

UNITED STATES  
DEPARTMENT OF THE INTERIOR  
FISH AND WILDLIFE SERVICE  
REGION 6 ENGINEERING

Lakewood, Colorado



**HURON MULTIPURPOSE BUILDING  
AND VISITOR CENTER**

**HURON NATIONAL WILDLIFE REFUGE  
BEADLE COUNTY, SOUTH DAKOTA**

21-006  
CONSTRUCTION DOCUMENTS  
APRIL 29, 2022

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**HURON MULTIPURPOSE BUILDING  
AND VISITOR CENTER  
21-006**

Owner:

United States  
Department of the Interior  
Fish and Wildlife Service  
Region 6 Engineering  
134 Union Boulevard  
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APRIL 29, 2022

HURON NATIONAL WILDLIFE REFUGE  
MULTIPURPOSE BUILDING AND VISITOR CENTER  
(21-006)

DESCRIPTION/SPECIFICATIONS  
CONSTRUCTION DOCUMENTS

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## SECTION 011000 - SUMMARY

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Project information.
2. Project background.
3. Work covered by Contract Documents.
4. Work under separate contracts.
5. Access to site.
6. Coordination with occupants.
7. Coordination with local utilities.
8. Work restrictions.
9. Permits and Fees.
10. Applicable codes, standards, and specifications.
11. Means and methods.
12. Safety.
13. Environmental Protection.

##### B. Related Requirements:

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

#### 1.2 PROJECT INFORMATION

- A. Project Location: 39169 US Hwy 14 Wolsey, SD 57384
- B. Station Contact Information: Boyd Schulz, [boyd\\_schulz@fws.gov](mailto:boyd_schulz@fws.gov), 605-352-7014

#### 1.3 PROJECT BACKGROUND

- A. Design & construct a new HQ building, which includes a Visitor Contact area & Office spaces, at the Huron WMD near Huron South Dakota.

#### 1.4 WORK COVERED BY CONTRACT DOCUMENTS

- 1.5 The work consists of the design of a new 9,000 square foot office building and associated site utilities and improvements. The work includes, but is not limited to earthwork, site utilities, exterior concrete flatwork, concrete foundations and floor slabs, structural insulated panel walls

with siding, shop-fabricated wood truss roof, doors and windows, interior framed partitions and finishes, plumbing, HVAC system, and electrical power and lighting systems.

#### 1.6 WORK UNDER SEPARATE CONTRACTS

- A. General: In the event there is work being performed under a separate contract the Contractor shall cooperate fully with separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying work under this Contract or other contracts. Coordinate the Work of this Contract with work performed under separate contracts.

#### 1.7 ACCESS TO SITE

- A. All operations of the Contractor (including storage of materials) upon Government premises shall be confined to areas authorized or approved by the Contracting Officer.
- B. Limit use of Project site areas within the Contract limits indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.
  - 1. Limits: Confine construction operations to project site.
  - 2. Driveways, Walkways and Entrances: Keep driveways and loading areas, and entrances serving premises clear and available to Government, Government Representatives, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.
- C. Condition of Existing Building: Maintain portions of existing building affected by construction operations in a weather tight condition throughout construction period. Repair damage caused by construction operations.

#### 1.8 COORDINATION WITH OCCUPANTS

- A. Partial Government Occupancy: Government will occupy the premises during entire construction period, with the exception of areas under construction. Cooperate with Station Manager during construction operations to minimize conflicts and facilitate usage. Perform the Work so as not to interfere with Government operations. Maintain existing exits unless otherwise indicated.
  - 1. Provide not less than 48 hours' notice to Government of activities that will affect Government's operations.

#### 1.9 WORK RESTRICTIONS

- A. Work Restrictions, General: Comply with restrictions on construction operations. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.
- B. On-Site Work Hours: Limit work in the existing building to normal business working hours of 7:00 a.m. to 4:00 p.m., Monday through Friday, unless otherwise indicated.
  - 1. Work on weekends will be restricted to Contracting Officers approval and at the Station Managers discretion.
  - 2. No work will take place over Federally observed holidays.

- C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated:
  - 1. Notify Station Manager not less than 48 hours in advance of proposed utility interruptions.
- D. Noise, Vibration, and Odors: Coordinate operations that may result in high levels of noise and vibration, odors, or other disruptions to the Government.
  - 1. Notify Station Manager not less than 48 hours in advance of proposed disruptive operations.
- E. Nonsmoking Building: Smoking is not permitted within the building or within 25 feet (8 m) of entrances, operable windows, or outdoor-air intakes.

#### 1.10 COORDINATION WITH LOCAL UTILITIES

- A. The Contractor shall be responsible for contracting and arranging with local utility for the termination, moving, or connection of utilities that serve existing buildings and ones that are planned to serve the new Work.
- B. Local utilities that serve Huron WMD are:
  - 1. Northwest Energy, (800) 245-6977

#### 1.11 PERMITS AND FEES

- A. The Contractor shall be responsible for obtaining all necessary local, State, and Federal permits and licenses, and payment of related fees, per the Contract Clauses.

#### 1.12 APPLICABLE CODES, STANDARDS AND SPECIFICATIONS

- A. All work shall comply with the codes and standards applicable to each type of work as listed in individual Sections of these Specifications.
- B. Where a conflict occurs between a referenced document and the Project Specifications, the Project Specifications govern.
- C. Where a conflict occurs between referenced documents, the document containing the most stringent requirements governs.
- D. Where referenced documents are not specified by date, the document current at the bid opening applies.
- E. Materials, applications, and tests specified by reference to published standards of society, association, code, or other published standards are included in the specifications as if written in their entirety.

- F. Conform to all regulations and statutes of the State of South Dakota and to all Federal Regulations which apply.

#### 1.13 MEANS AND METHODS

- A. Means and methods of construction shall be such as the Contractor or subcontractors may choose; subject, however, to the Contracting Officer's right to reject means and methods proposed which:
  - 1. Constitute a hazard to the work, persons, or property.
  - 2. Will not produce finished work in accordance with terms of the contract.
  - 3. Are contrary to specified means or methods included in the contract.
- B. The right to reject means and methods of the Contractor or subcontractor shall not be construed or interpreted as acceptance of control of means and methods by the Contracting Officer.
- C. The Contracting Officer's approval of means and methods or failure to exercise right to reject means and methods shall not relieve the Contractor of the obligation to complete the work required by the contract.
- D. Total responsibility for control of all means and methods lies with the Contractor for all work.

#### 1.14 SAFETY

- A. The Contractor shall provide, erect and maintain all necessary barricades, suitable and sufficient flasher lights, flagmen, danger signals and signs, and shall take all necessary precautions for the protection of the work and the safety of the public. All ponds and water control structures shall remain accessible by vehicle. Roads closed to traffic shall be protected by effective barricades and shall be placed with acceptable warning signs. All barricades and obstructions shall be illuminated at night and all lights shall be kept burning from sunset until sunrise. Install appropriate traffic signs at crossroads and approaches to site as needed to direct affected public traffic. Specific signs and barricade requirements are detailed in the U.S. Department of Transportation, "Manual on Uniform Traffic Control Devices".
- B. The Contractor shall assume full responsibility and liability for compliance with all applicable Federal, State, and local regulations pertaining to the protection of workers, visitors to the site, and persons occupying areas adjacent to the site, including the provisions of 29CFR1910 and 29CFR1926 of the Code of Federal Regulations. The Contractor shall hold harmless the Government for failure to comply with any applicable safety or health regulation on the part of himself, his employees, or his subcontractors.
- C. Provide personal safety equipment and training commensurate with the hazards which may exist at the work site. The personal safety equipment and training shall be determined by a thorough hazard analysis of all work site areas. The safety program available at all work sites shall include a minimum of:
  - 1. One nonfreezing-type fire extinguisher in each workshop and shed used for storage of materials at the work site. Place in location readily accessible to construction personnel.

2. A first aid kit for use of construction personnel commensurate with size of project with items necessary for first aid treatment of all injuries.
3. The Contractor shall conduct regular onsite safety inspections and all construction personnel shall receive a safety orientation.
4. Post telephone numbers of nearest hospital, ambulance service or flight for life, and fire station in conspicuous location. Advise all workers of location of telephone numbers.

#### 1.15 ENVIRONMENTAL PROTECTION

- A. The Contractor shall abate and control all environmental pollution arising from construction activities by complying with all applicable Federal, State, and local laws and regulations concerning environmental pollution control and abatement, as well as the specified requirements in this contract. Compliance with this requirement by subcontractors will be the responsibility of the Contractor.
- B. Fossils and Artifacts
  1. Should the Contractor discover any fossils or artifacts during construction operations, such objects shall become the property of the Government. The Contractor shall cease construction operations in the area of the "find," and immediately notify the station manager of such discovery. Construction operations may proceed in other areas not affected by this clause. Care shall be exercised by the Contractor not to damage fossils or artifacts uncovered during excavation operations.
  2. Failure to comply with this requirement may be considered a violation of the Archeological Resources Protection Act of 1979 as amended. Destruction of historic and prehistoric sites and/or unauthorized collection of cultural materials can result in criminal and/or civil penalties. Penalties can include fines, prison sentences, and/or confiscation of equipment.
  3. If the Contractor uses fill from a nongovernmental source to perform work that is required under this project, and a new borrow site is opened or an existing borrow area is expanded in order to obtain such materials, the Contractor shall assure that any new borrow area disturbance meet the requirements of Section 106 of the National Historic Preservation Act.
- C. Abatement of Air Pollution
  1. The Contractor shall comply with applicable Federal, State, and local laws and regulations concerning the prevention and control of air pollution.
  2. Construction activities shall be performed in such a manner that air pollution will be held to a minimum.
  3. Burning of materials, trees and brush, combustible construction materials, and rubbish will not be permitted. Construction debris shall be disposed of at a location designated by the Contracting Officer or hauled off the Station to an approved disposal site.
- D. Prevention of Water Pollution
  1. The Contractor is responsible for implementing the terms and requirements of the (insert state) storm water discharge permit, as issued to the State under the National Pollution Discharge Elimination System (NPDES) by the Environmental Protection Agency (EPA). The Contractor shall apply for and execute all permits as required by the State of (insert state) regarding storm water discharge from the construction site. The Contractor shall

submit to the Contracting Officer a copy of all permit applications and a copy of all approvals from the State. Allow the Government 10 days for review of the application package prior to submission.

E. Prevention of site contamination

1. The purpose of this section is to prevent invasive species from being introduced to the project work sites. This includes both plant and animal species. Invasive species can have long last detrimental effects at project sites at US Fish and Wildlife Service lands.
2. Prior to entrance to the work site, all equipment brought on site will be thoroughly washed to remove dirt, seeds, and plant parts. Any equipment that has been any body of water within the past 30 days will be thoroughly cleaned with hot water greater than 140 degree F (typically the temperature found at commercial truck washes) and dried for a minimum of five days before being used at this project site. In addition, before transporting equipment from the project site all visible mud, plants and fish/animals will be removed, all water will be eliminated, and the equipment will be thoroughly cleaned. Anything that came in contact with water will be cleaned and dried following the above procedure.

- F. Environmental Litigation: Time lost due to work stoppage because of failure of the Contractor to comply with these requirements may not be the subject of a claim for extension of time, for additional costs, or damages.

END OF SECTION 011000

## SECTION 012500 - SUBSTITUTION PROCEDURES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes administrative and procedural requirements for substitutions.
- B. Related Requirements:
  - 1. Section 016000 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.

#### 1.2 DEFINITIONS

- A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.

#### 1.3 ACTION SUBMITTALS

- A. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
  - 1. Substitution Request Form: Use CSI Form 13.1A
  - 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
    - a. Statement indicating why specified product or fabrication, or installation cannot be provided, if applicable.
    - b. Coordination information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors, that will be necessary to accommodate proposed substitution.
    - c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
    - d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
    - e. Samples, where applicable or requested.
    - f. Certificates and qualification data, where applicable or requested.
    - g. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
    - h. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.

- i. Research reports evidencing compliance with building code in effect for Project, from the applicable code organization.
  - j. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
  - k. Cost information, including a proposal of change, if any, in the Contract Sum.
  - l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.
  - m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within 7 days of receipt of a request for substitution. Architect will notify Contractor through Construction Manager of acceptance or rejection of proposed substitution within 15 days of receipt of request, or 7 days of receipt of additional information or documentation, whichever is later.
- a. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.
  - b. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

#### 1.4 QUALITY ASSURANCE

- A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

### PART 2 - PRODUCTS

#### 2.1 SUBSTITUTIONS

- A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.
  - 1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied:
    - a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
    - b. Requested substitution provides sustainable design characteristics that specified product provided

- c. Requested substitution will not adversely affect Contractor's construction schedule.
  - d. Requested substitution has received necessary approvals of authorities having jurisdiction.
  - e. Requested substitution is compatible with other portions of the Work.
  - f. Requested substitution has been coordinated with other portions of the Work.
  - g. Requested substitution provides specified warranty.
  - h. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
- B. Substitutions for Convenience: Not allowed unless otherwise indicated.
- C. Substitutions for Convenience: Architect will consider requests for substitution if received within 60 days after the Notice to Proceed
- 1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied:
    - a. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
    - b. Requested substitution does not require extensive revisions to the Contract Documents.
    - c. Requested substitution is consistent with the Contract Documents and will produce indicated results.
    - d. Requested substitution provides sustainable design characteristics that specified product provided
    - e. Requested substitution will not adversely affect Contractor's construction schedule.
    - f. Requested substitution has received necessary approvals of authorities having jurisdiction.
    - g. Requested substitution is compatible with other portions of the Work.
    - h. Requested substitution has been coordinated with other portions of the Work.
    - i. Requested substitution provides specified warranty.
    - j. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

PART 3 - EXECUTION (Not Used)

END OF SECTION 012500

## SECTION 012900 – PAYMENT PROCEDURES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.

#### 1.2 SCHEDULE OF VALUES

- A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule.
  - 1. Submit the schedule of values to Contracting Officer at earliest possible date but no later than seven days before the date scheduled for submittal of initial Applications for Payment.

#### 1.3 APPLICATIONS FOR PAYMENT

- A. Each Application for Payment shall be consistent with previous applications and payments as certified by Contracting Officer.
- B. Payment Application Times: The date for each progress payment is indicated in the Agreement between Government and Contractor.
- C. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
  - 1. Schedule of values.
  - 2. Contractor's construction schedule (preliminary if not final).
  - 3. Submittal schedule (preliminary if not final).
- D. Final Payment Application: After completing Project closeout requirements, submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:
  - 1. Evidence of completion of Project closeout requirements.
  - 2. Written guarantees, warranties, and certificates.
  - 3. Record (As-Built) Drawings
  - 4. All test reports.

END OF SECTION 012900

## SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
  - 1. Coordination drawings.
  - 2. Requests for Information (RFIs).
  - 3. Project meetings.

#### 1.2 DEFINITIONS

- A. RFI: Request from Government, Owner, Construction Manager, Architect, or Contractor seeking information required by or clarifications of the Contract Documents.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
  - 1. Name, address, and telephone number of entity performing subcontract or supplying products.
  - 2. Number and title of related Specification Section(s) covered by subcontract.
  - 3. Drawing number and detail references, as appropriate, covered by subcontract.

#### 1.4 GENERAL COORDINATION PROCEDURES

- A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections, which depend on each other for proper installation, connection, and operation.
  - 1. Provide a construction schedule noting demolition activities, construction activities, deliveries, payments, etc., as needed to convey coordination information to the Contacting Officer, Contacting Officer's Technical Representative (COTR), Government Inspector as well as local staff.
  - 2. 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.

3. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
  4. Make adequate provisions to accommodate items scheduled for later installation.
- B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
1. Prepare similar memoranda for Owner 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 as well as any 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 (SOV).
  3. Installation and removal of temporary facilities and controls.
  4. Delivery and processing of submittals.
  5. Progress meetings.
  6. Pre-installation conferences.
  7. Project closeout activities.
  8. Startup and adjustment of systems.

## 1.5 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, where installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.
1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:
    - a. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
    - b. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
- B. Coordination Drawing Organization: Organize coordination drawings as follows:
1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to an acoustical ceiling grid.

2. Plenum Space: Indicate subframing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within ceiling plenum to accommodate layout of light fixtures indicated on Drawings.
3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment, etc.
4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
6. Review: The Government will review coordination drawings to confirm that the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility.

#### 1.6 REQUESTS FOR INFORMATION (RFIs)

- A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
  1. The Government will return RFIs as submitted to the Government by other entities controlled by Contractor with no response. RFI's must come directly from the Contractor.
  2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
  1. Project name.
  2. Project number.
  3. Date.
  4. Name of Contractor.
  5. RFI number, numbered sequentially.
  6. RFI subject.
  7. Specification Section number and title and related paragraphs, as appropriate.
  8. Drawing number and detail references, as appropriate.
  9. Field dimensions and conditions, as appropriate.
  10. Contractor's suggested resolution. If Contractor's solution(s) have an impact the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
  11. Contractor's signature.
  12. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.

- C. RFI Forms: AIA Document G716, or Software-generated form with substantially the same content as indicated above, acceptable to the Government.
- D. The Government's Action: The Government will review each RFI, determine action required, and respond. Allow seven working days for the Government's response for each RFI. RFIs received after 1:00 p.m. will be considered as received the following working day.
  - 1. The following RFIs will be returned without action:
    - a. Requests for approval of submittals.
    - b. Requests for approval of substitutions.
    - c. Requests for coordination information already indicated in the Contract Documents.
    - d. Requests for adjustments in the Contract Time or the Contract Sum.
    - e. Requests for interpretation of Architect's actions on submittals.
    - f. Incomplete RFIs or inaccurately prepared RFIs.
    - g. Request For Information submitted by a sub-contractor to the Contractor.
  - 2. The Government's action may include a request for additional information, in which case the time for response will date from time of receipt of additional information.
  - 3. The Government's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal.
    - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Contacting Officer and COR in writing within 10 days of receipt of the RFI response.
- E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly with not less than the following information:
  - 1. Project name.
  - 2. Name and address of Contractor.
  - 3. Name and address of Contacting Officer and COR.
  - 4. RFI number including RFIs that were dropped and not submitted.
  - 5. RFI description.
  - 6. Date the RFI was submitted.
  - 7. Date the Contacting Officer's response was received.
- F. On receipt of the Government's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify the Government within seven days if Contractor disagrees with response.
  - 1. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
  - 2. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.

## 1.7 PROJECT MEETINGS

- A. General: The construction contractor shall coordinate and schedule and conduct weekly construction progress meetings at the 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 the Facility Director, the Contracting officer and the 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 the Contracting Officer and the COTR, Construction Manager, and other FWS personnel, within three days of the meeting.
- B. Preconstruction Conference: The Contracting Officer will schedule a preconstruction conference before starting construction, at a time convenient to the Contracting Officer, COTR, Facility Director, On-Site Government Inspector and Contractor.
1. Attendees: Authorized representatives of the Contracting Officer, Government Project Manager, Owner's Commissioning Authority, Construction Manager, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
  2. Agenda: Discuss items of significance that could affect progress, including the following:
    - a. Tentative construction schedule.
    - b. Phasing.
    - c. Critical work sequencing and long-lead items.
    - d. Designation of key personnel and their duties.
    - e. Procedures for processing field decisions and Change Orders.
    - f. Procedures for RFIs.
    - g. Procedures for testing and inspecting.
    - h. Procedures for processing Applications for Payment.
    - i. Distribution of the Contract Documents.
    - j. Submittal procedures.
    - k. Preparation of record documents.
    - l. Use of the premises and existing building.
    - m. Work restrictions.
    - n. Working hours.
    - o. Owner's occupancy requirements.
    - p. Responsibility for temporary facilities and controls.
    - q. Procedures for moisture and mold control.
    - r. Procedures for disruptions and shutdowns.
    - s. Construction waste management and recycling.
    - t. Parking availability.
    - u. Office, work, and storage areas.
    - v. Equipment deliveries and priorities.
    - w. First aid.

- x. Security.
  - y. Progress cleaning.
3. Minutes: The construction contractor shall be responsible for conducting meeting, recording minutes and distributing the meeting minutes.
- 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 and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise the Government of scheduled meeting dates.
  2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
    - a. Contract Documents.
    - b. Options.
    - c. Related RFIs.
    - d. Related Change Orders.
    - e. Purchases.
    - f. Deliveries.
    - g. Submittals.
    - h. Review of mockups.
    - i. Possible conflicts.
    - j. Compatibility problems.
    - k. Time schedules.
    - l. Weather limitations.
    - m. Manufacturer's written instructions.
    - n. Warranty requirements.
    - o. Compatibility of materials.
    - p. Acceptability of substrates.
    - q. Temporary facilities and controls.
    - r. Space and access limitations.
    - s. Regulations of authorities having jurisdiction.
    - t. Testing and inspecting requirements.
    - u. Installation procedures.
    - v. Coordination with other work.
    - w. Required performance results.
    - x. Protection of adjacent work.
    - y. Protection of construction and personnel.
  3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
  4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.

5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- D. Progress Meetings: Conduct weekly construction progress meetings as directed by the Contracting officer and/or the COTR.
1. Attendees: In addition to representatives of the Government, Construction Manager, and COTR (as applicable), each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
  2. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
    - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
      - 1) Review schedule for next period.
    - b. Review present and future needs of each entity present, including the following:
      - 1) Interface requirements.
      - 2) Sequence of operations.
      - 3) Status of submittals.
      - 4) Deliveries.
      - 5) Off-site fabrication.
      - 6) Access.
      - 7) Site utilization.
      - 8) Temporary facilities and controls.
      - 9) Progress cleaning.
      - 10) Quality and work standards.
      - 11) Status of correction of deficient items.
      - 12) Field observations.
      - 13) Status of RFIs.
      - 14) Status of proposal requests.
      - 15) Pending changes.
      - 16) Status of Change Orders.
      - 17) Pending claims and disputes.
      - 18) Documentation of information for payment requests.
  3. Minutes: The construction contractor shall be responsible for conducting meeting, recording minutes and distributing the meeting minutes.

- a. Schedule Updating: Revise the 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.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013100

## SECTION 013200 – CONSTRUCTION PROGRESS DOCUMENTATION

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
  - 1. Contractor's construction schedule.
  - 2. Construction schedule updating reports.
  - 3. Daily construction reports.
  - 4. Site condition reports.

