth in CDOT Construction and Material Specifications.

B. Cutback Prime Coat: AASHTO M-82, medium-curing cutback asphalt, RC-70 or RC-250, in accordance with CDOT Construction and Material Specifications.

C. Consult state or local CDOT for recommended asphalt-emulsion prime coat for local conditions.

D. Emulsified Asphalt Prime Coat: AASHTO M 140 emulsified asphalt or AASHTO M 208 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application, in accordance with curing materials specified in CDOT Construction and Material Specifications.

E. Tack Coat: AASHTO M 140 emulsified asphalt or AASHTO M 208 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application, in accordance with CDOT Construction and Material Specifications.

F. Water: Potable.

G. Undersealing Asphalt: ASTM D 3141/D 3141M; pumping consistency.

2.3 AUXILIARY MATERIALS

A. Herbicide: Commercial chemical for weed control, registered by the EPA, and not classified as "restricted use" for locations and conditions of application. Provide in granular, liquid, or wettable powder form.

B. Sand: ASTM D 1073 or AASHTO M 29, Grade No. 2 or No. 3.

C. Joint Sealant: ASTM D 6690 or AASHTO M 324, Type I, hot-applied, single-component, polymer-modified bituminous sealant.

2.4 MIXES

A. Recycled Content of Hot-Mix Asphalt: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 10 percent or more than 15 percent by weight.

1. Surface Course Limit: Recycled content no more than 10 percent by weight.

B. Hot-Mix Asphalt: Dense-graded, hot-laid, hot-mix asphalt plant mixes approved by CDOT and complying with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
2. Provide mixes in accordance with the CDOT Construction and Material Specifications.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction. Limit vehicle speed to 3 mph.
2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by COR, and replace with compacted backfill or fill as directed.

C. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 COLD MILLING

A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.

1. Mill to a depth indicated or required.
2. Mill to a uniform finished surface free of excessive gouges, grooves, and ridges.
3. Control rate of milling to prevent tearing of existing asphalt course.
4. Repair or replace curbs, manholes, and other construction damaged during cold milling.
5. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled hot-mix asphalt.
6. Patch surface depressions deeper than 1 inch after milling, before wearing course is laid.
7. Handle milled asphalt material according to disposal methods approved by COR.
8. Keep milled pavement surface free of loose material and dust.
9. Do not allow milled materials to accumulate on-site.

3.3 PATCHING

A. Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into perimeter of

adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.

1. Pump hot undersealing asphalt under rocking slab until slab is stabilized or, if necessary, crack slab into pieces and roll to reseat pieces firmly.
2. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.

C. Tack Coat: Before placing patch material, apply tack coat uniformly to vertical asphalt surfaces abutting the patch. Apply at a rate of 0.05 to 0.15 gal./sq. yd..

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

D. Placing Patch Material: Fill excavated pavement areas with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

E. Placing Patch Material: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

3.4 REPAIRS

A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.

1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.

B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch.

1. Clean cracks and joints in existing hot-mix asphalt pavement.
2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.
3. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

3.5 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

1. Mix herbicide with prime coat if formulated by manufacturer for that purpose.

C. Cutback Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.15 to 0.50 gal./sq. yd.. Apply enough material to penetrate and seal, but not flood, surface. Allow prime coat to cure.

1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
2. Protect primed substrate from damage until ready to receive paving.

D. Emulsified Asphalt Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.10 to 0.30 gal./sq. yd. per inch depth. Apply enough material to penetrate and seal, but not flood, surface. Allow prime coat to cure.

1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
2. Protect primed substrate from damage until ready to receive paving.

E. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd..

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.6 PLACING HOT-MIX ASPHALT

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand in areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
2. Place hot-mix asphalt surface course in single lift.
3. Spread mix at a minimum temperature of 250 deg F.
4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Overlap mix placement about 1 to 1-1/2 inches from strip to strip to ensure proper compaction of mix along longitudinal joints.
2. Complete a section of asphalt base course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.7 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
3. Offset transverse joints, in successive courses, a minimum of 24 inches.
4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.8 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 96 percent of reference laboratory density according to ASTM D 6927 or AASHTO T 245, but not less than 94 percent or greater than 100 percent.

2. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent or greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.9 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch.
2. Surface Course: Plus 1/4 inch, no minus.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch.
2. Surface Course: 1/8 inch.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

D. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979 or AASHTO T 168.

1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.

    a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than three cores taken.
    b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.

E. Replace and compact hot-mix asphalt where core tests were taken.

F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

END OF SECTION 32 12 16

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SECTION 32 13 13 - CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Curbs and gutters.
2. Walks.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Other Action Submittals:

1. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.3 QUALITY ASSURANCE

A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

B. ACI Publications: Comply with ACI 301 unless otherwise indicated.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

A. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from as-drawn steel wire into flat sheets.