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

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.
  - 1. Submit a working electronic copy of schedule, using software indicated, and labeled to comply with requirements for submittals. Include type of schedule (initial or updated) and date on label.
- B. Construction Schedule Updating Reports: Submit with Applications for Payment.

#### 1.4 COORDINATION

- A. Coordinate Contractor's construction schedule with the schedule of values, submittal schedule, progress reports, payment requests, and other required schedules and reports.
  - 1. Secure time commitments for performing critical elements of the Work from entities involved.
  - 2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

## PART 2 - PRODUCTS

### 2.1 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

- A. Time Frame: Extend schedule from date established from the Notice to Proceed to the date of completion.
- B. Activities: Treat each story or separate area as a separate numbered activity for each main element of the Work. Comply with the following:
  - 1. Activity Duration
  - 2. Procurement Activities
  - 3. Submittal Review Time
  - 4. Punch List and Final Completion: Include not more than 15 days for completion of punch list items and final completion.
- C. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
  - 1. Phasing: Arrange list of activities on schedule by phase.
  - 2. Work under More Than One Contract: Include a separate activity for each contract.
  - 3. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.
  - 4. Work Restrictions: Show the effect of the following items on the schedule:
    - a. Coordination with existing construction.
    - b. Limitations of continued occupancies.
    - c. Uninterruptible services.
    - d. Partial occupancy before Substantial Completion.
    - e. Use of premises restrictions.
    - f. Provisions for future construction.
    - g. Seasonal variations.
    - h. Environmental control.
  - 5. Work Stages: Indicate important stages of construction for each major portion of the Work.
  - 6. Other Constraints
- D. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and final completion and the following interim milestones.
  - 1. Insert milestones not indicated elsewhere.

END OF SECTION 013200

## SECTION 013233 - PHOTOGRAPHIC DOCUMENTATION

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
  - 1. Preconstruction photographs.
  - 2. Periodic construction photographs.
- B. Related Requirements:
  - 1. Section 017700-Closeout Procedures for submitting photographic documentation as Project Record Documents at Project closeout.

#### 1.2 INFORMATIONAL SUBMITTALS

- A. Key Plan: Submit key plan of Project site and building with notation of vantage points marked for location and direction of each photograph. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.
- B. Digital Photographs: Submit unaltered, original, full-size image files within 5 days of taking photographs.
  - 1. Digital Camera: Minimum sensor resolution of 8 megapixels.
  - 2. Digital photographs to be submitted in the order in which they were taken with the photograph "name" as given by the device used to take to photo.
  - 3. Identification: Provide the following information with each image description in file metadata tag:
    - a. Date and time photograph was taken
    - b. Unique photograph number

#### 1.3 QUALITY ASSURANCE

- A. Photographs to be clear, focused, level, have proper exposure settings (not over exposed or under exposed), and clearly show and document the subject matter. Detail photographs (close-ups) to be preceded by a larger overall view of the area being documented.

#### 1.4 USAGE RIGHTS

- A. If a professional photographer is used for this requirement, obtain and transfer copyright usage rights from photographer to Owner for unlimited reproduction of photographic documentation.

## PART 2 - PRODUCTS

### 2.1 PHOTOGRAPHIC MEDIA

- A. Digital Images: Provide images in JPG format, with minimum size of 8 megapixels.

## PART 3 - EXECUTION

### 3.1 CONSTRUCTION PHOTOGRAPHS

- A. Photographer: Engage a qualified photographer to take construction photographs. Photographer need not be a professional photographer, but an individual familiar with and able to produce clear, focused photographs of the subject area with good reference points.
- B. General: Take photographs using the maximum range of depth of field, and that are in focus, to clearly show the Work. Photographs with blurry or out-of-focus areas will not be accepted.
  - 1. Maintain key plan with each set of construction photographs that identifies each photographic location.
- C. Digital Images: Submit digital images exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.
  - 1. Date and Time: Include date and time in file name for each image.
  - 2. Field Office Images: Maintain one set of images accessible in the field office at Project site, available at all times for reference. Identify images in the same manner as those submitted to the Government.
- D. Preconstruction Photographs: Before commencement of excavation, commencement of demolition and starting construction, take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Government.
  - 1. Flag excavation areas before taking construction photographs.
  - 2. Take minimum of 10 photographs, or as needed, to show existing conditions adjacent to property before starting the Work.
  - 3. Take minimum of 10 photographs, or as needed, of existing buildings either on or adjoining property to accurately record physical conditions at start of construction.
- E. Periodic Construction Photographs: Take photographs as needed to fully document the construction progress. Select vantage points to show status of construction and progress since last photographs were taken. Try to retake progress photos from the same vantage points when possible so as to show relative construction progress.
- F. Final Completion Construction Photographs: Take color photographs after date of Substantial Completion for submission as Project Record Documents. The Government will inform photographer of desired vantage points.

- G. Additional Photographs: The Government may request photographs in addition to periodic photographs specified as needed to verify progress or to verify work completion accuracy.
1. Three days' notice will be given, where feasible.
  2. In emergency situations, take additional photographs within 24 hours of request.
  3. Circumstances that could require additional photographs include, but are not limited to, the following:
    - a. Special events planned at Project site.
    - b. Immediate follow-up when on-site events result in construction damage or losses.
    - c. Photographs to be taken at fabrication locations away from Project site. These photographs are not subject to unit prices or unit-cost allowances.
    - d. Substantial Completion of a major phase or component of the Work.
    - e. Extra record photographs at time of final acceptance.
    - f. Owner's request for special publicity photographs.
- H. Upon closeout of the project, all photos are to be provided on a CD-ROM or similar, and included in the Operation and Maintenance Manual. Photos shall be structured within folders for the date which the photo was taken. Folders shall be named as such: (Year)-(MNDY). For example, July 11, 2021 would be noted as 2021-0711.

END OF SECTION 013233

## SECTION 013300 – SUBMITTAL PROCEDURES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.

#### 1.2 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require Architect's Contracting Officer responsive action.
- B. Informational Submittals: Written and graphic information and physical samples that do not require Architect's Contracting Officer responsive action. Submittals may be rejected for not complying with requirements.

#### 1.3 ACTION SUBMITTALS

- A. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by the Government and additional time for handling and reviewing submittals required by those corrections.

#### 1.4 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
  - 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
  - 2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
    - a. Contracting Officer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- B. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Contracting Officer receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals. Submittals received after 1:00 PM will be considered to having arrived the following day.

1. Initial Review: Allow 10 working days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Contracting Officer will advise Contractor when a submittal being processed must be delayed for coordination.
  2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
  3. Resubmittal Review: Allow 10 working days for review of each resubmittal.
- C. Paper Submittals: Place a permanent label or title block on each submittal item for identification.
1. Transmittal for Paper Submittals: Assemble each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form.
    - a. Transmittal Form for Paper Submittals: Use FWS transmittal form. This form will be made available in either PDF or as a Word document.
- D. Electronic Submittals: Identify and incorporate information in each electronic submittal file as follows:
1. Name file with submittal number or other unique identifier, including revision identifier.
    - a. File name shall use a sequential submittal number followed by station initials and Specification Section number (Submittal 001-(Item Name)-(CSI Number)). Resubmittals shall include a numeric suffix after the submittal number (e.g., Submittal 001-R1-(Item Name)-(CSI Number)).
  2. Transmittal Form for Electronic Submittals: Use FWS transmittal form. This form will be made available in either PDF or as a Word document.
- E. Options: Identify options requiring selection by the Government.
- F. Deviations: Identify deviations from the Contract Documents on submittals.
- G. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
1. Note date and content of previous submittal.
  2. Note date and content of revision in label or title block and clearly indicate extent of revision.
  3. Resubmit submittals until they are marked with approval notation from Contracting Officer's action stamp.
  4. The contractor is allowed (2) resubmittals for any one item or group of related items for a total of (3) reviews of any given item or group of items. If at that time the contractor has not provided the required, requested information, the Government shall be allowed a credit for additional review time and associated costs.
- H. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

- I. Use for Construction: Retain complete copies of submittals on project site. Use only final action submittals that are marked with approval notation from Contracting Officer's action stamp.

## PART 2 - PRODUCTS

### 2.1 SUBMITTAL PROCEDURES

#### A. General Electronic Submittal Procedure Requirements:

1. Submit electronic submittals via email as PDF electronic files.
2. PDF files shall be formatted as an 8.5x11 or 11x17 size "sheet" to allow readability and reduce file size.
3. Contracting Officer's Representative, through the Contracting Officer, will return annotated file by e-mail and/or standard mail. Annotate and retain one copy of file as an electronic Project record document file.

#### B. General Paper Submittal Procedure Requirements:

1. Action Submittals: Submit four (4) paper copies of each submittal unless otherwise indicated. Contracting Officer's Representative through the Contracting Officer will return three (3) copies.
2. Informational Submittals: Submit three (3) paper copies of each submittal unless otherwise indicated. Contracting Officer will not return copies.
3. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
  - a. Provide a digital signature with digital certificate on electronically-submitted certificates and certifications where indicated.
  - b. Provide a notarized statement on original paper copy certificates and certifications where indicated.

#### C. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment. Do not submit items of different CSI divisions together within a single submittal, they shall be submitted separately.

1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
2. Mark each copy of each submittal to show which products and options are applicable to the item being submitted for approval. Submittals that are not clearly marked will be returned without review.
3. Include the following information, as applicable:
  - a. Manufacturer's catalog cuts.
  - b. Manufacturer's product specifications.
  - c. Standard color charts.
  - d. Statement of compliance with specified referenced standards.

- e. Testing by recognized testing agency.
  - f. Application of testing agency labels and seals.
  - g. Notation of coordination requirements.
  - h. Availability and delivery time information.
4. For equipment, include the following in addition to the above, as applicable:
- a. Wiring diagrams showing factory-installed wiring.
  - b. Printed performance curves.
  - c. Operational range diagrams.
  - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
5. Submit Product Data before or concurrent with Samples.
6. Submit Product Data in the following format:
- a. PDF electronic file.
  - b. Four (4) paper copies of Product Data unless otherwise indicated. Contracting Officer's Representative through the Contracting Officer will return two (2) copies.
- D. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data unless submittal based on drawing files is otherwise permitted.
1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
- a. Identification of products.
  - b. Schedules.
  - c. Compliance with specified standards.
  - d. Notation of coordination requirements.
  - e. Notation of dimensions established by field measurement.
  - f. Relationship and attachment to adjoining construction clearly indicated.
  - g. Seal and signature of professional engineer if specified.
2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches, but no larger than 30 by 42 inches.
3. Submit Shop Drawings in the following format:
- a. PDF electronic file formatted as an 11x17 "sheet" as a maximum size to allow readability and reduce file size.
  - b. Four (4) opaque copies of each submittal. Contracting Officer's Representative through the Contracting Officer will retain two (2) copies; remainder will be returned.
- E. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.

1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
  2. Identification: Attach label on unexposed side of Samples that includes the following:
    - a. Generic description of Sample.
    - b. Product name and name of manufacturer.
    - c. Sample source.
    - d. Number and title of applicable Specification Section.
  3. For projects where electronic submittals are required, provide corresponding electronic submittal of Sample transmittal, digital image file illustrating Sample characteristics, and identification information for record.
  4. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
    - a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
    - b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
  5. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the manufacturers standard of colors, textures, and patterns available.
    - a. Number of Samples: Submit one (1) full set of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Contracting Officer's Representative through the Contracting Officer's will return submittal with options selected.
  6. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
    - a. Number of Samples: Submit two (2) sets of Samples. Contracting Officer will retain one (1) Sample set; remainder will be returned. Mark up and retain one returned sample set as a project record sample.
- F. Contractor's Construction Schedule: Comply with requirements specified in Section 013200-Construction Progress Documentation.
- G. Application for Payment and Schedule of Values: Comply with requirements specified in Section 012900-Payment Procedures.

- H. Test and Inspection Reports and Schedule of Tests and Inspections Submittals: Comply with requirements specified in Section 014000-Quality Requirements and complying with requirements in the Construction Documents.
- I. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Section 017700-Closeout Procedures.
- J. Maintenance Data: Comply with requirements specified in Section 017823-Operation and Maintenance Data.
- K. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.
- L. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
- M. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
- N. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- O. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
- P. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
- Q. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
- R. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project.
- S. Schedule of Tests and Inspections: Comply with requirements specified in Section 014000-Quality Requirements and complying with requirements in the Construction Documents.
- T. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
- U. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed

before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.

- V. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
- W. Design Data: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

## 2.2 DELEGATED-DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
  - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Contracting Officer.
- B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit three (3) paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
  - 1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

## PART 3 - EXECUTION

### 3.1 CONTRACTOR'S REVIEW

- A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Contracting Officer.
- B. Project Closeout and Maintenance Material Submittals: See requirements in Section 017700-Closeout Procedures.
- C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 CONTRACTING OFFICER AND CONTRACTING OFFICER'S REPRESENTATIVE ACTION

- A. General: Contracting Officer's Representative will not review submittals that do not bear Contractor's approval stamp and will return them without action.
- B. Action Submittals: Contracting Officer's Representative will review each submittal, make marks to indicate corrections or revisions required, and return it. Contracting Officer's Representative will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action as follows:
  - 1. A: Approved as submitted.
  - 2. B: Approved, except as noted. Resubmission not required.
  - 3. C: Approved, except as noted. Resubmission required.
  - 4. D: No action taken. See comments on reverse. Resubmission required.
  - 5. E: Disapproved.
  - 6. Other: (comments as noted)
- C. Informational Submittals: Contracting Officer's Representative will review each submittal and will not return it, or will return it if it does not comply with requirements. Contracting Officer will forward each submittal to appropriate party.
- D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
- E. Submittals not required by the Contract Documents may not be reviewed and may be discarded.

END OF SECTION 013300

**U.S. FISH & WILDLIFE SERVICE**  
**Mountain-Prairie Region 6**

<b>TRANSMITTAL OF SHOP DRAWINGS, EQUIPMENT DATA, MATERIAL, SAMPLES, MANUFACTURER'S CERTIFICATES OF COMPLIANCE FOR REVIEW.</b> ONLY ONE SPECIFICATION SECTION NUMBER ALLOWED PER SUBMITTAL TRANSMITTAL.	Date  <span style="color: blue; font-size: 1.2em;">XX/XX/XXXX</span>	Submittal No.  <span style="color: blue; font-size: 1.2em;">00X</span>
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**Section I (Contractor) CONTRACTOR SHALL EXPLICITLY INDICATE ANY REQUESTED DEVIATIONS OR SUBSTITUTIONS FROM THE CONTRACT REQUIREMENTS.**

To: Michael LeMieux, COR US Fish & Wildlife Service Regional Engineer Region 6-Division of Engineering 134 Union Blvd., Lakewood, CO P: 303.236.4478	From: <span style="color: red;">(CONTRACTOR PM)</span> <span style="color: red;">(CONTRACTOR COMPANY)</span> <span style="color: red;">(STREET ADDRESS)</span> <span style="color: red;">(CITY, ST 00001)</span> <span style="color: red;">P: (XXX.XXX.XXXX)</span> <span style="color: red;">E: (NAME@GC.COM)</span>	Contract No.:  <hr/> Project and Location:	Previously Submitted on Transmittal No. _____
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Item No.	Description <small>(Include Brand or Manufacturer's Name)</small>	Identify Submittal	No. of Copies	Contract Specification Para. No.	Contract Drawing No.	Reg'n Engr Use Only <small>Action Code*</small>
1						

Name:  
 (Contractor Project Manager)

Contractor certifies he has reviewed the plans and specifications, the submittal is in accordance with the contract documents or deviations are clearly identified; individual product characteristics and assemblies have been coordinated with actual field conditions; systems are complete; system and system components can be installed and will function as intended.

Comments:  <hr/> <hr/> <hr/>	Date Received:  <hr/>
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Reviewed By:	Signature: Approving Authority: COR - COTR	Date:
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<u>Action Codes:</u> A - Approved as Submitted B - Approved As Noted - Resubmission Not Required	C - Approved As Noted - Resubmission Required D - No Action Taken - See Comments, Resubmission Required.	E - Rejected – See Comments, Resubmission Required. O - Other: _____	Distribution: Regional Engineer/Contract File Inspector's File Contractor
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## SECTION 014000 - QUALITY REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
  - 1. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
  - 2. Requirements for Contractor to provide quality-assurance and -control services required by Contracting Officer or authorities having jurisdiction are not limited by provisions of this Section.
  - 3. Specific test and inspection requirements are not specified in this Section.

#### 1.2 DEFINITIONS

- A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Contracting Officer.
- C. Mockups: Full-size physical assemblies that are constructed on-site. Mockups are constructed to verify selections made under Sample submittals; to demonstrate aesthetic effects and, where indicated, qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
  - 1. Laboratory Mockups: Full-size physical assemblies constructed at testing facility to verify performance characteristics.
- D. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.

- E. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
- F. Source Quality-Control Testing: Tests and inspections that are performed at the source, e.g., plant, mill, factory, or shop.
- G. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
- I. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
- J. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

### 1.3 CONFLICTING REQUIREMENTS

- A. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Contracting Officer for a decision before proceeding.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Contracting Officer for a decision before proceeding.

### 1.4 INFORMATIONAL SUBMITTALS

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

### 1.5 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
  - 1. Date of issue.
  - 2. Project title and number.

3. Name, address, and telephone number of testing agency.
  4. Dates and locations of samples and tests or inspections.
  5. Names of individuals making tests and inspections.
  6. Description of the Work and test and inspection method.
  7. Identification of product and Specification Section.
  8. Complete test or inspection data.
  9. Test and inspection results and an interpretation of test results.
  10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
  11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
  12. Name and signature of laboratory inspector.
  13. Recommendations on retesting and reinspecting.
- B. **Manufacturer's Field Reports:** Prepare written information documenting tests and inspections specified in other Sections. Include the following:
1. Name, address, and telephone number of representative making report.
  2. Statement on condition of substrates and their acceptability for installation of product.
  3. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
  4. Results of operational and other tests and a statement of whether observed performance complies with requirements.
  5. Other required items indicated in individual Specification Sections.
- C. **Permits, Licenses, and Certificates:** For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

## 1.6 QUALITY ASSURANCE

- A. **General:** Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. **Manufacturer Qualifications:** A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- C. **Fabricator Qualifications:** A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. **Installer Qualifications:** A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- E. **Professional Engineer Qualifications:** A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system,

assembly, or products that are similar in material, design, and extent to those indicated for this Project.

- F. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
  - 1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.
- G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
  - 1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
  - 2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.
- H. Manufacturer's Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
  - 1. Contractor responsibilities include the following:
    - a. Provide test specimens representative of proposed products and construction.
    - b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
    - c. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
    - d. When testing is complete, remove test specimens, assemblies, and mockups; do not reuse products on Project.
  - 2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Contracting Officer with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.
- J. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
  - 1. Build mockups in location and of size indicated or, if not indicated, as directed by Contracting Officer.
  - 2. Notify Contracting Officer seven days in advance of dates and times when mockups will be constructed.

3. Demonstrate the proposed range of aesthetic effects and workmanship.
4. Obtain Contracting Officer approval of mockups before starting work, fabrication, or construction.
  - a. Allow seven days for initial review and each re-review of each mockup.
5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
6. Demolish and remove mockups when directed unless otherwise indicated.

## 1.7 QUALITY CONTROL

- A. Government Responsibilities: Where quality-control services are indicated as Government's responsibility, Government will engage a qualified testing agency to perform these services.
  1. Government will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
  2. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor.
- B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Government are Contractor's responsibility. Perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.
  1. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.
    - a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
  2. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
  3. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
  4. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
- C. Manufacturer's Field Services: Where indicated, engage a manufacturer's representative to observe and inspect the Work. Manufacturer's representative's services include examination of substrates and conditions, verification of materials, inspection of completed portions of the Work, and submittal of written reports.
- D. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- E. Testing Agency Responsibilities: Cooperate with Contracting Officer and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.

1. Notify Contracting Officer and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
  2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
  3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
  4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
  5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
  6. Do not perform any duties of Contractor.
- F. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel.
- G. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
1. Schedule times for tests, inspections, obtaining samples, and similar activities.

#### 1.8 SPECIAL TESTS AND INSPECTIONS

- A. Special Tests and Inspections: Conducted by a qualified testing agency or special inspector as required by authorities having jurisdiction, as indicated in individual Specification Sections and as follows:
1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviews the completeness and adequacy of those procedures to perform the Work.
  2. Notifying Contracting Officer and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
  3. Submitting a certified written report of each test, inspection, and similar quality-control service to Contracting Officer with copy to Contractor and to authorities having jurisdiction.
  4. Submitting a final report of special tests and inspections at Substantial Completion including a list of unresolved deficiencies.
  5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
  6. Retesting and reinspecting corrected work.
  7. Any other tests that were performed for the project.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

- A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:
  - 1. Date test or inspection was conducted.
  - 2. Description of the Work tested or inspected.
  - 3. Date test or inspection results were transmitted to Contracting Officer.
  - 4. Identification of testing agency or special inspector conducting test or inspection.
- B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect's reference during normal working hours.

3.2 REPAIR AND PROTECTION

- A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
  - 1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching as per the specifications.
- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 014000

## SECTION 015000 – TEMPORARY FACILITIES AND CONTROLS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.
- B. Related Requirements:
  - 1. Section 011000-Summary for work restrictions and limitations on utility interruptions.

#### 1.2 USE CHARGES

- A. General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities to use temporary services and facilities without cost, including, but not limited to testing agencies, and authorities having jurisdiction.
- B. Water and Sewer Service from Existing System:
  - 1. Potable and Non-potable water will **NOT** be available for use on site. The Contractor shall provide, protect, and maintain an adequate water supply for use on the project for construction purposes.
  - 2. Sanitary Facilities: Use of Government existing toilet facilities will **NOT** be permitted. Contractor shall comply with the requirements within this section for temporary sanitary facilities.
- C. Electric Power Service from Existing System:
  - 1. Electrical power from Station existing system is **NOT** available for use, the Contractor shall be responsible for providing temporary electrical service for connections and extensions of services as required for construction operations.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Erosion- and Sedimentation-Control Plan: Show compliance with requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.

#### 1.4 QUALITY ASSURANCE

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

- B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.
- C. Accessible Temporary Egress: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

## 1.5 PROJECT CONDITIONS

- A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Governments acceptance, regardless of previously assigned responsibilities.