B. Dowel Bars: ASTM A 615/A 615M, Grade 60 plain-steel bars. Cut bars true to length with ends square and free of burrs.

2.2 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source throughout Project:

1. Portland Cement: ASTM C 150, gray portland cement Type I/II. Supplement with the following:

   a. Fly Ash: ASTM C 618, Class C or Class F.
   b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C 33, Class 4S, uniformly graded. Provide aggregates from a single source.

C. Water: Potable and complying with ASTM C 94/C 94M.

D. Air-Entraining Admixture: ASTM C 260.

E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

2.3 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

F. White, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B, dissipating.

2.4 RELATED MATERIALS

A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork in preformed strips.

2.5 WHEEL STOPS

A. Wheel Stops: Precast, air-entrained concrete.

1. Dowels: Galvanized-steel, 3/4 inch in diameter, 10-inch minimum length.

2. Adhesive: As recommended by wheel stop manufacturer for application to concrete pavement.

2.6 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, with the following properties:

1. Compressive Strength (28 Days): 4000 psi.
2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.45.
3. Slump Limit: 4 inches, plus or minus 1 inch.
4. Air Content: 6 percent plus or minus 1.5 percent.

B. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

2.7 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

A. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.

B. Remove loose material from compacted subbase surface immediately before placing concrete.

3.2 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.3 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

3.4 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, to match jointing of existing adjacent concrete paving.

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.5 CONCRETE PLACEMENT

A. Moisten subbase to provide a uniform dampened condition at time concrete is placed.

B. Comply with ACI 301 requirements for measuring, mixing, transporting, placing, and consolidating concrete.

C. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

D. Screed paving surface with a straightedge and strike off.

E. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

3.6 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

3.7 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to 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.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these.

3.8 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:

1. Elevation: 3/4 inch.
2. Thickness: Plus 3/8 inch, minus 1/4 inch.
3. Surface: Gap below 10-foot- long, unleveled straightedge not to exceed 1/2 inch.
4. Joint Spacing: 3 inches.
5. Contraction Joint Depth: Plus 1/4 inch, no minus.
6. Joint Width: Plus 1/8 inch, no minus.

3.9 WHEEL STOPS

A. Install wheel stops in bed of adhesive applied as recommended by manufacturer.

B. Securely attach wheel stops to paving with not less than two galvanized-steel dowels located at one-quarter to one-third points. Install dowels in drilled holes in the paving and bond dowels to wheel stop. Recess head of dowel beneath top of wheel stop.

3.10 REPAIRS AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

C. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 32 13 13

SECTION 32 17 23 - PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes painted markings applied to asphalt pavement.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to marking pavement including, but not limited to, the following:

a. Pavement aging period before application of pavement markings.
b. Review requirements for protecting pavement markings, including restriction of traffic during installation period.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include technical data and tested physical and performance properties.

B. Shop Drawings: For pavement markings.

1. Indicate pavement markings, colors, lane separations, defined parking spaces, and dimensions to adjacent work.
2. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of California DOT (CDOT) for pavement-marking work.

1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.5 FIELD CONDITIONS

A. Environmental Limitations: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for alkyd materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 PAVEMENT-MARKING PAINT

A. Pavement-Marking Paint: Fast dry traffic paint, water borne in accordance with Section 640 of the California Department of Transportation (CDOT) Construction and Material Specifications.

1. Color: White.

B. Glass Beads: AASHTO M 247, Type 1 in accordance with Section 740.09 of the CDOT Construction and Material Specifications.

1. Roundness: Minimum 80 percent true spheres by weight.
2. Use materials certified according to Supplement 1089.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that pavement is dry and in suitable condition to begin pavement marking according to manufacturer's written instructions.

B. Proceed with pavement marking only after unsatisfactory conditions have been corrected.

3.2 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with COR.

B. Allow paving to age for a minimum of 30 days before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

1. Apply graphic symbols and lettering with paint-resistant, die-cut stencils, firmly secured to pavement. Mask an extended area beyond edges of each stencil to prevent paint application beyond the stencil. Apply paint so that it cannot run beneath the stencil.

2. Broadcast glass beads uniformly into wet markings at a rate of 6 lb/gal..

3.3 PROTECTING AND CLEANING

A. Protect pavement markings from damage and wear during remainder of construction period.

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SECTION 32 31 13 - CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Chain-link fences.
2. Swing gates.
3. Privacy slats.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Inspect and discuss electrical roughing-in, equipment bases, and other preparatory work specified elsewhere.
2. Review sequence of operation for each type of gate operator.
3. Review coordination of interlocked equipment specified in this Section and elsewhere.
4. Review required testing, inspecting, and certifying procedures.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

a. Fence and gate posts, rails, and fittings.
b. Chain-link fabric, reinforcements, and attachments.
c. Accessories: Barbed wire.
d. Gates and hardware.
e. Gate operators, including operating instructions and motor characteristics.

B. Shop Drawings: For each type of fence and gate assembly.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include accessories, hardware, gate operation, and operational clearances.
3. Gate Operator: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
4. Wiring Diagrams: For power, signal, and control wiring.

C. Samples for Initial Selection: For each type of factory-applied finish.

D. Samples for Verification: For each type of component with factory-applied finish, prepared on Samples of size indicated below:

1. Polymer-Coated Components: In 6-inch lengths for components and on full-sized units for accessories.

E. Delegated-Design Submittal: For structural performance of chain-link fence and gate frameworks, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For factory-authorized service representative.

B. Product Certificates: For each type of chain-link fence, and gate.

C. Product Test Reports: For framework strength according to ASTM F 1043, for tests performed by a qualified testing agency.

D. Field quality-control reports.

E. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For gate operators to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing fence grounding; member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

B. Emergency Access Requirements: According to requirements of authorities having jurisdiction for gates with automatic gate operators serving as a required means of access.

C. Mockups: Build mockups to set quality standards for fabrication and installation.

1. Build mockup for typical chain-link fence and gate, including accessories.

a. Size: 8-foot length of fence.

1.7 FIELD CONDITIONS

A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.8 WARRANTY

A. Special Warranty: Manufacturer and Installer agree to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure to comply with performance requirements.
b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
c. Faulty operation of gates.

2. Warranty Period: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design chain-link fence and gate frameworks.

B. Structural Performance: Chain-link fence and gate frameworks shall withstand the design wind loads and stresses for fence height(s) and under exposure conditions indicated according to ASCE/SEI 7

1. Design Wind Load: As indicated on Drawings.

a. Minimum Post Size: Determine according to ASTM F 1043 for post spacing not to exceed 8 feet for Material Group IC, electric-resistance-welded round steel pipe
b. Minimum Post Size and Maximum Spacing: Determine according to CLFMI WLG 2445, based on mesh size and pattern specified.

C. Lightning Protection System: Maximum resistance-to-ground value of 25 ohms at each grounding location along fence under normal dry conditions.

2.2 CHAIN-LINK FENCE FABRIC

A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist according to "CLFMI Product Manual" and requirements indicated below:

1. Fabric Height: 96 inches.
2. Steel Wire for Fabric: Wire diameter of 0.192 inch

    a. Mesh Size: 2-1/8.

    b. Coat selvage ends of metallic-coated fabric before the weaving process with manufacturer's standard clear protective coating.

3. Selvage: Twisted top and knuckled bottom.

2.3 FENCE FRAMEWORK

A. Posts and Rails: ASTM F 1043 for framework, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1043 or ASTM F 1083 based on the following:

1. Fence Height: 96 inches.

2. Heavy-Industrial-Strength Material: Group IC, round steel pipe, electric-resistance-welded pipe.

    a. Line Post: 2.875 inches in diameter.
    b. End, Corner, and Pull Posts: 4.0 inches in diameter.

3. Horizontal Framework Members: Intermediate, top and bottom rails according to ASTM F 1043.

    a. Top Rail: 1.66 inches in diameter.

4. Brace Rails: ASTM F 1043.

5. Metallic Coating for Steel Framework:
    a. External, Type B: Zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film. Internal,
    b. Type C: Zn-5-Al-MM alloy, consisting of not less than 1.8-oz./sq. ft. coating.
    c. Coatings: Any coating above.

2.4 TENSION WIRE

A. Metallic-Coated Steel Wire: 0.177-inch-diameter, marcelled tension wire according to ASTM A 817 or ASTM A 824, with the following metallic coating:

1. Type II: Zinc coated (galvanized) by hot-dip or electrolytic process, with the following minimum coating weight:

    a. Matching chain-link fabric coating weight.

2. Type III: Zn-5-Al-MM alloy with the following minimum coating weight:

   a. Matching chain-link fabric coating weight.

2.5 SWING GATES

A. General: ASTM F 900 for gate posts and swing gate types.

1. Gate Leaf Width: 36 inches.
2. Framework Member Sizes and Strength: Based on gate fabric height of more than 72 inches.

B. Pipe and Tubing:

1. Zinc-Coated Steel: ASTM F 1043 and ASTM F 1083; protective coating and finish to match fence framework.
2. Gate Posts: Round tubular steel
3. Gate Frames and Bracing: Round tubular steel.