## PART 2 - PRODUCTS

### 2.1 TEMPORARY FACILITIES

- A. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.
- B. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.

### 2.2 EQUIPMENT

- A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.
- B. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.
  - 1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
  - 2. Heating Units: Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.
  - 1. Locate facilities to limit site disturbance as specified in Section 011000-Summary.

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

### 3.2 TEMPORARY UTILITY INSTALLATION

- A. General: Install temporary service or connect to existing service.
  - 1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
- B. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
  - 1. Toilets: Use of Owner's existing toilet facilities will be permitted, as long as facilities are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.
- C. Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.
- D. Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.
- E. Electric Power Service:
  - 1. Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.
- F. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
  - 1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
- G. Telephone Service: Provide temporary telephone service in common-use facilities for use by all construction personnel.
  - 1. Provide superintendent with cellular telephone or portable two-way radio for use when away from field office.

### 3.3 SUPPORT FACILITIES INSTALLATION

- A. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas within construction limits indicated on Drawings.
  - 1. Provide dust-control treatment that is nonpolluting and nontracking. Reapply treatment as required to minimize dust.
- B. Traffic Controls: Comply with requirements of authorities having jurisdiction.
  - 1. Protect existing site improvements to remain including curbs, pavement, and utilities.
  - 2. Maintain access for fire-fighting equipment and access to fire hydrants.
- C. Parking: use areas designated by Contracting Officer or Station Manager as parking areas for construction personnel.
- D. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.
  - 1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
  - 2. Remove snow and ice as required to minimize accumulations.
- E. Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted.
  - 1. Identification Signs: Provide Project identification signs as indicated on Drawings.
  - 2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.
    - a. Provide temporary, directional signs for construction personnel and visitors.
  - 3. Maintain and touchup signs so they are legible at all times.
- F. Waste Disposal: Fuels, lubricants, petroleum products, chemicals or other waste materials shall be disposed of in properly designated areas off Government premises.
  - 1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.
- G. Existing Stair Usage: Use of Owner's existing stairs will be permitted, provided stairs are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore stairs to condition existing before initial use.
  - 1. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If stairs become damaged, restore damaged areas so no evidence remains of correction work.

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

### 3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.
- B. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
- C. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.
- D. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
  - 1. Where heating or cooling is needed and permanent enclosure is not complete, insulate temporary enclosures.

### 3.5 OPERATION, TERMINATION, AND REMOVAL

- A. Maintenance: Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage until removal.
- B. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.
- C. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

END OF SECTION 015000

## SECTION 016000 - PRODUCT REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.
- B. Related Requirements:
  - 1. Section 012500 "Substitution Procedures" for requests for substitutions.

#### 1.2 DEFINITIONS

- A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
  - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature, that is current as of date of the Contract Documents.
  - 2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
  - 3. Comparable Product: Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Basis-of-Design Product Specification: A specification in which a specific manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification.

#### 1.3 ACTION SUBMITTALS

- A. Comparable Product Requests: Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
  - 1. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within one week of receipt of a comparable product request. Architect will notify Contractor of approval or rejection of proposed comparable

product request within 15 days of receipt of request, or 7 days of receipt of additional information or documentation, whichever is later.

- a. Form of Approval: As specified in Section 013300 "Submittal Procedures."
- b. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.

- B. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 013300 "Submittal Procedures." Show compliance with requirements.

#### 1.4 QUALITY ASSURANCE

- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.

#### 1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.

- B. Delivery and Handling:

- 1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
- 2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
- 3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
- 4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.

- C. Storage:

- 1. Store products to allow for inspection and measurement of quantity or counting of units.
- 2. Store materials in a manner that will not endanger Project structure.
- 3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
- 4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
- 5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
- 6. Protect stored products from damage and liquids from freezing.

## 1.6 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
  - 1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
  - 2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
  - 1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
  - 2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
  - 3. Refer to other Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Section 017700 "Closeout Procedures."

## PART 2 - PRODUCTS

### 2.1 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
  - 1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
  - 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
  - 3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
  - 4. Where products are accompanied by the term "as selected," Architect will make selection.
  - 5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
- B. Product Selection Procedures:
  - 1. Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.

2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
  3. Products:
    - a. Restricted List: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered unless otherwise indicated.
    - b. Nonrestricted List: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed, or an unnamed product, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product.
  4. Manufacturers:
    - a. Restricted List: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered unless otherwise indicated.
    - b. Nonrestricted List: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed, or a product by an unnamed manufacturer, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed manufacturer's product.
  5. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.
- C. Visual Matching Specification: Where Specifications require "match Architect's sample", provide a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.
1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 012500 "Substitution Procedures" for proposal of product.
- D. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or similar phrase, select a product that complies with requirements. Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

## 2.2 COMPARABLE PRODUCTS

- A. Conditions for Consideration: Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect may return requests without action, except to record noncompliance with these requirements:
1. Evidence that the proposed product does not require revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
  2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
  3. Evidence that proposed product provides specified warranty.
  4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
  5. Samples, if requested.

PART 3 - EXECUTION (Not Used)

END OF SECTION 016000

## SECTION 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
  - 1. Salvaging nonhazardous demolition and construction waste.
  - 2. Recycling nonhazardous demolition and construction waste.
  - 3. Disposing of nonhazardous demolition and construction waste.

#### 1.2 DEFINITIONS

- A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
- B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.
- C. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.
- D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.
- E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse at the facility or by another Government facility.
- F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

#### 1.3 PERFORMANCE REQUIREMENTS

- A. General: Archive end-of-Project rates for salvage/recycling as much as possible. Track all items salvaged, recycled and given over to the Facility and present that list at the end of the project.

#### ACTION SUBMITTALS

- B. Waste Management Plan: Submit plan within 14 days of the Notice to Proceed and/or prior to beginning work that would require the use of material disposal.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.
- B. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.
- C. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
- D. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
- E. Qualification Data: For waste management coordinator.

#### 1.5 WASTE MANAGEMENT PLAN

- A. General: Develop a waste management plan and present to the Contracting Officer's Representative and/or Contracting officer at the beginning of the project. Plan shall consist of waste identification, any salvageable items, and items that are to be handed over to the Facility for reuse elsewhere.
- B. Waste Identification: Indicate anticipated types and quantities of demolition and construction waste generated by the Work. Include estimated quantities and assumptions for estimates.
- C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.
  - 1. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work.
  - 2. Salvaged Materials for Sale: For materials that will be sold to individuals and organizations, include list of their names, addresses, and telephone numbers.
  - 3. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
  - 4. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
  - 5. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
  - 6. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location where materials separation will be performed.

## PART 2 - PRODUCTS (Not Used)

## PART 3 - EXECUTION

### 3.1 PLAN IMPLEMENTATION

- A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
- B. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan.
- C. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work occurring at Project site.
  - 1. Distribute waste management plan to everyone concerned within three days of submittal return.
  - 2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.
- D. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
  - 1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.

### 3.2 SALVAGING DEMOLITION WASTE

- A. Salvaged Items for Reuse in the Work:
  - 1. Clean salvaged items.
  - 2. Pack or crate items after cleaning. Identify contents of containers.
  - 3. Store items in a secure area until installation.
  - 4. Protect items from damage during transport and storage.
  - 5. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.
- B. Salvaged Items for Owner's Use:
  - 1. Clean salvaged items.
  - 2. Pack or crate items after cleaning. Identify contents of containers.
  - 3. Store items in a secure area as directed by the Facility Manager.
  - 4. Transport items to Owner's storage area as coordinated by the Facility Manager.
  - 5. Protect items from damage during transport and storage.

### 3.3 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

- A. General: Recycle paper and beverage containers used by on-site workers.
- B. Recycling Receivers and Processors: Shall be secured by the Contractor.
- C. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Owner unless otherwise noted.
- D. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical according to approved construction waste management plan.
  - 1. Provide appropriately marked containers or bins for controlling recyclable waste until they are removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.
    - a. Inspect containers and bins for contamination and remove contaminated materials if found.
  - 2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
  - 3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
  - 4. Store components off the ground and protect from the weather.
  - 5. Remove recyclable waste from Owner's property and transport to recycling receiver or processor.

### 3.4 RECYCLING DEMOLITION WASTE

- A. Concrete: Remove reinforcement and other metals from concrete and sort with other metals.
  - 1. Secure a concrete recycler and deliver as needed for processing.
- B. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.
- C. Metals: Separate metals by type.
  - 1. Structural Steel: Stack members according to size, type of member, and length.
  - 2. Remove and dispose of bolts, nuts, washers, and other rough hardware.
- D. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location. Remove edge trim and sort with other metals. Remove and dispose of fasteners.
- E. Piping: Reduce piping to straight lengths and store by type and size. Separate supports, hangers, valves, sprinklers, and other components by type and size.
- F. Conduit: Reduce conduit to straight lengths and store by type and size.

### 3.5 RECYCLING CONSTRUCTION WASTE

#### A. Packaging:

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

#### B. Wood Materials:

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

#### C. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location.

1. Clean Gypsum Board: Grind scraps of clean gypsum board using small mobile chipper or hammer mill. Screen out paper after grinding.

### 3.6 DISPOSAL OF WASTE

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

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

#### B. Disposal: Remove waste materials from Owner's property and legally dispose of them.

END OF SECTION 017419

## SECTION 017700 – CLOSEOUT PROCEDURES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
  - 1. Final completion procedures.
  - 2. Closeout Submittals.
  - 3. Final cleaning.
  - 4. Repair of the Work.

#### 1.2 FINAL COMPLETION PROCEDURES

- A. Submit a written request for inspection to Contracting Officer to determine Final Completion a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. Contracting Officer will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Government, that must be completed or corrected.

#### 1.3 CLOSEOUT SUBMITTALS

- A. Submit all items listed per the requirements under Section 013300 to the Contracting Officer prior to final payment.
  - 1. Certificates of Release: From Contracting Officer.
  - 2. Guarantees, warranties, and certificates.
  - 3. Record (As-Built) Drawings.
  - 4. Final reports of all tests.
  - 5. O&M Manuals both PDF electronic form and hard copy binders.

### PART 2 - PRODUCTS (Not Used)

### PART 3 - EXECUTION

#### 3.1 FINAL CLEANING

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

- B. Fuels, lubricants, petroleum products, chemicals or other waste materials shall be disposed of in properly designated areas off Government premises.
- C. No burning of rubbish on Government premises will be allowed.

### 3.2 REPAIR OF THE WORK

- A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.
- B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.
  - 1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.
  - 2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that already show evidence of repair or restoration.
    - a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.

END OF SECTION 017700

## SECTION 017823 – OPERATION AND MAINTENANCE DATA

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
  - 1. Operation and maintenance documentation directory.
  - 2. Emergency manuals.
  - 3. Operation manuals for systems, subsystems, and equipment.
  - 4. Product maintenance manuals.
  - 5. Systems and equipment maintenance manuals.

#### 1.2 CLOSEOUT SUBMITTALS

- A. Manual Content: Operations and maintenance manual content is specified in individual Specification Sections to be reviewed at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
  - 1. The Government will comment on whether content of operations and maintenance submittals are acceptable.
  - 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Format: Submit operations and maintenance manuals in the following format:
  - 1. PDF electronic file. Assemble each manual into a composite electronically indexed file. Submit on digital media acceptable to Architect.
    - a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically linked operation and maintenance directory.
    - b. Enable inserted reviewer comments on draft submittals.
  - 2. Three paper copies. Include a complete operation and maintenance directory. Enclose title pages and directories in clear plastic sleeves.
- C. Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. The Government will return copy with comments.
  - 1. Correct or revise each manual to comply with the Government's comments. Submit copies of each corrected manual within 15 days of receipt of the Government's comments and prior to commencing demonstration and training.

## PART 2 - PRODUCTS

### 2.1 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

- A. Directory: Prepare a single, comprehensive directory of emergency, operation, and maintenance data and materials, listing items and their location to facilitate ready access to desired information.
- B. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
  - 1. Title page.
  - 2. Table of contents.
  - 3. Manual contents.
- C. Title Page: Include the following information:
  - 1. Subject matter included in manual.
  - 2. Name and address of Project.
  - 3. Name and address of Owner.
  - 4. Date of submittal.
  - 5. Name and contact information for Contractor.
  - 6. Name and contact information for Construction Manager.
  - 7. Name and contact information for Architect.
  - 8. Name and contact information for Commissioning Authority.
  - 9. Names and contact information for major consultants to the Architect that designed the systems contained in the manuals.
  - 10. Cross-reference to related systems in other operation and maintenance manuals.
- D. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
- E. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
- F. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
  - 1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
  - 2. File Names and Bookmarks: Enable bookmarking of individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily

navigated file tree. Configure electronic manual to display bookmark panel on opening file.

- G. Manuals, Paper Copy: Submit manuals in the form of hard copy, bound and labeled volumes.
1. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
    - a. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents (as needed for multi-volume manuals). Indicate volume number for multiple-volume sets.
  2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
  3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment.
  4. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
    - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
    - b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

## 2.2 EMERGENCY MANUALS

- A. Content: Organize manual into a separate section for each of the following:
1. Type of emergency.
  2. Emergency instructions.
  3. Emergency procedures.
- B. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:
1. Fire.
  2. Flood.
  3. Gas leak.
  4. Water leak.
  5. Power failure.
  6. Water outage.
  7. System, subsystem, or equipment failure.
  8. Chemical release or spill.

- C. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.
- D. Emergency Procedures: Include the following, as applicable:
  - 1. Instructions on stopping.
  - 2. Shutdown instructions for each type of emergency.
  - 3. Operating instructions for conditions outside normal operating limits.
  - 4. Required sequences for electric or electronic systems.
  - 5. Special operating instructions and procedures.

## 2.3 OPERATION MANUALS

- A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
  - 1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
  - 2. Performance and design criteria if Contractor is delegated design responsibility.
  - 3. Operating standards.
  - 4. Operating procedures.
  - 5. Operating logs.
  - 6. Wiring diagrams.
  - 7. Control diagrams.
  - 8. Piped system diagrams.
  - 9. Precautions against improper use.
  - 10. License requirements including inspection and renewal dates.
- B. Descriptions: Include the following:
  - 1. Product name and model number. Use designations for products indicated on Contract Documents.
  - 2. Manufacturer's name.
  - 3. Equipment identification with serial number of each component.
  - 4. Equipment function.
  - 5. Operating characteristics.
  - 6. Limiting conditions.
  - 7. Performance curves.
  - 8. Engineering data and tests.
  - 9. Complete nomenclature and number of replacement parts.
- C. Operating Procedures: Include the following, as applicable:
  - 1. Startup procedures.
  - 2. Equipment or system break-in procedures.
  - 3. Routine and normal operating instructions.
  - 4. Regulation and control procedures.
  - 5. Instructions on stopping.
  - 6. Normal shutdown instructions.

7. Seasonal and weekend operating instructions.
  8. Required sequences for electric or electronic systems.
  9. Special operating instructions and procedures.
- D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.
- E. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

## 2.4 PRODUCT MAINTENANCE MANUALS

- A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.
- C. Product Information: Include the following, as applicable:
1. Product name and model number.
  2. Manufacturer's name.
  3. Color, pattern, and texture.
  4. Material and chemical composition.
  5. Reordering information for specially manufactured products.
- D. Maintenance Procedures: Include manufacturer's written recommendations and the following:
1. Inspection procedures.
  2. Types of cleaning agents to be used and methods of cleaning.
  3. List of cleaning agents and methods of cleaning detrimental to product.
  4. Schedule for routine cleaning and maintenance.
  5. Repair instructions.
- E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
- F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

## 2.5 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

- A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.

- B. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.
- C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:
  - 1. Standard maintenance instructions and bulletins.
  - 2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
  - 3. Identification and nomenclature of parts and components.
  - 4. List of items recommended to be stocked as spare parts.
- D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
  - 1. Test and inspection instructions.
  - 2. Troubleshooting guide.
  - 3. Precautions against improper maintenance.
  - 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
  - 5. Aligning, adjusting, and checking instructions.
  - 6. Demonstration and training video recording, if available.
- E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
- F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
- G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

## PART 3 - EXECUTION

### 3.1 MANUAL PREPARATION

- A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.
- B. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

- C. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.
- D. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
- E. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.
  - 1. Do not use original project record documents as part of operation and maintenance manuals.
- F. Comply with Section 017700-Closeout Procedures for schedule for submitting operation and maintenance documentation.

END OF SECTION 017823

## SECTION 019113 - GENERAL COMMISSIONING REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Covers:
  - 1. Commissioning Plan
  - 2. Systems to be commissioned
  - 3. Commissioning team
  - 4. Submittals
  - 5. Materials.
  - 6. Coordination.
  - 7. Commissioning scheduling
  - 8. Equipment training
  - 9. Functional performance testing
  - 10. Documentation of equipment and system deficiencies
  - 11. Corrective actions and acceptance of corrected equipment and systems

#### 1.2 COMMISSIONING PLAN

- A. The Commissioning Plan and subsequent revisions shall be incorporated by reference into this contract.

#### 1.3 SYSTEMS TO BE COMMISSIONED

- A. Mechanical Systems
  - 1. Hydronic Heating System (boilers and pumps)
  - 2. Radiant Heating Zone Controls
  - 3. Packaged Outdoor Gas-Fired AHU with DX Cooling
  - 4. VAV terminal units with HW reheat
  - 5. General Exhaust Fans
  - 6. Cabinet Unit Heater
  - 7. Building Automation System
- B. Plumbing Systems
  - 1. Domestic Hot Water w/Integrated Recirculation Pump
- C. Lighting Controls
  - 1. Exterior photocell controls
  - 2. Interior local dimming and occupancy sensors

## SECTION 019113 - GENERAL COMMISSIONING REQUIREMENTS

### 1.4 COMMISSIONING TEAM

Owner	United States Department of Interior Fish and Wildlife Service Region 6 Engineering
Owner's Operations & Maintenance Civil Engineer (Engineer of Record)	Huron National Wildlife Refuge DOWL
Design Engineers	Associated Construction Engineering
General Contractor	TBD
Mechanical Contractor	TBD
Electrical Contractor	TBD
Commissioning Professional	Questions & Solutions Engineering

- A. Commissioning Coordination Supervisor: The General Contractor shall assign a person with five (5) years of experience with the coordination of disciplines of construction. The coordinator's responsibilities include:
1. Communication with Owner's Commissioning Professional
  2. Commissioning coordination meeting attendance
  3. Planning
  4. Scheduling
  5. Enforcement of subcontractors' specification requirements
  6. Subcontractors' quality assurance
  7. Documentation
  8. Direction of subcontractors' corrective actions
- B. Contractors' Representative: Each of the subcontractors shall assign a person responsible for communications with the General Contractor's Commissioning Coordination Supervisor. Responsibilities include:
1. Communication with Commissioning Coordination Supervisor
  2. Commissioning coordination meeting attendance
  3. Planning
  4. Scheduling
  5. Operations & Maintenance training and manuals
  6. Review of final functional performance test procedures
  7. Functional performance test participation
  8. Corrective actions

### 1.5 SUBMITTALS

- A. General Contractor shall submit the name of person(s) assigned as Commissioning Coordination Supervisor within (2) weeks of construction notice to proceed. General Contractor shall submit the following information for each assigned Commissioning Representative:
1. Company Name
  2. Name
  3. Title
  4. Years of Experience
  5. Office Phone Number
  6. Cell Phone Number
  7. Fax Number
  8. E-Mail Address
- B. Each subcontractor shall submit the name of person(s) assigned as representatives to Commissioning Team within (2) weeks of construction notice to proceed. Each Subcontractor shall submit the following information for each assigned Commissioning Representative:
1. Company Name

## SECTION 019113 - GENERAL COMMISSIONING REQUIREMENTS

2. Name
  3. Title
  4. Years of Experience
  5. Office Phone Number
  6. Cell Phone Number
  7. Fax Number
  8. E-Mail Address
- C. Equipment submittals and shop drawings:
1. Submit a list of all required submittals to the Commissioning Professional prior to submitting any equipment submittals for review.
  2. Commissioning Professional will identify submittals for which copies shall be submitted to the Commissioning Professional.
  3. Submit copies of selected final approved submittals to Commissioning Professional for use in developing functional performance test procedures. The Commissioning Professional will not be conducting a formal review of the submittals.
- D. Master Construction Schedule: Incorporate all commissioning milestones into the Master Construction Schedule. See 3.2-A below for a listing of minimum milestones for inclusion in the Master Construction Schedule.
1. Submit Master Construction Schedule with the inclusion of the commissioning milestones no later than 8 weeks after Construction Notice-to-Proceed.
  2. Submit updated Master Construction Schedule to the Commissioning Professional at a minimum once per month.
- E. Submit copies of Construction Meeting Minutes, Requests for Proposals (RFP), Requests for Information (RFI), Addendums, Proposal Requests (PR), etc., to the Commissioning Professional.
- F. Document training agendas on Equipment Training Agenda Form provided by the Commissioning Professional.
- G. Submit the specific date, time, and place for individual training sessions on the Training Plan no later than 4 weeks prior to the scheduled training sessions.
- H. Submit detailed functional performance testing schedule to the Commissioning Professional at least four (4) weeks prior to the start of testing.
1. System single line diagrams – submit within 2 weeks after functional testing.
  2. As-built sequences of operation, control drawings, and original setpoints - submit within 2 weeks after functional testing.
  3. Operating instructions for integrated building systems – submit 8 weeks after submittals have been approved.
  4. Recommended schedule for recalibrating sensors and actuators – submit 8 weeks after submittals have been approved.
  5. Recommended schedule and frequency for each manufacturer’s recommended maintenance activity - submit 8 weeks after submittals have been approved.
- I. Submit final TAB Reports to the Commissioning Professional upon completion and at least two (2) working days before the scheduled start of functional performance testing for the respective system. System functional performance testing shall not commence until its system is documented to be ready for testing.
- J. Submit estimated completion dates and status updates to outstanding items on the Commissioning Action List to the Commissioning Professional weekly.

## SECTION 019113 - GENERAL COMMISSIONING REQUIREMENTS

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. Provide tools, services and instruments required to test and adjust equipment and to verify compliance with design documents. Refer to individual Functional Performance Test Procedures for the requirements of each procedure.

### PART 3 - EXECUTION

#### 3.1 COORDINATION

- A. Assign Commissioning Representatives (see 1.5-A. and 1.5-B. for submittal requirements).
- B. Participate in Commissioning Coordination meetings conducted by the Commissioning Professional.
- C. Review the commissioning requirements.
- D. Request clarification as needed.

#### 3.2 COMMISSIONING SCHEDULING

- A. Include the following commissioning milestone activities in the master schedule (not a separate commissioning schedule):
  1. Site observation by Commissioning Professional.
  2. Testing and balancing
  3. Testing and balancing review and approval period
  4. Controls completion (including graphics and functioning trend logs)
  5. Equipment training sessions
  6. Pre-testing of systems per the functional performance test procedures provided by the Commissioning Professional and correction of any deficiencies found during pre-testing.
  7. Confirmation of readiness for functional performance testing.
  8. Functional performance testing
  9. Deficiency correction period
  10. Functional performance retesting (as necessary)

#### 3.3 EQUIPMENT TRAINING

- A. Coordinate operation and maintenance training activities through the Owner.
- B. The Training Plan (refer to 3.9-B below for a sample Training Plan) lists each training session and associated specification section for equipment associated with systems being commissioned. The Training Plan will be used to document level of rigor for each session, pre-substantial completion and post-substantial completion training hours and tracking of training to completion. In addition, the Training Plan will be used as the tool for scheduling the training sessions with the Owner's Operations and Maintenance Personnel. Note: this is not a comprehensive list of training for the project, just the training for the commissioned systems.
- C. One Equipment Training Agenda will be provided by the General Contractor for each training session associated with the systems being commissioned. A sample training agenda has been provided for reference in 3.9-A below.
- D. The contractor shall submit the name, company, and phone number for the proposed trainer(s) on each training session in the Training Plan submitted to the Owner for review.

SECTION 019113 - GENERAL COMMISSIONING REQUIREMENTS

- E. Schedule the training dates with the Owner for the convenience of the trainees. Training may be deferred for equipment that is inoperable (e.g., due to weather conditions, future startup, etc.) during pre-substantial completion training.
- F. Controls system training shall occur on site using the Owner’s computer.
- G. Document completion of each training session by completing the approved Equipment Training Agenda Form (refer to 3.9-A below) and sending completed forms back to the Owner and Commissioning Professional.
- H. Contractor shall provide post-occupancy training for the number of hours indicated in the Training Plan (3.9-B). Post-occupancy training shall be scheduled for up to one year after building turnover and at the request of the owner after owner’s staff has had time to operate the systems and develop additional questions for the contractors.
- I. Provide electronic copies to the Owner of all training materials provided during training including presentations, drawings, manuals, etc. Provide source files and PDF files of this training material.
- J. All training must occur onsite, and all training sessions must be videotaped. The recordings must be provided to owner’s staff in a digital format on a USB drive. Ensure audio and video is of high quality.

3.4 FUNCTIONAL PERFORMANCE TESTS

- A. The table below shows the list of Functional Performance Test Procedures expected for this project and the sample rate at which the Commissioning Professional will test similar systems.

<b>Base Systems to be Commissioned</b>	<b>Assumed Total Qty</b>	<b>Percent Tested</b>	<b>Qty to be Tested</b>
Hydronic Heating System	1	100%	1
Radiant Heating Zone Controls	10	50%	5
Packaged outdoor gas-fired AHU with DX cooling coil	1	100%	1
VAV terminal units with HW reheat	11	55%	6
General Exhaust Fans	8	50%	4
Cabinet Unit Heaters	1	100%	1
Building Automation System	1	100%	1
Domestic Hot Water Heater w/integrated recirculation pump	1	100%	1
Lighting Controls (exterior photocell control, interior local dimming and occupancy sensors)	1	2-hr allowance	1

## SECTION 019113 - GENERAL COMMISSIONING REQUIREMENTS

- B. Functional Performance Tests have not yet been customized for the project design. Other test procedures will be developed during construction. See 3.9-C for example tests.
- C. Test procedures will be developed during construction.
- D. Final functional performance test procedures shall be prepared by the Commissioning Professional after reviewing submittals, change orders, supplemental instructions, proposal requests, and other construction-phase modifications and/or additions to the designed systems. The General Contractor shall review and comment on draft procedures and acceptance criteria prior to the Commissioning Professional issuing final procedures. Provide feedback as to the efficiency of the procedures and possible alternate approaches to achieving the same results.
- E. Provide input into the master scheduling process, with regard to timing and duration of the functional performance test procedures.
- F. Provide personnel and equipment as required to perform the functional performance test procedures under the direction of the Commissioning Professional.
- G. Participate in seasonal testing as scheduled by the Commissioning Professional. If project completion is set for the summer, seasonal testing of systems will be conducted the following winter and vice versa.
- H. If a system cannot be fully and adequately tested at the end of construction, participate in post-substantial completion testing scheduled by the Commissioning Professional. The exact systems requiring deferred testing will be dependent on the final construction schedule.

### 3.5 DEFICIENCY TRACKING/CORRECTIVE ACTIONS

- A. Perform corrective actions for resolution of deficiencies found during:
  - 1. Site Observation
  - 2. Test and Balance
  - 3. Installation Checkout
  - 4. Functional Performance Testing
- B. During Functional Performance Testing, a deficiency is defined as equipment that does not function as expected and more than five (5) minutes is required to correct the problem.
- C. During construction or testing anyone finding deficiencies may share those deficiencies with the Commissioning Professional. The Commissioning Professional will document the deficiencies on a Commissioning Action List (CAL) (refer to 3.11-D for an example) within one working day of discovery or of notification by third parties. The Commissioning Action List will be stored in a web-accessible file that will the entire commissioning team will be granted access to view and to provide status updates.
  - 1. Deficiency Identification Process (by Commissioning Professional)
    - a. Date
    - b. Comment Generator
    - c. Responsible Party
    - d. Description of deficiency
    - e. Distribute copies to the commissioning team
  - 2. Corrective Action Completed (by General Contractor or subcontractor in the Status Update field of the web-based Commissioning Action List)
    - a. Date of correction
    - b. Description of final equipment status or corrective action performed

## SECTION 019113 - GENERAL COMMISSIONING REQUIREMENTS

- c. Name of person(s) performing the work
- d. Commissioning Professional distributes updated copies to the commissioning team

### 3. Verification of Corrective Action Completion (by Owner or Commissioning Professional)

- a. Date of retest
- b. Status description: resolved or more work required
- c. Name(s) of person(s) performing verification
- d. Enter resolution into the CAL
- e. Distribute copies to the commissioning team

## 3.6 RETESTING

- A. Following the deficiency correction period, the Commissioning Professional will perform one three (3) hour site visit for retesting to verify that deficiencies have been corrected.
- B. The contractor is responsible for the owner's additional costs associated retesting activities, requiring additional on-site testing hours, and/or any additional trips to the project site. The owner's additional costs include, but are not limited to, the commissioning professional's time and expenses to direct, witness, and document the retesting activities.

## 3.7 MAINTENANCE ACCEPTANCE

- A. The Owner will take responsibility for maintenance of the equipment associated with the mechanical and electrical systems once both of the following have occurred:
  - 1. The project has reached Substantial Completion.
  - 2. All training sessions have been accepted by the Owner.

## 3.8 OPERATIONS ACCEPTANCE

- A. Prior to the successful completion of commissioning functional performance tests:
  - 1. The General Contractor shall be responsible for the operation of all systems and all adjustments necessary to successfully pass the functional performance test procedures.
  - 2. The General Contractor shall document and respond to all concerns and questions from building occupants in a timely and professional manner.
  - 3. The Owner shall not attempt to change system operating setpoints, programming, or user interfaces but must work through the General Contractor to resolve issues that come to the Owner's attention.
- B. Upon successful completion of all functional performance testing:
  - 1. The Owner shall take responsibility for operation of the mechanical and electrical systems. This may or may not occur at the same time as Maintenance Acceptance.
  - 2. The General Contractor shall not attempt to change system operating setpoints, programming, or user interfaces but must work through the Owner to resolve issues that come to the General Contractor's attention.
- C. The contractor will be responsible for the monitoring of the systems and call-backs related to the operation of the commissioned system equipment until all three of the following requirements have been met:
  - 1. Successful completion of functional performance testing.
  - 2. O&M manuals have been delivered to the Owner.
  - 3. O&M training sessions have been completed and accepted by the Owner.
- D. Operational acceptance is a requirement of final completion and must be documented prior to submitting the Final Application for Payment. This is in addition to any requirements defined in Section 012900 Payment Procedures.

## SECTION 019113 - GENERAL COMMISSIONING REQUIREMENTS

Acknowledgment of operations acceptance shall be at the discretion of the Owner.

### 3.9 COMMISSIONING DOCUMENTATION (attached)

- A. Sample Equipment Training Agenda Form
- B. Equipment Training Plan
- C. Sample Functional Performance Test Procedures
- D. Commissioning Action List Template

END OF SECTION 019113



# Equipment: Operations & Maintenance Training Agenda

<b>Equipment</b>	Packaged, Large-Capacity, Air Conditioning Units
<b>Specification section(s)</b>	237416.13

## Agenda

Agenda of general subjects covered	Complete
X General purpose of the equipment	
X Review of control drawings and schematics (have copies for attendees)	
X Startup, loading, normal operation, unloading, shutdown, unoccupied operation, seasonal changeover, optimal start logic, etc., as applicable.	
X Integral controls (packaged): programming, troubleshooting, alarms, & manual/bypass operation	
X Building automation controls (BAS): programming, troubleshooting, alarms, manual operation, interface with integral controls	
X Interactions with other systems, operation during power outage and fire alarm system	
X Relevant health and safety issues & concerns, special safety features, and special access issues for this equipment	
X Energy conserving operation and strategies	
X Any special issues to maintain warranty	
X Common troubleshooting issues and methods, control system warnings and error messages, including using the control system for diagnostics	
X Special requirements of tenants for this equipment's function	
X Service, maintenance and preventative maintenance (sources, spare parts inventory, special tools, etc.)	
X Question & Answer Period	

Training Methods	Notes
X Use O&M manuals (show where the training information is found)	
X Completed factory start-up checklist/report	
X Control drawings, schematics, and sequence of operations	
X A copy of this agenda.	
X Discussion/lecture at site	
X Site demonstration of equipment operation	
X Written handouts	
X Manufacturer training manuals	
X Classroom lecture	
Classroom hands-on equipment	
X Video presentation	
X Question and answer period	



O&M STAFF EQUIPMENT TRAINING PLAN

Scope, Scheduling and Tracking

Training Group #	Description		Scope					Trainer Information			Scheduling			Tracking				
	Equipment	Spec Section	Pre-Substantial Completion Training			Total Hours	Notes	Post Occupancy Training Hours	Primary Responsible Contractor	Name	Company	Phone Number	Date	Time	Location	Agenda Approved	Training Session Complete	Training Session Approved
			<sup>1</sup> Scope A	<sup>1</sup> Scope B	<sup>1</sup> Scope C													
	<b>MECHANICAL</b>																	
	<b>HVAC - one session @ 4.75 hours</b>																	
1	General Overview	N/A	0.5			0.5		No										
	Hydronic Piping	232113	0.25			0.25		No										
	Hydronic Piping Specialties	232116	0.25			0.25		No										
	Hydronic Pumps	23 2123	0.25			0.25		No										
	Water Treatment For Closed Loop Hydronic Systems	232513	0.25			0.25		No										
	Air Duct Accessories	233300	0.25			0.25		No										
	HVAC Power Ventilators	233423	0.25			0.25		No										
	Air Terminal Units	233600	0.25			0.25		No										
	Condensing Boilers	235216	1			1		No										
	Packaged, Large-Capacity, Air-Conditioning Units	237416.13	1			1		No										
	Cabinet Unit Heaters	238239.13	0.25			0.25		No										
Radiant-Heating Hydronic Piping	238316	0.25			0.25		No											
	<b>Temperature Controls - one session @ 8 hours</b>																	
2	Direct Digital Control (DDC) System for HVAC	230923	3			3		No										
	Control Valves	230923.11	0.5			0.5		No										
	Sequences of Operations for HVAC DDC	230993.11	4.5			4.5		No										
	<b>PLUMBING - One session needed @ 0.5 hours</b>																	
3	General Overview		0.25			0.25		No										
	Fuel-Fired Domestic Water Heaters	223400	0.25			0.25		No										
	<b>LIGHTING CONTROLS - One session needed @ 0.5 hours</b>																	
3	Interior Lighting	265100	0.25			0.25		No										
	Exterior Lighting	265600	0.25			0.25		No										

<sup>1</sup>**General Scope Codes** (refer to the specific equipment Training Agenda for additional details)  
A. Provide an **overview** of the purpose and operation of this equipment, including required interactions of trainees with the equipment. (Approximately 15 to 30 minutes)  
B. At an **intermediate level**, provide technical information regarding the purpose, operation and maintenance of this equipment, expecting that serious malfunctions will be addressed by factory reps. (Approximately 1 to 2 hours)  
C. At a **very technical level**, provide information regarding the purpose, operation, troubleshooting and maintenance of this equipment, expecting that almost all operation, service and repair will be provided by the trainees. (Hours vary by level of complexity.)

# Sample Heating Hot Water System Test



## SAMPLE OF A FUNCTIONAL TEST PROCEDURE

YES	NO	N/A	SEQUENCE OF OPERATION	TEST PROCEDURE NOTES	SETPOINT	TESTING NOTES	ADD ISSUE
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	This test applies to Boilers B-1, B-2, B-3 and heating hot water pumps P-1 & P-2 and boiler circulating pumps P-3, P-4 & P-5 Expansion Tank ET-1 Air Separator AS-1	Following test is based on approved HVAC submittal			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Test Date:				
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Tested by:	Record QSE and contractor participants in test			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Perform visual observation of system installation versus contract documents	Refer to details XXX & YYY on MXXX..			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/> Perform visual observation for equipment service access				
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Check for clearances around boilers per submittal: Left side: 1" Right side: 12" Top: 24" Back: 6" Closet, Front: 1" Alcove, Front: 24"				
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Check for 75 psi pressure relief valve installed on boilers				
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Boiler model is NTH 600. With 600,000 BTU/hr input, 572,000 BTU/hr output.				
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	System contains glycol. Ensure makeup water is not hard-piped to heating system.				
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Ensure decoupling loop is no more than 4x pipe diameter (typically a max of 12")	From Schematic on M4.11			
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> <b>1.4 HEATING CONTROL SEQUENCES</b>				
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Configure boilers in a master/slave cascade. Wire communication MOD from Master to Slaves.				
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Wire OA temp and system supply water sensor to master boiler.				
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> <b>A. General: Boiler controls are furnished by the boiler manufacturer.</b>	Per Specs 23 2120, 2.06			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1. Install controls furnished by the boiler manufacturer for field installation. Refer to Section 23 2120, 2.06.				
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	2. Panel shall provide microprocessor-based staging, hot water supply temperature reset control, and automatic "lead-lag" control.				
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	3. Sensors shall include supply water temperature sensor and outdoor temperature sensor.				
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	4. Control panel shall be a sequencer automatically alternating the lead boiler.				
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	5. Each boiler shall have the ability to operate at a 5:1 turndown ratio.	Test by reducing load on the boiler (using setpoint changes) and verify minimum firing rate is 20% of maximum.			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	6. Each boiler shall operate at full fire prior to energizing next lag boiler to prevent flow issues with the variable speed system.	Verify each lag boiler comes on as load is increased (by temporarily raising the HWS setpoint).			
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> <b>B. Test of staging controls.</b>				
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Shut down the first lag boiler (to simulate a failure) and verify that the 2nd lag boiler will start upon increase in load.	Boiler does have cascade and auto rotation			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Test cascade controls operation if the Lead boiler has failed.	Document results.			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/> Verify boilers are set to automatically rotate.	Document if this is done on runtime, or number of cycles, etc..			
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> <b>B. Heating-Water Supply Temperature Control:</b>				

YES	NO	N/A	SEQUENCE OF OPERATION	TEST PROCEDURE NOTES	SETPOINT	TESTING NOTES	ADD ISSUE
26	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Adjust control such that hot water supply temperature shall be reset from 90 degrees F. to 180 degrees F. as the outside air temperature varies from 90 degrees F. to -10 degrees F.			
27	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/> To test the sequence above:			
28	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1. Adjust the HWS temp range to something different and verify the new master HWS setpoint changes accordingly while leaving the outdoor air temp range the same.			
29	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	2. Adjust the OA temp range to something different and verify the new master HWS setpoint changes accordingly while leaving the HWS temp range the same.			
30	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	3. Return both setpoints to original specified values following the test.			
31	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> C. Secondary Pump Control (P-1 & P-2)			
32	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Pumps P-1 & P-2 are fully redundant. Only one pump should be needed to handle the load.	Per 23 0900, 3.03.B		
33	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Pumps are arranged in parallel arrangement.			
34	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Pump nameplates indicate they are sized for 150 gpm @ 55' head.	Per submittal review comment.		
35	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Provide P1 & P2 with lead-leg control to automatically switch over lead pumps on a weekly basis.	Mech. Contractor is using ABB VFDs that have that capability built into the VFDs.		
36	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Lead pumps shall run continuously and lag pumps shall normally be off.	Mech. Contractor is using ABB VFDs that have that capability built into the VFDs.		
37	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Provide differential pressure switches that shall upon failure of the lead pump shall energize the associated lag pump and initiate an alarm condition at the building automation system.	Mech. Contractor is using ABB VFDs that have that capability built into the VFDs. A remote DP transmitter will provide the signal to the drive speed control.		
38	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Provide differential pressure sensor and controller complete with control valve at location indicated on plans to maintain minimum system flow to prevent "dead-heading" of pumps.	Shown on detail 1, M6.11. Also per 23 0900, 3.03.D. Mech. Contractor is using ABB VFDs that have that capability built into the VFDs. A remote DP transmitter will provide the signal to the drive speed control.		
39	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	How is pump speed controlled? Same DP sensor as line above?	Mech. Contractor is using ABB VFDs that have that capability built into the VFDs. A remote DP transmitter will provide the signal to the drive speed control.		
40	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Test failure of lead pump. Verify if lag pump automatically starts.			
41	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	D. Primary Pumps (P-3, P-4 & P-5)			
42	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Primary (boiler circulating pumps) are sized for 50 gpm @ 25' head.	Per submittal review comment.		
43	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Individual pumps are cycled on by the boiler master control panel when a boiler is commanded to run.			
44	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Boiler primary pump cycles off, following a time delay, when its associated boiler stages off.	Will shut off when boiler loop water temp is satisfied		
45	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	END OF TEST	Release all overrides. Return system to normal operation. Verify stable operation. Compare set points and operation to pre-test conditions. Clear any alarms from alarm history caused by testing.		

**CLIENT  
PROJECT**

ACTION ITEM #	DATE LOGGED	ENTRY TYPE	TECHNICAL CATEGORY	COMMENT GENERATOR	RESPONSIBLE TEAM MEMBER(S)	ITEM DESCRIPTION	STATUS	EXPECTED COMPLETION DATE	STATUS UPDATE	CLOSE DATE
1	06/18/10	Meeting Minutes	General	RTE	[OWNER]		DEFERRED	MM/DD/YYYY		
2	06/18/10	Email Correspondence	Mechanical	MSM	[ARCHITECT]		ON GOING	MM/DD/YYYY		
3	06/18/10	Verbal	Electrical	JPH	[ELEC CONTR]		OPEN	MM/DD/YYYY		
4	06/18/10	Site Observation	Plumbing	MBM	[MECH CONTR]		CLOSED	MM/DD/YYYY		
5	06/18/10	Verification Testing	Fire Protection	AAK	[CONTROLS]		READY TO VERIFY	MM/DD/YYYY		

## SECTION 024119 - SELECTIVE DEMOLITION

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Demolition and removal of selected portions of building or structure.
2. Demolition and removal of selected site elements.
3. Salvage of existing items to be reused or recycled.

##### B. Related Requirements:

1. Section 011000 "Summary" for restrictions on use of the premises, Owner-occupancy requirements, and phasing requirements.
2. Section 311000 "Site Clearing" for site clearing and removal of above- and below-grade improvements not part of selective demolition.

#### 1.2 DEFINITIONS

- A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.
- B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to owner or store.
- C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.
- D. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.
- E. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

#### 1.3 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.
- B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.
  1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

#### 1.4 PREINSTALLATION MEETINGS

- A. Predemolition 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.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and for noise control. Indicate proposed locations and construction of barriers.
- B. 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 Owner's on-site operations 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.
- C. Predemolition Photographs or Video: Show existing conditions of adjoining construction, including finish surfaces, that might be misconstrued as damage caused by salvage and demolition operations. Comply with Section 013233 "Photographic Documentation." Submit before Work begins.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Inventory: Submit a list of items that have been removed and salvaged.

#### 1.7 FIELD CONDITIONS

- A. Owner may occupy portions of site adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
- B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
  - 1. Before selective demolition, Owner will remove the following items:
    - a. (none)
- C. Notify Owner or Engineer of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

- D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
  - 1. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.
  - 2. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures 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. Protect and maintain existing fiber optic, phone and buried cables during selective demolition operations.

## 1.8 COORDINATION

- A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE 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. Standards: Comply with ANSI/ASSP A10.6 and NFPA 241.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.
- B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
- C. Survey of Existing Conditions: Record existing conditions by use of preconstruction photographs or video.
  - 1. Inventory and record the condition of items to be removed and salvaged.

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.

### 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 utility services and mechanical/electrical systems serving areas to be selectively demolished.
  1. Arrange to shut off utilities with utility companies.
  2. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.

### 3.3 PROTECTION

- A. Temporary Protection: 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. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 015000 "Temporary Facilities and Controls."
- B. Remove temporary barricades and protections where hazards no longer exist.

### 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:
- B. 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.
- C. Removed and Salvaged Items:
  1. Clean salvaged items.
  2. Pack or crate items after cleaning. Identify contents of containers.
  3. Store items in a secure area until delivery to Owner.
  4. Transport items to Owner's storage area designated by Owner.

5. Protect items from damage during transport and storage.

D. 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.

- E. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, 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. Asphalt: Demolish in small sections. Cut asphalt full depth at junctures with construction to remain and at regular intervals using power-driven saw, and then remove asphalt between saw cuts.

### 3.6 DISPOSAL OF DEMOLISHED MATERIALS

- A. Remove demolition waste materials from Project site and dispose of them in an approved construction and demolition waste landfill acceptable to authorities having jurisdiction.
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.
  3. Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."
- B. Burning: Do not burn demolished materials.