C. Frame Corner Construction: Welded or assembled with corner fittings.

D. Extended Gate Posts and Frame Members: Fabricate gate posts and frame end members to extend 12 inches above top of chain-link fabric at both ends of gate frame to attach barbed wire assemblies.

E. Hardware:

1. Hinges: 360-degree inward and outward swing.
2. Latch: Permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.
3. Lock: Manufacturer's standard internal device.
4. Closer: Manufacturer's standard.

2.6 FITTINGS

A. Provide fittings according to ASTM F 626.

B. Post Caps: Provide for each post.

1. Provide line post caps with loop to receive tension wire or top rail.

C. Rail and Brace Ends: For each gate, corner, pull, and end post.

D. Rail Fittings: Provide the following:

1. Top Rail Sleeves: Pressed-steel or round-steel tubing not less than 6 inches long.
2. Rail Clamps: Line and corner boulevard clamps for connecting intermediate and bottom rails to posts.

E. Tension and Brace Bands: Pressed steel.

F. Tension Bars: Steel length not less than 2 inches shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.

G. Truss Rod Assemblies: Steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.

H. Barbed Wire Arms: Pressed steel or cast iron, with clips, slots, or other means for attaching strands of barbed wire, integral with post cap, for each post unless otherwise indicated, and as follows:

1. Provide line posts with arms that accommodate top rail or tension wire.
2. Provide corner arms at fence corner posts unless extended posts are indicated.
3. Single-Arm Type: Type I, slanted arm.

I. Tie Wires, Clips, and Fasteners: According to ASTM F 626.

1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, according to the following:

a. Hot-Dip Galvanized Steel: 0.148-inch- diameter wire; galvanized coating thickness matching coating thickness of chain-link fence fabric.

J. Finish:

1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz./sq. ft. of zinc.

2.7 BARBED WIRE

A. Steel Barbed Wire: ASTM A 121, two-strand barbed wire, 0.099-inch-diameter line wire with 0.080-inch-diameter, four-point round barbs spaced not more than 5 inches o.c.

1. Zinc Coating: Type Z, Class 3.

2.8 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout, recommended in writing by manufacturer, for exterior applications.

B. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating, and that is recommended in writing by manufacturer for exterior applications.

2.9 GROUNDING MATERIALS

A. Comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.

1. Do not begin installation before final grading is completed unless otherwise permitted by COR.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 CHAIN-LINK FENCE INSTALLATION

A. Install chain-link fencing according to ASTM F 567 and more stringent requirements specified.

1. Install fencing on established boundary lines inside property line.

B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

C. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

a. Exposed Concrete: Extend 2 inches above grade; shape and smooth to shed water.

D. Terminal Posts: Install terminal end, corner, and gate posts according to ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more.

E. Line Posts: Space line posts uniformly at 96 inches o.c.

F. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fence posts. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.

1. Locate horizontal braces at midheight of fabric 72 inches or higher, on fences with top rail, and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

G. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fence posts. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch-diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:

1. Extended along top and bottom of fence fabric. Install top tension wire through post cap loops. Install bottom tension wire within 6 inches of bottom of fabric and tie to each post with not less than same diameter and type of wire.
2. Extended along top of barbed wire arms.

H. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fence posts. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.

I. Intermediate and Bottom Rails: Secure to posts with fittings.

J. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts, with tension bands spaced not more than 15 inches o.c.

K. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric according to ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.

1. Maximum Spacing: Tie fabric to line posts at 12 inches o.c. and to braces at 24 inches o.c.

L. Fasteners: Install nuts for tension bands and carriage bolts on the side of fence opposite the fabric side.

M. Barbed Wire: Install barbed wire uniformly spaced, angled outward toward security side of fence. Pull wire taut, install securely to extension arms, and secure to end post or terminal arms.

3.4 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-

resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation.

3.5 GROUNDING AND BONDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Fence and Gate Grounding:

1. Ground for fence and fence posts shall be a separate system from ground for gate and gate posts.
2. Install ground rods and connections.
3. Ground fence on each side of gates and other fence openings.

    a. Bond metal gates to gate posts.
    b. Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities.

C. Fences Enclosing Electrical Power Distribution Equipment: Ground according to IEEE C2 unless otherwise specified elsewhere.

D. Bonding to Lightning Protection System: Ground fence and bond fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor.

E. Comply with requirements in Section 26 41 13 "Lightning Protection for Structures."

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests.

B. Grounding Tests: Comply with requirements in Section 26 41 13 "Lightning Protection for Structures."

C. Prepare test reports.

3.7 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Lubricate hardware and other moving parts.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain chain-link fences and gates.

END OF SECTION 32 31 13