### 3.7 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.

### 3.8 SELECTIVE DEMOLITION SCHEDULE

- A. Remove:
  - 1. Culvert in highway approach
- B. Remove and Salvage:
  - 1. Right-of-way fence, posts and gate.
- C. Remove and Reinstall:
  - 1. Fencing and connect to new line posts and brace posts.
- D. Existing to Remain:
  - 1. Fiber optic cable.

END OF SECTION 024119

## SECTION 033000 – CAST-IN-PLACE CONCRETE

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section specifies cast-in place concrete both regular and integrally colored, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:
  - 1. Footings
  - 2. Pilasters
  - 3. Slabs-on-Grade (Interior and Exterior)
- B. Related Sections:
  - 1. General Notes on Structural Drawings Sheet S101 for concrete design mix.

#### 1.2 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.
  - 1. Indicate amounts of mixing water to be withheld for later addition at project site.
- C. Samples: Submit manufacturer's samples of standard concrete colors mixed with cement as specified.
- D. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
- E. Qualification Data: For installer and testing agency.
- F. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:
  - 1. Aggregates.
- G. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Form materials and form-release agents.
4. Steel reinforcement and accessories.
5. Curing compounds.
6. Floor and slab treatments.
7. Bonding agents.
8. Adhesives.
9. Vapor retarders.
10. Semirigid joint filler.
11. Joint-filler strips.
12. Repair materials.

#### 1.4 QUALITY ASSURANCE

- A. **Installer Qualifications:** A qualified installer who employs on project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
- B. **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.
  1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- C. **Testing Agency Qualifications:** An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
  1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
  2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
- D. **Source Limitations:** Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.
- E. **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 303R 04 – Guide to Cast in Place Architectural Concrete
  3. ACI 305R – Hot Weather Concreting
  4. ACI 306R – Cold Weather Concreting
  5. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

- F. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.
- G. Verify compatibility of curing compounds and other applied materials with all scheduled floor finishes including adhesives, paints and coatings.
- H. When below-slab vapor barriers are indicated, Contractor shall take all available precautions to minimize slab curling.

## 1.5 PROJECT CONDITIONS

- A. Environmental Requirements
  - 1. Schedule placement to minimize exposure to wind and hot sun before curing materials are applied.
  - 2. Avoid placing concrete if rain, snow, or frost is forecast within 24 hours. Protect fresh concrete from moisture and freezing.
  - 3. Schedule delivery of concrete to provide consistent mix times from batching until discharge. Mix times shall meet manufacturer's written recommendations.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

## 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. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.

### 2.2 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.
  - 1. Plywood, metal, or other approved panel materials.
- B. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.
- C. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.
- D. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
  - 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

2. Form Release Agent: Form release agent shall be "Crete-Lease 880-VOC" as manufactured by Cresset Chemical Co., One Cresset Center, Weston, Ohio 43569, or approved equal. Form release agent shall be a blend of neutralized vegetable oils in mineral oil, containing no waxes, no silicones no carcinogens and shall be biodegradable. Form release application shall be so that a CCS 2 finish surface shall be achieved after formwork removal. Release agent shall not be diluted with fuel oil or diesel fuels.
- E. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
  2. Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.
  3. Furnish ties with integral water-barrier plates to walls indicated to receive damp proofing or waterproofing.

### 2.3 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed unless indicated otherwise.
- B. Plain-Steel Wire: ASTM A 1064 Grade 70, as drawn.
- C. Deformed-Steel Wire: ASTM A 496.
- D. Epoxy-Coated Wire: ASTM A 884/A 884M, Class A, Type 1 coated, as-drawn, plain-steel wire, with less than 2 percent damaged coating in each 12-inch wire length.
- E. Plain-Steel Welded Wire Reinforcement: ASTM A 1064, plain, fabricated from as-drawn steel wire into flat sheets.

### 2.4 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, cut bars true to length with ends square and free of burrs.
- B. Epoxy-Coated Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, ASTM A 775/A 775M epoxy coated.
- C. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A 775/A 775M.
- D. 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," of greater compressive strength than concrete and as follows:

## 2.5 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 V sulfate resistant, gray. Supplement with the following:
    - a. Fly Ash: ASTM C 618, Class F.
- B. Normal-Weight Aggregates: ASTM C 33, Class 3M coarse aggregate or better, graded. Provide aggregates from a single source throughout the Project.
  - 1. Maximum Coarse-Aggregate Size – Standard Concrete: 3/4 inch nominal.
  - 2. Maximum Coarse-Aggregate Size – Integrally Colored Concrete with Special Concrete Floor Finishes: 3/8 inch nominal.
  - 3. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Water: ASTM C 94/C 94M and potable.

## 2.6 ADMIXTURES

- A. Air entraining admixture: ASTM C 260
- B. Water reducing admixture: ASTM C 494, Type A, F or G
- C. 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. Admixtures shall be coordinated so that they do not adversely affect the color and finish of the concrete. Do not use calcium chloride or admixtures containing calcium chloride.

## 2.7 VAPOR RETARDERS

- A. Plastic Vapor Retarder: Specified in Division 7 “Vapor Retarders”.

## 2.8 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
  - 1. Evaporation retarder shall be approved by colored pigment manufacturer for use with colored concrete.
  - 2. Available Products:
    - a. Burke by Edoco; BurkeFilm.
    - b. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company; Aquafilm.
    - c. Dayton Superior Corporation; Sure Film.
    - d. Euclid Chemical Company (The); Eucobar.
- B. Absorptive cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9oz./sq. yd when dry.

- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. The film must break down in a four to six week period. Provide data from an independent laboratory indicating a maximum moisture loss of 0.30 kg/m<sup>2</sup> at 72 hours when tested in accordance with ASTM C156.
- F. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering. Must be acceptable to use with concrete stabilizer.
  - 1. Available Products:
    - a. Anti-Hydro International, Inc.; AH Curing Compound #2 DR WB.
    - b. BASF Construction Chemicals - Building Systems; Kure 200.
    - c. ChemMasters; Safe-Cure Clear.
    - d. Conspec by Dayton Superior; W.B. Resin Cure.
    - e. Dayton Superior Corporation; Day-Chem Rez Cure (J-11-W).
    - f. Edoco by Dayton Superior; Res X Cure WB.
    - g. Euclid Chemical Company (The), an RPM company; Kurez W VOX; TAMMSCURE WB 30C.
    - h. Kaufman Products, Inc.; Thinfilm 420.
    - i. Lambert Corporation; AQUA KURE - CLEAR.
    - j. L&M Construction Chemicals, Inc.; L&M Cure R.
    - k. Meadows, W. R., Inc.; 1100-CLEAR.
    - l. Nox-Crete Products Group; Resin Cure E.
    - m. Right Pointe; Clear Water Resin.
    - n. SpecChem, LLC; Spec Rez Clear.
    - o. Symons by Dayton Superior; Resi-Chem Clear.
    - p. TK Products, Division of Sierra Corporation; TK-2519 DC WB.
    - q. Vexcon Chemicals, Inc.; Certi-Vex Enviocure 100.

## 2.9 CONCRETE MIXTURES, GENERAL

- 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.
  - 1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
  - 1. Fly Ash: 25 percent, 15 percent minimum.
- C. Limit water-soluble, chloride-ion content in hardened concrete to 1.00 percent by weight of cement.
- D. Admixtures: Use admixtures according to manufacturer's written instructions.
- E. Add air entraining agent to normal weight concrete mix for work exposed to exterior.

## 2.10 CONCRETE MIXTURES FOR BUILDING ELEMENTS

- A. Footings, Stem Walls and Pilasters, and Exterior Slabs. Proportion normal-weight concrete mixture as follows:
  - 1. Minimum Compressive Strength: 4000 psi at 28 days.
  - 2. Slump Limit: 4 inches, plus or minus 1 inch.
  - 3. Air Content: 4 to 7 percent
- B. Interior Slabs: Proportion normal-weight concrete mixture as follows:
  - 1. Minimum Compressive Strength: 4000 psi at 28 days.
  - 2. Slump Limit: 4 inches, plus or minus 1 inch.
  - 3. Air Content: 0 to 3 percent

## 2.11 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116, 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.
- B. Color Additives: Mix in accordance with manufacturer's instructions. Mix until color additives are uniformly dispersed throughout mixture and disintegrating bags, if used, have disintegrated.
- C. Do not re-temper mix by adding water in field.

## 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. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
  - 1. Class C, 1/2 inch for rough-formed finished surfaces.
- D. Construct forms tight enough to prevent loss of concrete mortar.
- E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
  - 1. Install keyways, reglets, recesses, and the like, for easy removal.
  - 2. Do not use rust-stained steel form-facing material.

- F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- H. Chamfer exterior corners and edges of permanently exposed concrete.
- I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.
- M. All formwork surfaces that will provide the finish surface of exposed concrete must be accepted by the Architect before depositing 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 REMOVING AND REUSING FORMS

- A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.
  - 1. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved its 28-day design compressive strength.
  - 2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

### 3.4 SHORES AND RESHORES

- A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.
  - 1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.
- B. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

### 3.5 VAPOR RETARDERS

- A. Plastic Vapor Retarders: Place, protect, and repair vapor retarders as specified in Division 7 "Vapor Retarders".

### 3.6 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
  - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- E. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

### 3.7 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
  - 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
  - 2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
  - 3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.

- C. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
- D. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

### 3.8 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. Before test sampling and placing concrete, water may be added at project site, subject to limitations of ACI 301.
- C. 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. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
  - 2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
  - 3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
- D. Deposit and consolidate concrete for slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
  - 1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
  - 2. Maintain reinforcement in position on chairs during concrete placement.
  - 3. Scream slab surfaces with a straightedge and strike off to correct elevations.
  - 4. Slope surfaces uniformly to drains where required.
  - 5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
- E. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
  - 1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
  - 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
  - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

- F. Hot-Weather Placement: Comply with ACI 305 and as follows:
  - 1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
  - 2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

### 3.9 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, or to be covered with a coating or covering material applied directly to concrete.
- C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

### 3.10 FINISHING FLOORS AND SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces. Interior concrete slabs shall have a flatness ( $F_F$ ) value of 30 or greater and a levelness ( $F_L$ ) value of 25 or greater.
- B. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
  - 1. Apply float finish to surfaces to receive trowel finish
- C. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
  - 1. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
  - 2. Finish and measure surface so gap at any point between concrete surface and an unlevelled, freestanding, 10-foot- long straightedge resting on 2 high spots and placed anywhere on the surface does not exceed 3/16 inch.

- D. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set method. While concrete is still plastic, slightly scarify surface with a fine broom.
  - 1. Comply with flatness and levelness tolerances for trowel finished floor surfaces.
- E. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
  - 1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

### 3.11 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

### 3.12 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. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- E. 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 with the following materials:

- a. Water.
  - b. Continuous water-fog spray.
  - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
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.
- a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
  - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
  - c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project..
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 unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.

### 3.13 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
  - 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension in solid concrete, but not less than 1 inch in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
  - 2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding

- with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
  2. After concrete has cured at least 14 days, correct high areas by grinding.
  3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
  4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
  5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
  6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
  7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Architect's approval.

### 3.14 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Inspections:
1. Steel reinforcement placement.
  2. Anchor rods.

3. Verification of use of required design mixture.
  4. Concrete placement, including conveying and depositing.
  5. Curing procedures and maintenance of curing temperature.
  6. Verification of concrete strength before removal of shores and forms from beams and slabs.
- C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
1. Testing Frequency: Obtain at least one composite sample for each 50 cubic yards or fraction thereof of each concrete mixture placed each day.
    - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
  2. Slump: ASTM C 143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
  3. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
  4. Compression Test Specimens: ASTM C 31.
    - a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
  5. Compressive-Strength Tests: ASTM C 39; test one set of two laboratory-cured specimens at 7 days, one set of two specimens at 28 days, and one specimen at 56 days.
    - a. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
  6. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
  7. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
  8. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Owner but will not be used as sole basis for approval or rejection of concrete.
  9. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Owner. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Owner.
  10. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
  11. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

3.15 PROTECTION OF INTERIOR CONCRETE FLOORS

- A. All hydraulic powered equipment must be diapered to avoid staining of the concrete.
- B. No trade will park vehicles on the inside slab. If necessary to complete their scope of work, drop cloths will be placed under vehicles at all times.
- C. No pipe cutting machine will be used on the inside floor slab.
- D. Steel will not be placed on interior slab to avoid rust staining.
- E. Acids and acidic detergents will not come into contact with slab.
- F. All trades must be informed that the slab must be protected at all times.

END OF SECTION 033000

## SECTION 048500 - NATURAL THIN VENEER STONE

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Natural thin veneer stone for exterior vertical surfaces.
  - 2. Cut limestone column base caps as shown on drawings.
  - 3. Mortar, grout, and masonry accessories.

#### 1.2 RELATED REQUIREMENTS

- A. Section 033000 – Cast-In-Place Concrete
- B. Section 061200 – Structural Insulated Panels
- C. Section 079200 – Joint Sealants

#### 1.3 REFERENCES

- A. ACI 530.1/ASCE 6/TMS 602 – Specifications for Masonry Structures.
- B. ANSI A118.4 – Specifications for Latex-Portland Cement Mortar.
- C. ASTM C 144 – Standard Specification for Aggregate for Masonry Mortar.
- D. ASTM C 207 – Standard Specification for Hydrated Lime for Masonry Purposes.
- E. ASTM C 270 – Standard Specification for Mortar for Unit Masonry.
- F. ASTM C 503 – Standard Specification for Marble Dimension Stone.
- G. ASTM C 568 – Standard Specification for Limestone Dimension Stone.
- H. ASTM C 615 – Standard Specification for Granite Dimension Stone.
- I. ASTM C 616 – Standard Specification for Quartz Based Dimension Stone.
- J. ASTM C 629 – Standard Specification for Slate Dimension Stone.
- K. ASTM C 847 – Standard Specification for Metal Lath.
- L. ASTM C 979 – Standard Specification for Pigments for Integrally Colored Concrete.
- M. ASTM C 1063 – Standard Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster.
- N. ASTM D 226 – Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.

- O. PCA – Portland Cement Plaster (Stucco) Manual.

#### 1.4 SUBMITTALS

- A. Product Data: Submit manufacturer’s product data on stone, mortar products, and sealant products, including:
  - 1. Surface preparation and installation instructions.
  - 2. Storage and handling instructions.
- B. Shop Drawings: Submit manufacturer’s shop drawings, including plans, elevations, sections, and details, indicating layout, dimensions, anchorages, and jointing methods.
- C. Samples:
  - 1. Submit four (4) full-size samples of natural thin veneer stone for Owner to color range match.
  - 2. Submit two (2), 4” wide, full-size samples of limestone column base cap showing complete cut profile.
  - 3. Submit mortar color samples.
- D. Warranty: Submit manufacturer’s standard warranty for natural thin veneer stone.

#### 1.5 QUALITY ASSURANCE

- A. Manufacturer’s Qualifications: Manufacturer regularly engaged, for preceding 10 years, in manufacture of natural thin veneer stone of similar type to that specified.
- B. Mock-ups: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
  - 1. Finish areas designated by Owner.
  - 2. Do not proceed with remaining work until workmanship, color, and finish are approved by Owner.
  - 3. Refinish mock-up area as required to produce acceptable work.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials to site in manufacturer’s original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
- B. Storage:
  - 1. Store materials in accordance with manufacturer’s instructions.
  - 2. Store materials in manufacturer's unopened packaging until ready for installation.
  - 3. Store stone materials on pallets on dry, level surface and cover with tarps.
  - 4. Do not stack pallets.
  - 5. Mortar: Store mortar under cover in area where air temperature is maintained between 40 degrees F and 110 degrees F.
- C. Handling: Protect materials during handling and installation to prevent damage or contamination.

## 1.7 ENVIRONMENTAL REQUIREMENTS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install natural thin veneer stone under environmental conditions outside manufacturer's limits.
- B. Hot and Cold weather requirements: ACI 530.1/ASCE 6/TMS 602.
- C. Air Temperature: 40° F or above during installation of natural thin veneer stone.
- D. Mortar Mixing Water: Heat mortar mixing water when air temperature falls below 50° F.
- E. Protect masonry work prior to, during, and 48 hours after completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURER

- A. Dakota Stone Mining & Stone Supply, 23863 Palmer Gulch Road, Hill City, South Dakota 57745. Phone: (605) 574-2760. Website: [www.dakotastone.net](http://www.dakotastone.net). Email: [info@dakotastone.net](mailto:info@dakotastone.net).

### 2.2 NATURAL THIN VENEER STONE

- A. Material: South Dakota limestone.
- B. Color: Selected by Owner from manufacturer's standard colors.
- C. Thickness: ¾" to 1¼"
- D. Pattern: Random Ashlar.
- E. Finishes: Split-face.
- F. Accurately cut stone to shape and dimension, including requirements necessary for proper installation and anchorage. Butt joints at corners.
- G. Anchors, lath, and other fastenings: Stainless steel Type 302 or 304 and as noted on Drawings.

### 2.3 LIMESTONE COLUMN BASE CAP

- A. Material: South Dakota limestone.
- B. Color: Selected by Owner from manufacturer's standard colors.
- C. Thickness: As shown on drawings.
- D. Shape: As shown on drawings. Slope to shed water away from column.
- E. Finishes: Smooth.

- F. Accurately cut stone to shape and dimension, including requirements necessary for proper installation and anchorage. Miter joints at corners.

## 2.4 ACCESSORIES

- A. Expanded Metal Lath: ASTM C 847; galvanized, self-furring.
- B. Lath Anchorage: Tie wire, nails, screws, and other metal supports; galvanized; type and size to suit application and to rigidly secure materials in place.
- C. Setting Buttons and Shims: Plastic.
- D. Joint Sealants and Joint Fillers: As specified in Section 079200.

## 2.5 MORTAR

- A. Portland Cement:
  - 1. Cement: ASTM C 270
  - 2. Lime: ASTM C 207
  - 3. Sand: ASTM C 144, natural or manufactured.
  - 4. Color Pigments: ASTM C979, mineral oxide.
  - 5. Water: Potable.
  - 6. Pre-Packaged Latex-Portland Cement Mortar: ANSI A118.4.
- B. Bonding Agent: Acrylic additive.
- C. Sealer: Water-based silane or siloxane masonry sealer, clear.
- D. Mortar Mixes:
  - 1. Grouted Joints:
    - a. Mix Mortar: ASTM C 270, Type S.
    - b. Add color pigments to mortar in accordance with pigment manufacturer's instructions.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine surfaces to receive natural thin veneer stone.
- B. Notify Architect of conditions that would adversely affect installation.
- C. Do not begin surface preparation or installation until unacceptable conditions are corrected.
- D. Do not begin installation until backing structure is plumb, bearing surfaces are level, and substrates are clean and properly prepared.

### 3.2 SURFACE PREPARATION

- A. Prepare surfaces in accordance with manufacturer's instructions.

- B. Clean surfaces thoroughly prior to installation.
- C. Prepare surfaces using methods for achieving best results for substrate under project conditions.
- D. For installation over concrete substrate:
  - 1. Wash concrete substrate thoroughly to remove dirt, oil, dust, and remaining form release agent. Allow to dry completely.
  - 2. Metal Lath:
    - a. Install metal lath in accordance with ASTM C 1063.
  - 3. Fastening Metal Lath:
    - a. Fasten lath to concrete using ¼" x 2" stainless steel screw anchors and manufacturer's lath clips at maximum 6 inches on center vertically and 12 inches on center horizontally.
    - b. Fasten with a minimum of 1½ inch penetration of concrete.
    - c. Wrap concrete column bases completely, overlapping mesh by at least 2 inches.
    - d. Stop lath 1 inch from finished edges.
- E. For installation over OSB, Plywood, Fiberglass Mat Faced Gypsum Sheathing, or other exterior grade sheathing, prepare substrate per instructions below:
  - 1. Water Resistant Air Barrier (WRB): Cover sheathing with self-adhered membrane with joints lapped shingle style a minimum of 4 inches.
  - 2. Metal Lath:
    - a. Install metal lath in accordance with ASTM C 1063.
    - b. Apply metal lath with long dimension perpendicular to supports and with joints lapped a minimum of 1 inch.
    - c. Secure laps with tie wire where they occur between supports.
  - 3. Fastening Metal Lath:
    - a. Fasten lath to wood supports using galvanized nails at maximum 6 inches on center vertically and 16 inches on center horizontally.
    - b. Fasten with a minimum of 1 inch penetration of wood studs.
    - c. Stop lath 1 inch from finished edges.
- F. Application of Base Coat Stucco:
  - 1. Apply scratch coat in accordance with PCA Plaster (Stucco) Manual.
  - 2. Apply scratch coat to nominal thickness of ½ inch to ¾ inch over metal lath surfaces.
  - 3. If weather is hot or surface is dry, dampen previous coat before applying mortar and thin stone veneer.
  - 4. If scratch coat is done in advance, use notch trowel to create texture for better bond. Smooth surface is not acceptable for bond.
- G. Prepare for Installation of Thin Veneer Stone:
  - 1. Coordination: Coordinate placement of reinforcement, anchors, accessories, flashings, weep holes, and other moisture-control products specified in other sections.
  - 2. Cleaning: Clean built-in items of loose rust, ice, mud, and other foreign matter before incorporating into wall.
  - 3. Prime or galvanize ferrous metal built into wall.
  - 4. Temporary Bracing:
    - a. Provide temporary bracing as required during installation of masonry.
    - b. Maintain bracing in place until building structure provides permanent support.

### 3.3 INSTALLATION

- A. Install thin veneer stone and mortar in accordance with manufacturer's instructions and ACI 530.1/ASCE 6/TMS 602.
- B. Maintain masonry courses to uniform dimensions. Form vertical and horizontal joints of uniform thickness.
- C. Pattern Bond:
  - 1. Lay out work in advance and distribute color range of stone uniformly over total work area.
  - 2. Lay stone with face exposed.
  - 3. Take care to avoid concentration of any 1 color to any 1 wall surface.
  - 4. Maintain approximate ½ inch (13-mm) joint, as stone allows.
  - 5. Do not use stacked vertical joints.
- D. Placing and Bonding:
  - 1. Dampen substrate as required to reduce excessive suction.
  - 2. Apply mortar in accordance with PCA Plaster (Stucco) Manual to thickness of ½ inch to ¾ inch (13 mm to 19 mm).
  - 3. Do not spread more than workable area of 5 to 10 square feet, so mortar will not set before stone is applied.
  - 4. Lay thin veneer stone in full bed of mortar with full head joints.
  - 5. Work from bottom up, laying corner pieces first.
  - 6. Remove excessive mortar as work progresses.
  - 7. Do not shift or tap veneer stone after mortar has achieved initial set. Where adjustment is required, remove mortar and replace.
  - 8. Isolate top of veneer stone from horizontal structural framing members and slabs or decks with compressible joint filler and sealant as specified in Section 079200.
- E. Joining Work: Where fresh masonry joins partially set masonry.
  - 1. Remove loose stone and mortar.
  - 2. Clean and lightly wet surface of set masonry.
  - 3. To avoid horizontal run of masonry, rack back 1/2 the length of stone in each course.
  - 4. Tothing is not permitted.
- F. Joints:
  - 1. Lay stone with approximate ½ inch (13 mm) mortar joint, as stone allows.
  - 2. Tool joints when "thumb-print" hard with round jointer, slightly larger than width of joint.
  - 3. Trowel point or concave tool exterior joints below grade.
  - 4. Flush cut joints to be finished with soft brush only.
  - 5. Re-tempering of mortar is not permitted.
  - 6. Use non-corrosive stone shims as required to maintain uniform joint thickness.
- G. Control and Expansion Joints: Control joints shall be designed in accordance with National Concrete Masonry Association TEK 10-2B for control joint design and locations.
  - 1. Keep joints open and free of debris.
  - 2. Coordinate control joints as specified in Section 079200 for sealant performance.
- H. Sealant Recesses:

1. Provide open joints  $\frac{3}{4}$  inch deep and  $\frac{1}{4}$  inch wide, where masonry meets doors, windows, and other exterior openings.
2. Coordinate sealant joints as specified in Section 079200 for sealant performance.

I. Cutting and Fitting:

1. Cut and fit thin veneer stone for chases, pipes, conduit, sleeves, grounds, and other penetrations and adjacent materials.
2. Coordinate with other work to provide correct size, shape, and location.

J. During progress of the work, cover top of unfinished stone masonry work for protection from weather.

### 3.4 CLEANING

- A. If residual mortar is on face of stone, allow to dry partially and brush mortar off surface and sponge off residue.
- B. Replace defective mortar. Match adjacent work.
- C. When work is completed, and mortar has set for 2 to 3 days, clean surface from top to bottom using mild masonry detergent acceptable to natural thin veneer stone manufacturer.
- D. Do not use harsh cleaning materials or methods that could damage stone.
- E. Do not use metal brushes or acids for cleaning.

### 3.5 PROTECTION

- A. Protect finished installation.
- B. Maintain protective boards at exposed external corners that may be damaged by construction activities. Provide such protection without damaging completed work.
- C. Heat materials and provide temporary protection of completed portions of masonry work. Extend covering at least 2' (600 mm) down both sides of walls and hold securely in place.
- D. Prevent mortar or soil from staining face of masonry to be left exposed. Remove immediately mortar in contact with such masonry. Protect base of walls from rain-splashed mud and mortar splatter by means of coverings spread on ground and over wall surface.
- E. At end of each day's work, cover tops of work with building paper or by other means to protect stone from becoming excessively wet.
- F. Touch-up, repair, or replace damaged stone before Substantial Completion.

END OF SECTION 048500

## SECTION 055000

### METAL FABRICATIONS

#### PART 1 - GENERAL

##### 1.1 SUMMARY

- A. Section Includes:
  - 1. Miscellaneous steel framing and supports.
  - 2. Metal Fence and Gate

##### 1.2 ACTION SUBMITTALS

- A. Product Data: For the following:
  - 1. Fasteners.
  - 2. Shop primers.
- B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

#### PART 2 - PRODUCTS

##### 2.1 METALS

- 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. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- C. Steel Tubing: ASTM A500/A500M, cold-formed steel tubing.
- D. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.
- E. Metal Fence Posts & Rails: ASTM F1083.

##### 2.2 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

## 2.3 MISCELLANEOUS MATERIALS

- A. Shop Primers: Provide primers that comply with Section 099000 "Painting and Coating."
- B. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.
- C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

## 2.4 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. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.
- E. 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.
- F. 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.
- G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

## 2.5 MISCELLANEOUS FRAMING AND SUPPORTS

- A. 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.

## 2.6 METAL FENCE AND GATE

- A. Fabricate metal fence and gate from steel shapes, plates, and bars of size and to dimensions indicated, fully welded together per Architectural Details.
  - 1. Provide self-closing hinges sized for the weight of the gate
  - 2. Provide galvanized steel cane bolts per Architectural Details: Grade 1, 24-inch 5/8 inch rods
  - 3. Provide galvanized steel latch bolts per Architectural Details: 1/2 inch rods
- B. Fence and Gate shall be constructed of galvanized steel and prepped for painting per Section 099000 "Painting and Coating".

## 2.7 GENERAL FINISH REQUIREMENTS

- A. Finish metal fabrications after assembly.

## 2.8 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.
  - 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
- B. Shop prime iron and steel items unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
- C. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:
  - 1. Galvanized-Steel Items: SSPC-SP 16, "Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals."

## PART 3 - EXECUTION

### 3.1 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.
- 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.
- 3.2 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS
- A. Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
- 3.3 REPAIRS
- A. Touchup Painting:
1. Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 055000

## SECTION 061000 – ROUGH CARPENTRY

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Wood framing, plates, nailers, grounds, and furring.
- B. Plywood sheathing and backing panels.
- C. Telecommunications and electrical panel boards.
- D. Concealed blocking for support of accessories, equipment, fixtures, specialty items, trim, and facing materials.
- E. Fire retardant treatment.
- F. Preservative treatment.
- G. Rough hardware and accessory materials.
- H. Sill gasket sealer.

#### 1.2 PRODUCT SUPPLIED BUT NOT INSTALLED UNDER THIS SECTION

- A. Sill plate anchor bolts for installation under Section 033000.

#### 1.3 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Sill plate anchor bolt installation.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Source quality control submittals:
  - 1. Wood preservative treatment data: Submit certification by treating plant, indicating compliance with specified requirements.
  - 2. Fire retardant treatment data: Submit certification by treating plant, indicating compliance with specified requirements.

#### 1.5 QUALITY ASSURANCE

- A. Regulatory requirements: Conform to applicable codes for fire retardant treatment of wood surfaces for flame/fuel/smoke ratings.
- B. Lumber: Comply with PS 20-20. Provide lumber species grade marked and complying with grading rules of following associations:

1. Southern pine: 2021 Standard Grading Rules for Southern Pine Lumber, published by Southern Pine Inspection Bureau (SPIB).
  2. Douglas fir, Western Larch and Hemlock: Western Lumber Grading Rules 2021, published by Western Wood Products Association (WWPA), or Standard Grading Rules for West Coast Lumber, Number 17, 2018, published by Pacific Lumber Inspection Bureau (PLIB).
  3. Spruce, pine, and fir: Northeastern Lumber Manufacturers Association (NELMA) and current Canadian Grading Rules by National Lumber Grades Authority.
- C. Plywood: Grade marked and manufactured in accordance with PS 1-19 or one of APA/EWA-APA -The Engineered Wood Association performance standards.
- D. Fire retardant treatment shall conform to requirements of Underwriters' Laboratories (UL).

## 1.6 DELIVERY, STORAGE AND HANDLING

- A. Keep materials dry and undamaged during delivery and site storage. Protect against weather exposure and contact with damp or wet surfaces. Stack rough carpentry materials to ensure proper drainage and ventilation. Protect from weather damage and deterioration.
- B. Store and protect rough carpentry accessories and hardware from weather damage and deterioration.
- C. Store shop-fabricated items indoors in well ventilated area with temperature and humidity stabilized and maintained at minimum of 60°F (16°C) temperature and maximum of 60% humidity.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Lumber:
  1. Nominal lumber sizes are indicated, except as shown by detail dimensions. Provide actual sizes as required by PS 20-20 for moisture content specified for each use.
  2. Provide dressed seasoned dimensioned lumber, S4S, air-dried with maximum 19% moisture content (S-DRY).
  3. Provide pressure preservative treated materials for material used at exterior of buildings.
  4. Grades: Southern Pine or Western Lumber species.
    - a. Beams: No. 2.
    - b. Joists and rafters: No. 2.
    - c. Studs, 10' (3,000 mm) and shorter: Stud.
    - d. Studs, longer than 10' (3,000 mm): No. 2.
    - e. Furring, blocking, and bracing: Utility.
  5. Exposed framing lumber 2" (50 mm) through 4" (100 mm) thick: Where framing will not be concealed by other work, provide Southern pine, appearance grade or Douglas fir, appearance framing.
- B. Plywood: Concealed performance-rated panels. Provide in thickness indicated on Drawings, if not indicated, not less than 1/2" (13 mm) thickness.

1. Wall sheathing and bracing: APA/EWA-rated sheathing "EXP 1," span rating 32/16, square edge.
  2. Roof sheathing: APA/EWA-rated sheathing EXP 1, span rating 48/24, square edge.
  3. Underlayment: APA/EWA underlayment INT with exterior glue or APA/EWA underlayment CC plugged EXT, square edge.
  4. Exposed interior use: APA/EWA-AD-INT plywood with A grade exposed.
- C. Oriented strand board (OSB): Sheathing rated by APA/EWA for intended use.
- D. Composite headers: Lumber manufactured by laminating visually graded wood veneers, whose thickness range from 0.15" to 0.25" (3 mm to 7 mm) in thickness and grain runs parallel to long axis, to narrow faces of oriented strand board to produce rectangular members with veneers making up not less than 32% of total cross section.
1. Wood species: Yellow poplar, sweet gum, red maple, and Southern pine, with minor amount of elm, ash, sycamore, and black gum not to exceed 15% to finished product.
  2. Adhesives: Melamine formaldehyde adhesive for gluing veneers to each other and phenol formaldehyde adhesive for gluing veneers to oriented flakeboard.
  3. Size: 1-1/2" (38 mm) thick by depth and length indicated.
  4. Manufacturer: "MICROLLAM LVL" headers and beams as manufactured by Weyerhaeuser Corporation, 220 Occidental Ave. S, Seattle, Washington 98104.
- E. Engineered Joists: Lumber manufactured by laminating visually graded wood veneers, whose thickness range from 0.15" to 0.25" (3 mm to 7 mm) in thickness and grain runs parallel to long axis, to narrow faces of oriented strand board to produce rectangular members with veneers making up not less than 32% of total cross section. Sections shall be used for top and bottom chords assembled with an OSB web to form an "I" profile joist.
1. Wood species: Yellow poplar, sweet gum, red maple, and Southern pine, with minor amount of elm, ash, sycamore, and black gum not to exceed 15% to finished product.
  2. Adhesives: Melamine formaldehyde adhesive for gluing veneers to each other and phenol formaldehyde adhesive for gluing veneers to oriented flakeboard.
  3. Size: 1-1/2" (38 mm) thick by depth and length indicated.
  4. Manufacturer: "TJI Joists" engineered joists as manufactured by Weyerhaeuser Corporation, 220 Occidental Ave. S, Seattle, Washington 98104.

## 2.2 ACCESSORY MATERIALS

- A. Rough hardware:
1. Provide bolts, plates, anchors, hangers, and other miscellaneous steel and iron shapes as required for framing and supporting woodwork and for anchoring or securing woodwork to concrete, masonry, or wood structures.
  2. Provide manufactured or fabricated items of sizes, shapes and dimensions required.
  3. Bolts: ASTM A307. Provide with double washers. Furnish sill plate anchor bolts for installation under Section 033000.
  4. Steel: ASTM A36.
  5. Fasteners and anchorages: Provide size, type, material, and finish required for nails, screws, bolts, nuts, washers, and anchoring devices. Provide hot-dip galvanized finish for exterior locations, high humidity locations and treated wood; plain finish for other interior locations; size and type to suit application.
- B. Metal connectors: Galvanized steel hangers, ties, and anchors. Provide 16 or 18 gage (2 mm or 1 mm) materials sized for full load carrying capacity of supported members.
- C. Plywood sheathing clips: Extruded 6063T6 aluminum alloy.

- D. Sill sealer: Per SIPS panel manufacturer's recommendations.

## 2.3 WOOD TREATMENT

- A. Wood preservative treatment:
  - 1. Borate:
    - a. For interior use only, not exposed to weather or ground.
    - b. Framing lumber and plywood pressure-treated with sodium borate.
    - c. OSB sheathing products treated with integral zinc borate.
    - d. Manufacturer: Nisus Corporation "Bora-Care," or equal.
  - 2. Copper Azole Type C (CA-C) or Type B (CA-B):
    - a. For above ground exposed use, ground contact general use, fresh-water immersion, and salt-water splash applications.
    - b. Water-based, clear paintable, glueable.
    - c. Fasteners: Corrosion-resistant, compatible with Copper Azole.
    - d. Manufacturer: Viance "Preserve CA" or equal.
  - 3. Fire-retardant treatment:
    - 4. Type: Chemically treated and pressure impregnated; capable of providing maximum flame spread/fuel contribution/smoke development rating of 25/25/25.
    - 5. Provide UL-approved identification on fire-retardant treated materials.
    - 6. Kiln dry wood after pressure treatment to maximum 19% moisture content for lumber and maximum 15% for plywood.
    - 7. Deliver fire-retardant treated materials cut to required sizes. Only end cuts, drilling holes, and joining cuts permitted.
    - 8. Fire-retardant wood shall meet interior Type A requirements in AWWA Standard C20 for lumber and C27 for plywood.
    - 9. Location: Where shown on Drawings.
    - 10. Manufacturer: Flameproof Companies, Inc., "Flametech", or equal.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Set carpentry work accurately to required lines and levels with members plumb, true and accurately aligned, cut, and fit. Work shall be performed in conformance with good trade practice, recommendations of manufacturer, building codes and specifications.
- B. Securely attach carpentry work to substrate by anchoring and fastening as required to support applied loading, in accordance with recognized standards.
  - 1. Provide washers under bolt heads and nuts.
  - 2. Use fasteners of proper size that will not penetrate members where opposite side will be exposed to view or receive finish materials.
  - 3. Do not drive threaded friction type fasteners.
  - 4. Tighten bolts and lag screws at installation and retighten as required.
  - 5. Nails, screws, and bolts used in connection with preservative treated wood shall be galvanized.
- C. Provide treated wood grounds, nailers, blocking, sleepers, and furring where required for screeding or attachment of other work and surface applied items. Attach to substrate as required to support applied loading.
  - 1. Material: Framing lumber.

2. Nominal size: Match adjacent framing lumber, unless otherwise shown on Drawings.
3. Extent of Work: Provide blocking behind wall-supported loads, including cabinets, wardrobe rods, siding, roofing, sheet metal flashing and trim, doors, windows, finish hardware including door stops, railings, toilet room accessories, mirrors, miscellaneous specialties, building equipment, window traverse rods and shades, and mechanical and electrical work; verify exact locations.

### 3.2 FRAMING, PLATES, NAILERS, BLOCKING, FURRING, AND GROUNDS

- A. Provide framing members of sizes and on spacings shown and frame openings to comply with International Building Code, latest edition. Cut, join, and tightly fit framing around other work. Do not splice structural members between supports.
- B. Use only sound thoroughly seasoned materials of longest practical lengths and sizes to minimize joints. Use materials free of warp, unless warp can be easily corrected by anchorage and attachment. Make tight connections between members. Discard units with defects which might impair quality of work and units which are too small to use in fabricating work with minimum joints or optimum joint arrangement.
- C. Anchor and nail framing to comply with International Building Code, latest edition.
- D. Provide treated sill plates where wood framing is supported by concrete construction. Install exterior wall sill plates over single layer of sill sealer. Anchor to embedded bolts.
- E. Provide special framing as shown for eaves, overhangs, dormers, and similar conditions.
- F. Provide fire stops and fire separations in wall and roof areas as required by applicable code requirements.
- G. Set studs at spacing shown on Drawings. Unless otherwise shown, use 2" x 4" (50 mm x 100 mm) wood studs spaced 16" (400 mm) o.c. with 4" (100 mm) face placed perpendicular to direction of wall or partition. Provide single bottom plate; double top plates, 2" (50 mm) thick by width of studs. Double studs at sides of framed openings. Arrange 3 studs to provide bearing for nailing at corners.
- H. Frame openings with multiple studs and headers. Provide nailed header members of thickness equal to that of studs. Set headers on edge and support on jamb studs.
- I. Place and install sill gasket sealer per SIPS panel manufacturer's recommendations.
- J. Erect wood framing members level and plumb. Place horizontal members laid flat, crown side-up. Construct framing members full length without splices.
- K. Bolting of wood to structural members of masonry shall be, in general, with a minimum of 1/2" (13 mm) bolts at 4'-0" (1,200 mm) oc except where shown otherwise. Situations requiring special bolting shall be with size and spacing of bolts to suit conditions.
- L. Install wood plates, blocking, furring, and nailing grounds as indicated and required. Coordinate work with other trades.

- M. Work shall be well fitted and securely fastened in proper location with nails, screws, or other approved fastening devices.

### 3.3 SHEATHING AND BACKING PANELS

- A. Install plywood sheathing where indicated. Comply with International Building Code, latest edition, for types of plywood products and applications indicated.
  - 1. Install with face grain across supports, using panels continuous over 2 or more spans with end joints between panels staggered and located over center of supports.
  - 2. At minimum, fasten 6" (150 mm) on center along panel ends and 12" (300 mm) on center at intermediate supports for spans less than 48" (1,200 mm) using 6d common nails.
  - 3. Allow 1/8" (3 mm) open space between end joints and edge joints for expansion and contraction of panels.
  - 4. Provide roof sheathing ply-clips at unsupported joints of panels between roof framing members.

### 3.4 CLEANING

- A. Clean up debris and cutting on regular periodic basis. Remove and dispose of excess materials and debris created by carpentry work.
- B. Maintain buildings and site free of accumulations of cutting and waste materials in neat orderly condition.

END OF SECTION 061000

## SECTION 061200 – STRUCTURAL INSULATED PANELS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Structural Insulated Panels (SIPs).

#### 1.2 RELATED SECTIONS

- A. Section 061000 – Rough Carpentry

#### 1.3 REFERENCES

- A. ACSE 7 – Minimum Loads for Buildings and other Structures.
- B. ASTM C578 – Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
- C. ASTM E1803 – Standard Test Method for Determining Structural Capacities of Insulated Panels.
- D. DOC PS2 – Performance Standard for Wood-based Structural-Use Panels.
- E. ICC ES AC04 – Acceptance Criteria for Sandwich Panels.
- F. ICC ES AC05 – Acceptance Criteria for Sandwich Panel Adhesives.
- G. ICC ES AC12 – Acceptances Criteria for Foam Plastic Insulation.
- H. ASTM D3273 – Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
- I. ASTM E1333 – Standard Test Method for Determining Formaldehyde Concentrations in Air and Emission Rates from Wood Products Using a Large Chamber.
- J. EPA – Registered products listing.

#### 1.4 SYSTEM DESCRIPTION

- A. Structural Insulated Panels (SIPs) framing system consist of oriented strand board (OSB) laminated with structural adhesives to an insect resistant EPS insulation core, or polyurethane foam core, structural lumber connecting splines, connectors and fasteners supplied by manufacturer, all as shown on drawings, specified herein, and or described in manufacturer's architectural detail binder.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Product Data: Submit product data for specified products.
  - 1. SIP Code Compliance: Submit a code report / material listing report for SIPs showing evidence of compliance with code requirements as an alternate method of construction. Submit current compliance report from an International Accreditation Service (IAS) Accredited Product Certification Agency that has demonstrated compliance with ISO Guide 65, General requirements for bodies operating product certification systems, showing conformance to the International Building Code (IBC) and International Residential Code (IRC).
    - a. Shear Wall use: The submitted code report / material listing report shall include all load cases for transverse, axial and racking shear loading for the SIPs. The report must demonstrate that the SIPs may be used as shear walls in all Seismic Design Categories A, B, C, D, E and F.
  - 2. Manufacturer to provide complete panel shop drawings, showing all panel sizes, electrical layout, door and window openings, product components and accessories, and any other structural elements
  - 3. Manufacturer's Instructions: SIP Manufacturer's construction detail book and load design charts.
- B. Calculations: Provide structural calculations by a professional engineer in the State of South Dakota qualified to perform such work.
- C. Quality Assurance Submittals: Submit the following:
  - 1. Certificate: Product certificate showing compliance to Third Party Quality Control program.
- D. Warranty: Warranty documents specified herein.

## 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Installer should be experienced in performing work of this section and should have specialized in installation of work similar to that required for this project.
- B. Source Limitations: Obtain all SIPs through one source. All accessories to be as furnished or recommended by the SIP manufacturer.

## 1.7 REGULATORY REQUIREMENTS

- A. SIPs shall be recognized for compliance with the most recent version of the International Building Code.
- B. Pre-installation Meeting: Conduct pre-installation meeting to verify project requirements, foundation/structural system/substrate conditions, SIP manufacturer's installation instructions and SIP manufacturer's warranty requirements. Comply with Division 1 Project Management and Coordination (Project Meetings) Section.

## 1.8 DELIVERY, STORAGE AND HANDLING

- A. Ordering: Comply with SIP manufacturer's ordering instructions and lead-time requirements to avoid construction delays.
- B. Delivery: Deliver materials from SIP manufacturer with identification labels or markings intact.
- C. Off-load SIPs from the truck and handle using forklift or other means to prevent damage to SIPs.
- D. SIPs shall be fully supported in storage and prevented from contact with the ground.
- E. SIPs shall be fully protected from weather. Protect against exposure to rain, water, dirt, mud, and other residue that may affect SIP performance. Cover stored SIPs with breathable protective wraps. SIPs shall be stored in a protected area of the work site.

## 1.9 WARRANTY

- A. Project Warranty: Refer to Conditions of the Contract for project warranty provisions.
- B. Manufacturer's Warranty: Submit SIP manufacturer's standard warranty document. SIP Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under Contract Documents.
  - 1. Warranty Period: 20 years from the date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Big Sky Insulations Inc., 15 Arden Drive, Belgrade, MT 59714. Phone (800) 766-3626. Website: [bigskyrcontrol.com](http://bigskyrcontrol.com)
- B. Thermacore Panel System, 1801 Hancel Parkway, Mooresville, IN 46158. Phone (317) 831-8888. Email: [salesinfo@thermocore.com](mailto:salesinfo@thermocore.com).
- C. Enercept, 3100 9<sup>th</sup> Ave. SE, Watertown, SD 57201. Phone: (605) 882-2222. Email: [info@enercept.com](mailto:info@enercept.com).
- D. Premier SIPs, 18504 Canyon Road East, Puyallup, WA 98375. Phone (800) 275-7086.
- E. ACME Panel, 1905 West Main Street, Radford, VA 24141. Phone (800) 331-4266. Email: [info@acmepanel.com](mailto:info@acmepanel.com).

### 2.2 MATERIALS

- A. SIPs consisting of the following:
  - 1. Panel Thickness:

- a. 8.25" (Wall) foam core panels with ½" OSB/OSB (interior/exterior) skins. Each panel has a foam core of expanded polystyrene (EPS), or polyurethane foam.
- b. 8.25" (Roof) foam core panels with ½" OSB (interior) / ¾" OSB (exterior) skins. Each panel has a foam core of expanded polystyrene (EPS), or polyurethane foam.
2. OSB identified with APA or PFS performance mark with Exposure I durability rating and performance in accordance with DOC PS-2 span rating 24/16 or greater.
3. Core is a UL certified for fire and physical properties of ASTM C578 Type I expanded polystyrene (EPS) with borate insect resistant treatment, or a Class 1/A fire rated polyurethane foam with a minimum density of 2.2 lbs.
4. Laminating Adhesives shall be in conformance with ICC ES AC-5.
5. Panels must be manufactured to a thickness tolerance of +/- 3/32".

## 2.3 ACCESSORY MATERIALS

- A. Splines: OSB, Premier SIP Spline, or I-beam for use in joining SIPs shall be supplied by SIPs manufacturer.
- B. Fasteners: Corrosion resistant SIP screws compatible with SIP system shall be provided by the SIPs manufacturer.
  1. Wood Screws for attachment to wood members
  2. Heavy Duty Metal Screws for attachment to metal members (16 gauge to 1/4")
  3. Light Duty Metal Screws for attachment to metal decks (18 gauge or thinner)
- C. SIP Mastic: Shall be specifically designed for use with SIPs. Mastic must be compatible with all components of the SIP. Mastic shall be provided by the SIP manufacturer.
- D. SIP Gasket: Foam Sealant Gaskets shall be provided by the SIP manufacturer.
- E. Dimensional Lumber: SPF, #2 or better, or engineered equivalent unless otherwise required by structural drawings.
- F. Vapor Retarder SIP Tape: Tape with an adhesive suitable for indoor use, min. 6 inch wide for use on SIP joints, 18 inch wide for use at roof beams. SIP Tape shall be supplied by the SIP manufacturer.

## 2.4 FABRICATION

- A. Sizes: SIPs shall be fabricated in accordance with approved Shop Drawings.
- B. Thermal Resistance, R-value:
  1. Roof: SIP with R-value of 30. (Panels shall be no thicker than 10".)
  2. Exterior Walls: SIP with R-value of 25. (Panels shall be no thicker than 8".)

## 2.5 PRODUCT SUBSTITUTIONS

- A. Substitutions: Core material selection shall be by SIPs manufacturer to meet R-value requirements.

## 2.6 RELATED MATERIALS

- A. Related Materials: Refer to other sections for related materials as follows:
  - 1. Dimensional Lumber: SPF #2 or better or pre-engineered equivalent: Refer to 061000 Rough Carpentry.

## 2.7 SOURCE QUALITY

- A. Source Quality Assurance: Each SIP component required shall be supplied by SIP manufacturer and shall be obtained from selected SIP manufacturer or its approved supplier.
  - 1. Each SIP shall be labeled indicating UL or other ISO Guide 65 approved Third Party certification.
  - 2. Provide evidence of UL Third Party inspection and labeling of all insulation used in manufacture of SIPs.
  - 3. When EPS is used, SIP manufacturer shall provide Lamination/R-Value Warranty documents for building owner acceptance and execution. Manufacturer's standard forms will be submitted.
  - 4. When EPS is used, provide EPS treated for insect resistance. Treatment shall be EPA registered.
  - 5. Dimensional Tolerance - shall comply with values listed in the manufacturer's Quality Control Manual.
- B. Source Quality: Obtain SIPs from a single manufacturer.

## PART 3 - EXECUTION

### 3.1 MANUFACTURER'S INSTRUCTIONS

- A. Compliance: Comply with manufacturer's ICC-ES or material listing report, Load Design Charts, Detail Book, Shop Drawings, and Product data, including product technical bulletins, for installation.
- B. Plans shall be reviewed by a qualified structural engineer, licensed in the State of South Dakota, and shall be sealed and signed. Deviations from standard details and load design values shall be calculated, sealed, and signed by the structural engineer.

### 3.2 EXAMINATION

- A. Site Verification of Conditions: Verify substrate conditions (which have been previously installed under other sections) are acceptable for product installation in accordance with manufacturer's instructions.
  - 1. Verify conditions of foundation/structural system/substrate and other conditions which affect installation of SIPs. Any adverse conditions shall be reported in writing to the SIP manufacturer and the design professional. Do not proceed with installation until adverse conditions are corrected.

### 3.3 INSTALLATION

#### A. SIP Installation:

1. SIP Supports: Provide level and square foundation/structural system/substrate that support wall SIPs. For wall SIPs, hold sill plate back from edge of rim board 3/4" to allow full bearing of OSB skins. Provide 1½" diameter access holes in plating to align with electrical wire chases in SIPs. Provide adequate bracing of SIPs during erection. Remove debris from plate area prior to SIP placement.
2. SIP Fastening: Connect SIPs by nails or staples as shown on drawings. Screws of equal strength may be substituted for nails and staples as specified by engineer. SIP mastic, or sealant gasket, must be used together with each fastening techniques. Where SIP Screw Fasteners are used, provide a minimum of 1" penetration into support. Join SIPs using plates and splines, or tongue and groove. Secure attachment with nails, staples, or screws. Apply SIP mastic, or foam sealant gaskets, following SIP manufacturer recommendations.
3. SIP Tape: Provide SIP Tape at joints between SIP wall panels, and as shown in SIP Manufacturer's details.
4. Vapor Retarders: Provide vapor retarders mandated by building code.
5. Thermal Barriers: Interior surfaces of SIPs shall be finished with a minimum 15-minute thermal barrier, such as gypsum wallboard or other approved materials. Apply code approved thermal barriers according to SIP manufacturer's recommendations.
6. Restrictions: Do not install SIPs directly on concrete. Do not put plumbing in SIPs without consulting SIP manufacturer. Do not over cut skins for field-cut openings and do not cut skins for electrical chases. SIPs shall be protected from exposure to solvents and their vapors that damage the EPS foam core.
7. Remove and replace insulated wall SIPs which have become excessively wet or damaged before proceeding with installation of additional SIPs or other work.

### 3.4 PROTECTION

- #### A. Protection: Protect installed product and finish surfaces from damage during construction.
1. After installation, cover SIPs to prevent contact with water on each exposed SIP edges and faces.

END OF SECTION 061200

## SECTION 061600 – SHEATHING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Interior shear wall sheathing.
  - 2. Sheathing joint and penetration treatment.
- B. Related Requirements:
  - 1. Division 06 Section 061000 Rough Carpentry

#### 1.3 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. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Include physical properties of treated materials.
  - 3. For fire-retardant treatments, include physical properties of treated plywood both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5516.
  - 4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
  - 5. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

#### 1.4 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.

## 1.5 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. Emissions: Products shall meet 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."
- B. 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.
  - 2. Oriented Strand Board (OSB).
- C. Plywood: Either DOC PS 1 or DOC PS 2 unless otherwise indicated.
- D. OSB: DOC PS 2 unless otherwise indicated.
- E. Thickness: As needed to comply with requirements specified, but not less than thickness indicated.
- F. Factory mark panels to indicate compliance with applicable standard.

### 2.2 ROOF SHEATHING

- A. Plywood or OSB Sheathing: Exterior sheathing.
  - 1. Span Rating: Not less than 40/20.
  - 2. Nominal Thickness: Not less than 1/2 inch

### 2.3 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
  - 1. For all sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.

## PART 3 - EXECUTION

### 3.1 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. NES NER-272 for power-driven fasteners.
  - 2. Table 2304.9.1, "Fastening Schedule," in ICC's "International Building Code."
  - 3. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's "International Residential Code for One- and Two-Family Dwellings."
- D. Coordinate 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.
- E. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.
- F. 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.

END OF SECTION 061600

## SECTION 061753 – SHOP FABRICATED WOOD TRUSSES

### 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. Shop Fabricated Wood Trusses

#### 1.3 DESIGN

- A. Trusses shall be designed in accordance with the Standard and where any applicable design feature is not specifically covered herein, design shall be in accordance with the applicable provisions of the latest edition of the *National Design Specification for Wood Construction (NDS)* and all applicable provisions of all statutes, laws, rules, regulations, ordinances, codes, or orders of the governing jurisdiction.
- B. Truss Manufacturer shall furnish truss design drawings and supporting calculations prepared in accordance with all applicable provisions of all statutes, laws, rules, regulations, ordinances, codes, or orders of the governing jurisdiction. Drawings and calculations shall be stamped by a licensed South Dakota professional engineer and submitted for contractor and engineer approval prior to manufacturing the trusses.
- C. The Truss Design Drawings shall include, at a minimum, the information specified below:
  - 1. Building Code used for Design.
  - 2. Slope, depth, span and spacing.
  - 3. Location of all joints and support locations.
  - 4. Number of plies if greater than one.
  - 5. Required bearing widths.
  - 6. Design loads as applicable, including:
    - a. Top chord live load (including uniform and unbalanced snow load condition per ASCE 7-16);
    - b. Top chord dead load;
    - c. Bottom chord live load;
    - d. Bottom chord dead load;
    - e. Additional loads and locations;
    - f. Environmental load design criteria (wind speed, snow, seismic, and all applicable factors as required to calculate the truss loads);
    - g. Other lateral loads, including drag strut loads.

7. Maximum reaction force and direction, including maximum uplift reaction forces where applicable.
8. Metal Connector Plate type, manufacturer, size, and thickness or gauge, and the dimensioned location of each Metal Connector Plate except where symmetrically located relative to the joint interface.
9. Size, species and grade for each wood truss member.
10. Truss-to-Truss connection and truss field assembly requirement including permanent bracing requirements.
11. Calculated span to deflection ration and/or maximum vertical and horizontal deflection for live and total load and creep factor as applicable.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Stack trusses 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 LUMBER

- A. Lumber use shall be identified by grade mark of a lumber inspection bureau or agency approved by the American Lumber Standards Committee, and shall be the size, species, and grade as shown on the truss design drawings.
- B. Adjustment of value for duration of load or conditions of use shall be in accordance with NDS.

#### 2.2. METAL CONNECTOR PLATES

- A. Metal connector plates shall be manufactured by a Truss Plate Institute (TPI) member plate manufacturer and shall not be less than 0.036 inches thick (20 gauge) and shall meet or exceed ASTM A653 grade 33, and galvanized coating shall meet or exceed ASTM A924, coating designation G60. Working stresses in steel are to be applied to the effectiveness ratios for plates as determined by tests and in accordance with the *National Design Standard for Metal Plate Connected Wood Truss Construction*.
- B. Adjustment of value for duration of load or conditions of use shall be in accordance with NDS.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION, GENERAL

- A. Contractor shall be responsible for the handling, installation, and temporary restraint/bracing of the trusses in a good workmanlike manner and in accordance with the recommendations set forth in the latest edition of *BCSI: Guide to Good Practice for Handling, Installing, Restraining & Bracing of Metal Plate Connected Wood Trusses (BCSI)*.

- B. Apparent damage to trusses shall be reported to the Truss Manufacturer prior to erection.
- C. Trusses shall be set and secured level and plumb in planned location and braced as required.
- D. Cutting and altering of trusses is not permitted. If any truss should become broken, damaged, or altered, written concurrence and approval by a Registered Design Professional is required.
- E. Concentrated loads shall not be placed on top of trusses until all specified restraint and bracing has been installed and decking is permanently nailed in place. Specifically avoid stacking full bundles of plywood or other concentrated loads on top of trusses.
- F. Trusses shall be permanently restrained and braced in a manner consistent with construction standard of care and as outlined in *BCSI*.
- G. Materials used in temporary and permanent restraint and bracing shall be furnished by Contractor.

END OF SECTION 061753

## SECTION 061800 - GLUED-LAMINATED CONSTRUCTION

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Structural glued-laminated timber.
  - 2. Timber connectors.
  - 3. Factory finishing.

#### 1.2 ACTION SUBMITTALS

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

#### 1.3 QUALITY ASSURANCE

- A. Manufacturer Qualifications: An AITC- or APA-EWS-licensed firm.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. General: Comply with provisions in AITC 111.
- B. Individually wrap members using plastic-coated paper covering with water-resistant seams.

### PART 2 - PRODUCTS

#### 2.1 STRUCTURAL GLUED-LAMINATED TIMBER

- A. General: Provide structural glued-laminated timber that complies with ANSI A190.1 and ANSI 117 or research/evaluation reports acceptable to authorities having jurisdiction.
  - 1. Factory mark each piece of structural glued-laminated timber with AITC Quality Mark or APA-EWS trademark. Place mark on surfaces that are not exposed in the completed Work.
  - 2. Provide structural glued-laminated timber made with wet-use adhesive complying with ANSI A190.1.
- B. Species and Grades for Structural Glued-Laminated Timber: Douglas fir-larch that complies with beam stress classifications indicated.
- C. Species and Grades for Beams and Purlins:

1. Species and Beam Stress Classification: Douglas fir-larch, 24F-1.8E.
2. Lay-up: Balanced.

D. Species and Grades for Truss Members:

1. Species and Combination Symbol: Douglas fir-larch, 1.

E. Appearance Grade: Architectural for exposed, Industrial elsewhere, complying with AITC 110.

## 2.2 TIMBER CONNECTORS

A. Manufacturers: Simpson Strong-Tie or equivalent product from another manufacturer.

B. Materials: Unless otherwise indicated, fabricate from the following materials:

1. Structural-steel shapes, plates, and flat bars complying with ASTM A36/A36M.
2. Round steel bars complying with ASTM A575, Grade M 1020.
3. Hot-rolled steel sheet complying with ASTM A1011/A1011M, Structural Steel, Type SS, Grade 33.

C. Finish steel assemblies and fasteners with rust-inhibitive primer, 2-mil (0.05-mm) dry film thickness.

D. Hot-dip galvanize steel assemblies and fasteners after fabrication to comply with ASTM A123/A123M or ASTM A153/A153M.

## 2.3 MISCELLANEOUS MATERIALS

A. End Sealer: Manufacturer's standard, transparent, colorless wood sealer that is effective in retarding the transmission of moisture at cross-grain cuts and is compatible with indicated finish.

B. Penetrating Sealer: Manufacturer's standard, transparent, penetrating wood sealer that is compatible with indicated finish.

## 2.4 FABRICATION

A. Camber: Fabricate horizontal and inclined members of less than 1:1 slope with either circular or parabolic camber equal to 1/500 of span.

B. End-Cut Sealing: Immediately after end cutting each member to final length, apply a saturation coat of end sealer to ends and other cross-cut surfaces, keeping surfaces flood coated for not less than 10 minutes.

C. Seal Coat: After fabricating, sanding, and end-coat sealing, apply a heavy saturation coat of penetrating sealer on surfaces of each unit.

D. Factory Finishing:

1. Water repellent.
2. Film-forming two-coat varnish.
3. Semitransparent stain.
4. Solid-color stain.
5. Paint.
6. Color: Match Architect's sample.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. General: Erect structural glued-laminated timber true and plumb and with uniform, close-fitting joints. Provide temporary bracing to maintain lines and levels until permanent supporting members are in place.
1. Handle and temporarily support glued-laminated timber to prevent surface damage, compression, and other effects that might interfere with indicated finish.
  2. Predrill for fasteners using timber connectors as templates.
  3. Finish exposed surfaces to remove planing or surfacing marks.
  4. Coat cross cuts with end sealer.

### 3.2 ADJUSTING

- A. Repair damaged surfaces after completing erection. Replace damaged structural glued-laminated timber if repairs are not approved by Architect.

### 3.3 PROTECTION

- A. Do not remove wrappings on individually wrapped members until they no longer serve a useful purpose, including protection from weather, sunlight, soiling, and damage from work of other trades.
1. Slit underside of wrapping to prevent accumulation of moisture inside the wrapping.

END OF SECTION 061800

## SECTION 062000 – FINISH CARPENTRY

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Finish carpentry items, other than special shop-fabricated work.
- B. Hardware and attachment accessories.
- C. Wood shelving.

#### 1.2 RELATED REQUIREMENTS

- A. Section 061000 - Rough Carpentry.
- B. Section 076200 - Sheet Metal Flashing and Trim.
- C. Section 079200 - Joint Sealants.
- D. Section 099000 - Paints and Coatings.
- E. Section 123200 – Manufactured Wood Casework.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Product Data:
  - 1. Architectural hardware.
  - 2. Siding; indicate:
    - a. Materials.
    - b. Component profiles.
    - c. Fastening method.
    - d. Jointing details.
    - e. Sizes.
    - f. Surface texture.
    - g. Finishes.
    - h. Accessories.
- B. Quality assurance data: Fabricator's AWI Quality Certification Program license and Project specific letters.

#### 1.4 ACTION SUBMITTALS

- A. Shop Drawings showing fabrication and installation details of:
  - 1. Sills.
  - 2. Trim.

## 1.5 QUALITY ASSURANCE

- A. Regulatory requirements: Conform to applicable codes for fire retardant treatment of wood surfaces for flame/fuel/smoke requirements.
- B. Perform work in accordance with "Quality Standards" of AWI.
- C. Lumber: Identify with grade stamp of agency certified by ALSC and manufactured in accordance with PS 20.
- D. Plywood: Identify with grade stamp of APA/EWA.
- E. Fire retardant treatment: Conform to UL requirements.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect finish carpentry materials during transit, storage, and handling operations to prevent damage, soiling, or deterioration.
- B. Do not deliver materials to site until painting, wet work, grinding, and similar operations, which may be detrimental to woodwork, have been completed in storage and installation areas.
- C. Store items indoors in ventilated area with temperature and humidity stabilized and maintained at minimum 60°F (16°C) temperature and maximum 60% humidity.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Softwood lumber:
  - 1. PS 20 premium grade in accordance with AWI and WWPA; kiln-dried to maximum moisture content of 6% for interior work and 10% for exterior work.
  - 2. Interior trim to be painted: Clear white or yellow pine or fir with smooth sanded finish and rounded edges.
  - 3. Exterior tongue and groove boards to be stained: Clear white or yellow pine or fir with smooth sanded finish.
  - 4. Exterior quarter-round edge trim to be stained: Clear white or yellow pine or fir with smooth sanded finish and rounded edges.
- B. Hardwood lumber:
  - 1. PS 58 premium grade in accordance with AWI and NHLA; kiln-dried to maximum moisture content of 6%.
  - 2. Interior trim to receive stained, transparent finish: Solid red oak with smooth-sanded finish selected from first grade lumber in accordance with NHLA.

### 2.2 ACCESSORIES

- A. Bolts, nuts, washers, lags, screws, nails, spikes, and staples:

1. Galvanized for high humidity locations.
  2. Plain finish for interior work.
  3. Size and type to suit application.
- B. Miscellaneous fastening hardware shall be of suitable type and of sufficient size and length to draw work firmly together.
1. Interior adhesives: Maximum volatile organic compound content in accordance with SCAQMD Rule 1168.
  2. Interior aerosol adhesives: Maximum volatile organic compound content in accordance with GS-36.

## 2.3 SHELVING

- A. Stained wood shelving AWI Custom Grade.
1. Shelving:  $\frac{3}{4}$ " (19 mm) thick APA/EWA-AD-INT hardwood veneer plywood with hardwood edge banks on exposed edges.
    - a. Species: Red Oak
- B. Painted wood shelving AWI Custom Grade.
1. Shelving:  $\frac{3}{4}$ " (19 mm) thick APA/EWA-AD-INT softwood veneer plywood with hardwood edge banks on exposed edges.
    - a. Veneer species: Birch
    - b. Exposed edge species: Maple
- C. Plastic Laminate shelving
1. Shelving:  $\frac{3}{4}$ " (19 mm) thick plywood with white plastic laminate finish on exposed faces and edges.

## 2.4 SHELF HARDWARE

- A. Brackets for exposed shelving: Haeefele "Shelf Support, Aluminum" 200 mm x 26 mm x 300 mm, 150 kg capacity per pair, white powder coated, with pre-drilled mounting holes.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Refer to Drawings for dimensions and design requirements of finish carpentry items not specifically described in this Section.
- B. Verify measurements in field. Contractor responsible for accuracy of measurements and precise fitting and assembly of finished products.
- C. Install items plumb, level, true to line and securely attached to building construction. Joints shall be uniform and tight.
- D. Accurately scribe and fit trim as required to adjacent surfaces and work of other trades. Use finishing nails and set for puttying.

- E. Accurately scribe materials as required to fit adjacent surfaces and install securely in place, plumb, level, and in proper line.
- F. Verify and conform to mechanical, electrical, and other building items affecting Work.
- G. Prime paint surfaces of items or assemblies in contact with cementitious materials.
- H. Install hardware in accordance with manufacturer's directions.
- I. Sand exposed wood surfaces smooth, set exposed nails and screws to receive finish.
- J. Provide backing sheet, primer, and adhesive as recommended by manufacturer compatible with prevailing conditions of use.

END OF SECTION 062000

## SECTION 071100 - DAMPPROOFING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Cold-applied asphalt bituminous dampproofing.

#### 1.2 RELATED REQUIREMENTS

- A. Section 072100 – Thermal Insulation: Board insulation protective cover.

#### 1.3 ENVIRONMENTAL REQUIREMENTS

- A. Maintain ambient temperatures above 40°F (4°C) for 24 hours before and during application until membrane has cured.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Master Builders Solutions, a brand of MBCC Group.
- B. Karnak Corporation.
- C. W. R. Meadows, Inc.
- D. Products referenced in this Section are manufactured by Master Builders Solutions, unless specified otherwise.

#### 2.2 MATERIALS

- A. “MasterSeal 615” fibrated asphalt emulsion.
- B. Primer: Type recommended by dampproofing manufacturer for substrate condition.
- C. Locations:
  - 1. Foundation exterior wall surfaces below finish grade.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Verify substrate surfaces are durable, free of frozen matter, loose particles, cracks, pits, rough projections, and foreign matter detrimental to adhesion or application of dampproofing system.
- B. Verify items which penetrate surfaces to receive dampproofing are securely installed.

- C. Do not apply dampproofing to damp, frozen, dirty, or dusty surfaces.
- D. Beginning of application means acceptance of substrate.

### 3.2 PREPARATION

- A. Protect adjacent surfaces not designated to receive dampproofing.
- B. Clean and prepare surfaces to receive dampproofing in accordance with manufacturer's instructions.
- C. Do not apply dampproofing to surfaces unacceptable to manufacturer or applicator.

### 3.3 APPLICATION

- A. Prime surfaces in accordance with manufacturer's instructions.
- B. Apply cold bitumen by spray application.
- C. Apply bitumen in accordance with manufacturer's instructions.
- D. Apply dampproofing coating at a continuous, uniform rate of 30 to 35 square feet per gallon.
- E. Fill cracks, crevices, and grooves making sure coating is continuous and free from breaks and pinholes.
- F. Apply from 2" below finish grade elevation to top of footings.
- G. Seal items projecting through dampproofing surface with mastic. Seal watertight.

### 3.4 PROTECTION

- A. In event of rain, provide protection while application is in progress and until coating has set.
- B. Do not backfill within 48 hours after application. When possible, backfill within a 7-day period.
- C. Protect membrane from damage by adhering insulation board over dampproofing surface. Neatly fit protective insulation boards tight around pipe and other projections.

END OF SECTION 071100

## SECTION 072100 – THERMAL INSULATION

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Rigid cellular plastic board insulation.
- B. Fiberglass sound control insulation.
- C. Adhesive materials and accessories.

#### 1.2 RELATED REQUIREMENTS

- A. Section 071100 - Dampproofing
- B. Section 072114 – Metal Faced Insulated Sheathing
- C. Section 072129 – Sprayed Foam Thermal Insulation
- D. Section 092116 - Gypsum Board Assemblies: Acoustical insulation in walls.

#### 1.3 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Site bearing original labels.
- B. Store materials as recommended by manufacturer in dry, enclosed area free from contact with soil and weather.
- C. Handle materials in a manner to prevent damage.

### PART 2 - PRODUCTS

#### 2.1 INSULATION MATERIALS

- A. Rigid board insulation:
  - 1. Type: Extruded polystyrene (XPS) meeting ASTM C 578, Type IV.
  - 2. Minimum compressive strength: 24 psi (165 kPa), ASTM D1621.
  - 3. Water absorption by volume: 0.1% maximum, ASTM C272.
  - 4. Foam blowing agent shall provide at least 90% reduction in ozone depletion potential as compared with standard CFC blowing agents and shall be certified by foam manufacturer.
  - 5. R-value: 5.0°F-ft<sup>2</sup>-h/Btu per inch, minimum, at 75°F (24°C) mean temperature, ASTM C518 and warranted by manufacturer to retain at least 90% of its published R-value for 15 years.

6. Thickness, at foundation walls: As indicated on Drawings.

B. Fiberglass sound control insulation:

1. Type: Preformed fiberglass batts, ASTM C665, Type I, and fire hazard classification in accordance with ASTM E84.
2. Thickness: 2-3/4" (69 mm) at 2x4 framed walls; 4" (100 mm) at 2x6 framed walls.
3. Use: Sound control insulation in stud walls where shown on Drawings.

## 2.2 ADHESIVE MATERIALS

A. Adhesive: Type recommended by insulation manufacturer for application.

## 2.3 ACCESSORIES

A. Nails or staples: Steel wire; electroplated or galvanized; type and size to suit application.

B. Tape: Type and size to suit application.

C. Protective covering: As recommended by manufacturer.

D. Insulation fasteners:

1. Impale clip type galvanized steel.
2. Adhere to or mechanically fasten to surface to receive rigid insulation.
3. Length to suit insulation thickness.
4. Capable of securely and rigidly fastening insulation in place.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Verify substrate and adjacent materials are dry and ready to receive insulation and adhesives.

B. Verify substrate surface is flat, free of honeycomb and fins, irregularities and materials that will impede adhesive bond.

C. Verify insulation boards are unbroken and free of damage.

D. Verify mechanical and electrical services within walls have been installed and tested.

### 3.2 INSTALLATION

A. Foundation perimeters:

1. Install boards on foundation perimeter with long dimension horizontal. Place boards in method to maximize contact bedding. Stagger joints. Butt edges and ends tight to adjacent board and to protrusions.

2. Immediately following installation of insulation boards, provide protective covering over insulation that will be exposed. Protection shall consist of 1/8" thick prefinished metal flashing.
- B. Fiberglass sound control insulation:
1. Install in accordance with manufacturer's instructions at locations shown on Drawings without gaps or voids.
  2. Trim insulation neatly to fit spaces. Use batts free of damage.
  3. Fit insulation tight in spaces and tight to exterior side of mechanical and electrical services within plane of insulation. Leave no gaps or voids.

END OF SECTION 072100

## SECTION 072114 - METAL FACED INSULATED SHEATHING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Metal faced insulated sheathing consisting of foamed-insulation-core panels and accessories.

#### 1.2 RELATED REQUIREMENTS

- A. Section 074646 - Fiber-Cement Siding.
- B. Section 076200 - Sheet Metal Flashing and Trim: For metal flashing components at openings and perimeter.

#### 1.3 REFERENCES

- A. Reference Standard Editions: Comply with requirements of specified standards edition cited in applicable building code, or if not cited in code, with requirements of edition current at time of issuing of specifications.
- B. American Society of Civil Engineers (ASCE): [www.asce.org/codes-standards](http://www.asce.org/codes-standards):
  - 1. ASCE 7 - Minimum Design Loads for Buildings and Other Structures
- C. ASTM International (ASTM): [www.astm.org](http://www.astm.org):
  - 1. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
  - 2. ASTM C 1363 - Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus
  - 3. ASTM E 72 - Test Methods of Conducting Strength Tests of Panels for Building Construction
  - 4. ASTM E 84 - Test Methods for Surface Burning Characteristics of Building Materials
  - 5. ASTM E 2357 - Standard Test Method for Determining Air Leakage of Air Barrier Assemblies
  - 6. ASTM E330 - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
  - 7. ASTM E 331 - Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference
  - 8. ASTM E 96 - Test Methods for Water Vapor Transmission of Materials
- D. National Fire Protection Association (NFPA): [www.nfpa.org](http://www.nfpa.org):
  - 1. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components

#### 1.4 PERFORMANCE REQUIREMENTS

- A. General: Provide metal faced insulated sheathing panel meeting the following performance requirements as determined by a qualified testing agency's application of specified tests on manufacturer's standard assemblies.
- B. Structural Performance: Provide metal faced insulated sheathing panel to withstand effects of indicated loads and stresses within limits and under conditions indicated, when tested per ASTM E 72.
  - 1. Wind Load Test: Determine loads based on uniform pressure indicated on the drawings.
  - 2. Deflection Limits Test: Withstand test pressures of 150 percent of inward and outward wind-load design pressures with maximum deflection of 1/120 of the span with no evidence of failure.
  - 3. Seismic Performance Test: Comply with ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Sections 11 - 23, "Seismic".
- C. Air Infiltration Test: Maximum 0.01 cfm/sq. ft. (.0038 cfm/ft<sup>2</sup> or 0.019 L/s per sq. m) per ASTM E 2357 at a static-air-pressure difference of 1.57 lbs/ft<sup>2</sup> (@75 Pa).
- D. Water Penetration Test: No uncontrolled water penetration at a static pressure of 15 lb./sq. ft. (0.7 kPa) per ASTM E 331.
- E. Thermal Performance Test: Thermal Resistance (R-value) indicated, per ASTM C 1363, corrected to 15 mph (24.1 k/h) outside and still air inside, as-installed condition including fastening and joints. (2" - R-11, U= .088 or 2.75" - R-16, U= .062)
- F. Vapor Performance Test: .011 gn/h/ft<sup>2</sup> inHg (Note 1 perm = 1 gr) per ASTM E 96.
- G. Fire-Test-Response Characteristics: Provide metal wall backup panel system with the following fire-test-response characteristics determined by the indicated test standard as applied by UL or other testing and inspection agency acceptable to authorities having jurisdiction.
  - 1. Surface Burning Characteristics: Not greater than the following, per ASTM E 84, for foam core and interior surface:
    - a. Flame spread index: 25 or less.
    - b. Smoke developed index: 450 or less.
  - 2. Intermediate Scale Multistory Fire Test: Representative mockup tested per NFPA 285.

#### 1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer listed in this Section or approved for project with minimum 5 years of experience in the manufacture of similar products in successful use in similar applications.
  - 1. Approval of Comparable Products: Submit the following in accordance with project substitution requirements, within the time allowed for substitution review:

- a. Product data, including certified independent test data indicating compliance with requirements.
    - b. Samples of each component.
    - c. Sample submittal from similar project.
    - d. Project references: Minimum of 5 installations not less than 5 years old, with owner contact information.
    - e. Sample warranty.
  - 2. Substitutions following award of contract are not allowed except as stipulated in Division 01 General Requirements.
  - 3. Approved manufacturers must meet separate requirements of Submittals Article.
- B. Installer Qualifications: Experienced Installer with minimum of 5 successful completed projects of similar materials and scope and employing workers trained by manufacturer to install products of this section.
- 1.6 ADMINISTRATIVE REQUIREMENTS
- A. Coordination: Coordinate the installation of metal wall backup panel system structural support and exterior wall cladding panels.
- 1.7 ACTION SUBMITTALS
- A. Product Data: Manufacturer's data sheets for metal wall backup panels and accessories.
- 1.8 INFORMATIONAL SUBMITTALS
- A. Product Literature: Indicating compliance of products with requirements, from a qualified independent testing agency.
- 1.9 CLOSEOUT SUBMITTALS
- A. Maintenance data.
- 1.10 DELIVERY, STORAGE, AND HANDLING
- A. Protect metal faced insulated sheathing panels during shipping, handling, and storage to prevent staining, denting, or other visible damage. Deliver, unload, store, and erect metal faced insulated sheathing panels without misshaping panels or exposing panels to surface damage from weather or construction operations. Protect from exposure to sunlight.
- 1.11 WARRANTY
- A. Manufacturer's Warranty: On manufacturer's standard form, in which manufacturer agrees to repair or replace metal wall backup panel assemblies that fail in materials and workmanship or due to exposure within 2 years from the date of substantial completion.
- B. Exposure Warranty: Metal faced insulated sheathing panels shall not deteriorate due to exposure to normal weather conditions for a period of 6 months commencing with the date of installation of the product in such structure. As part of normal installation metal faced insulated sheathing panels must be taped at the time of installation for exposure warranty to be in effect.

## PART 2 - PRODUCTS

### 2.1 SYSTEM DESCRIPTION

- A. Metal Faced Insulated Sheathing Panel: Sheathing panel installation consisting of foamed-insulation-core metal-faced wall panels and accessories, attached to metal stud framing with specified fasteners, serving as combined thermal, air, and moisture barrier and support for metal wall panel rainscreen cladding or other as specified in another section.

### 2.2 MANUFACTURERS

- A. Basis of Design: TetraShield Insulated Sheathing. Provide basis of design product or comparable products of other manufacturer approved by Architect in accordance with Instructions to Bidders and Division 01 General Requirements.

1. CENTRIA Architectural Systems; Moon Township PA 15108-2944; (800)759-7474; (412)299-8000; [info@CENTRIA.com](mailto:info@CENTRIA.com); [www.CENTRIA.com](http://www.CENTRIA.com).

- B. Single Source: Obtain metal faced sheathing panels through one source from a single approved manufacturer.

### 2.3 METAL FACED INSULATED SHEATHING PANELS

- A. Metal Faced Insulated Sheathing Panels: Foamed-insulation-core metal-faced panels with interlocking side joint and butted end joints. Produced in factory with metal facings bonded to foamed-in-place core.

1. Basis of Design Product: TetraShield Metal Faced Insulated Sheathing Panel.

- B. Panel Faces: 0.019-inch/26-ga. thick metallic-coated steel sheet: ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality.

- C. Panel Core: Foamed-in-place modified polyisocyanurate, closed-cell, CFC and HCFC free, with minimum density of 2.4 lb./cu. ft. and minimum compressive strength of 15 lb./sq. in.

- D. Horizontal Metal Faced Insulated Sheathing Panel Thickness and Thermal Resistance: 2-3/4" inches; R-16.

- E. Panel Width: 36 inches.

### 2.4 METAL WALL BACKUP PANEL ACCESSORIES

- A. Subgirts: Metallic-coated steel sheet, ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality, 0.054-inch/16-gage thick.

- B. Self-Adhering Sheet Flashing: Minimum 25-mil modified bituminous sheet, recommended by panel manufacturer for application.

- C. Fasteners: Corrosion-resistant, pancake head carbon steel #3 square drive screws and other fasteners as recommended by panel manufacturer for application.

## 2.5 FABRICATION

- A. General: Fabricate metal faced insulated sheathing panels at the factory, using manufacturer's standard procedures and processes identical to tested units and as necessary to meet performance requirements.
  - 1. Fabricate metal faced insulated sheathing panels with joints between panels designed to lock together.
  - 2. Factory form metal faced insulated sheathing panels in a continuous process with no glues or adhesives between dissimilar materials. Trim and square edges of sheets with no displacement of face sheets or protrusion of core material.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine building structure with Installer present. Inspect for erection tolerances and other conditions that would adversely affect installation.
- B. Wall Structure: Confirm that wall structure is within tolerances acceptable to metal faced insulated sheathing panel manufacturer.
  - 1. Maximum deviations acceptable:
    - a. 3/8 inch in any 20-foot length vertically or horizontally from the framing face plane.
    - b. 3/4 inch maximum deviation from the framing face plane on any building elevation.
- C. Framing: Inspect framing that will support metal faced insulated sheathing panel to determine if support components are installed as indicated on approved shop drawings.
- D. Advise General Contractor, in writing, of out-of-tolerance work and other deficient conditions prior to proceeding with metal wall panel system installation.
- E. Correct out of tolerance work and other deficient conditions prior to proceeding with metal faced insulated sheathing panel installation.

### 3.2 METAL FACED INSULATED SHEATHING PANEL INSTALLATION

- A. General: Install metal faced insulated sheathing panel in accordance with approved shop drawings and manufacturer's recommendations.
- B. Installation: Attach backup panels to supports at each panel connection point indicated on approved shop drawings.
  - 1. Install with drain plane of panel facing weather side of installation.
  - 2. Fasten metal faced insulated sheathing panels to building framing with fasteners and tape provided by manufacturer utilizing recommended fasteners.
  - 3. Horizontal Joint: Working from base to top of metal faced insulated sheathing panel installation, engage upper panel over lower panel to form a locked joint oriented to allow gravity drainage.
    - a. Tape horizontal joint

4. Vertical Joint:

- a. Install vertical butt joints tight with no gap, set against continuous supports.
- b. Seal butt joints between adjacent panels with a continuous strip of self-adhering flashing.

3.3 ERECTION TOLERANCES

- A. Installation Tolerances: Align metal faced insulated sheathing panel within installed tolerance of 1/4 inch in 20 feet, noncumulative, on level and plumb and location lines as indicated and within 1/8 inch offset of adjoining faces and of alignment of matching profiles.

END OF SECTION 072114

## SECTION 072129 - SPRAYED FOAM THERMAL INSULATION

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Sprayed on polyurethane foam insulation for building construction.
- B. Work shall include materials, equipment, labor, and services required to install insulation system.

#### 1.02 RELATED REQUIREMENTS

- A. Electrical, plumbing, and mechanical penetrations shall be completed prior to application. Clips, hangers, supports, sleeves, and other attachments to substrate shall be installed by other trades prior to application.
- B. Ducts, conduit, piping, and other equipment shall not be installed until after application of sprayed insulation system.

#### 1.03 QUALITY ASSURANCE

- A. Contractor shall use total system, including ignition barrier.

#### 1.04 SUBMITTALS

- A. Product Data:
  - 1. Manufacturer's certificate that product meets or exceeds specified requirements.
  - 2. Manufacturer's literature.
  - 3. Manufacturer's written certification that product contains no asbestos, fiberglass, or other man-made mineral fibers.

#### 1.05 DELIVERY, STORAGE, AND HANDLING

- A. Materials shall be delivered in original, unopened containers bearing name of manufacturer, and product identification.
- B. Store materials off ground in dry location.
- C. Protect foam products and adhesive from freezing.

#### 1.06 ENVIRONMENTAL CONDITIONS

- A. Work shall be performed under conditions stated in manufacturer's printed applications instructions.
- B. Provide sufficient heat and ventilation during installation and drying of sprayed insulation.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

- A. Foametix, Inc.
- B. Johns Manville Insulations.
- C. System referenced in this Section is manufactured by Johns Manville Insulations.

### 2.02 MATERIALS

- A. Type: Closed cell spray-applied polyurethane foam and spray-applied ignition barrier.
- B. Thickness: As indicated on Drawings.
- C. Thermal testing in accordance with ASTM C518:
  - 1. R value: 6.4 per inch.
  - 2. K-factor: 0.16 per inch.
- D. Fire hazard in accordance with ASTM E84:
  - 1. Flame spread: 25.
  - 2. Smoke developed: 450.
- E. Ignition barrier coating: Water-based intumescent coating.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Examine surfaces and conditions to which work of this Section is to be applied. Ensure they are adequate to provide satisfactory application of specified materials. Report deficiencies to Engineer.
- B. Location: Where shown on Drawings.

### 3.02 PREPARATION

- A. Remove dust, dirt, foreign material, loose paint, etc. on surfaces to which work is to be applied, which could otherwise create false bond or staining of insulation. Clean and seal as required.
- B. Verify bond requirements and compatibility of surfaces to receive thermal insulation materials.
- C. Ensure ducts, piping, equipment, or other items which would interfere with application of thermal insulation are not positioned until thermal insulation work is completed.

### 3.03 APPLICATION

- A. Mix and apply thermal insulation in strict accordance with manufacturer's recommendations.
- B. Bonding adhesive, if required, shall be mixed with fresh, clean potable water to exact proportions recommended by manufacturer.
- C. Apply insulation to substrate in sufficient thickness to achieve required thermal value.
- D. Apply ignition barrier coating in accordance with manufacturer's instructions.

3.04 CLEANUP

- A. Remove overspray from equipment and surfaces not intended to be covered. Perform removal work while installed product is still wet.
- B. Remove sprayed thermal insulation from material and surfaces not specifically required to be insulated.
- C. Broom clean work areas affected by work of this Section.

END OF SECTION 072129

## SECTION 072616 – BELOW-GRADE VAPOR RETARDERS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Under-slab vapor barrier.
- B. Seam Tape, Pipe Boots, and Mastic for installation under concrete slabs.
- C. Under-slab insulation board.

#### 1.2 RELATED REQUIREMENTS

- A. Section 033000 – Cast-In-Place Concrete

#### 1.3 REFERENCES

- A. ASTM D882 – Test Method for Tensile Properties of Thin Plastic Sheeting
- B. ASTM D1434 – Standard Test Method for Determining Gas Permeability Characteristics of Plastic Film and Sheeting
- C. ASTM D1709 – Test Method for Impact Resistance of Plastic Film by Free-Falling Dart Method
- D. ASTM D4833 – Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products
- E. ASTM E154 – Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover
- F. ASTM E1745 Class A, B & C – Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs
- G. ASTM F1249 – Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Product Data:
  - 1. Submit manufacturer's Product Data, installation instructions, use limitations and recommendations.
  - 2. Submit certification of data indicating Volatile Organic Compound (VOC) content of components of waterproofing system.

- B. Samples: Submit (3) 8.5 inch x 11 inch samples of specified vapor barrier.

#### 1.5 QUALITY ASSURANCE

- A. Installer: Firm which has at least 3 years of experience in work of type required by this Section.
- B. Materials: For each type of material required for work of this Section, provide primary materials which are products of one manufacturer.
- C. Manufacturer's representative: Contractor must arrange to have trained employee of manufacturer on Site periodically during membrane waterproofing work to review installation procedures.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Site in manufacturer's original, sealed containers bearing original labels.
- B. Store materials as recommended by manufacturer in enclosed area free from contact with soil and weather. Maintain materials at not less than 50°F (10°C) for at least 24 hours before use.
- C. Handle materials in a manner to prevent damage. Remove damaged materials from Site and replace with new specified materials.

#### 1.7 ENVIRONMENTAL REQUIREMENTS

- A. Apply waterproofing system in fair weather when air and surface temperatures are between 40°F (4°C) and 75°F (24°C).

#### 1.8 WARRANTY

- A. Sheet membrane waterproofing: Provide written 20 year, minimum, material warranty issued by membrane manufacturer upon completion of Work.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Stego Industries, LLC., 216 Avenue Fabricante, Suite 101, San Clemente, CA 92672. Phone (877)464-7834. [www.stegoindustries.com](http://www.stegoindustries.com).
- B. W.R. Meadows, P.O. Box 338, Hampshire, IL 60140-0338. Phone (800)342-5976. [www.wrmeadows.com](http://www.wrmeadows.com).
- C. ISI Building Products, 401 Truck Haven Road, East Peoria, IL 61611. Phone (855)698-6562. [www.viper2.com](http://www.viper2.com).

## 2.2 MATERIALS

### A. Qualities:

1. Permeance: Less than 0.006 perms per ASTM F1249.
2. Permeance: Less than 0.006 perms after conditioning when tested to ASTM E154 (ASTM E1745 Sections 7.1.2 - 7.1.15).
3. Puncture Resistance-not less than 3,000 grams per ASTM D1709, Method B.
4. ASTM E1745 "Class A".
5. Minimum 15 MIL thick.

### B. Vapor Barrier Membrane: Supply one of the following from a single source:

1. STEGO WRAP 15 MIL – Stego Industries, LLC.
2. PERMINATOR 15 MIL – W.R. Meadows
3. VIPER VAPORCHECK II 15 MIL – ISI Building Products
4. Or approved equal.

## 2.3 ACCESSORIES

### A. Accessories manufactured by Stego Industries, LLC, unless noted otherwise.

### B. Seam Tape: Permeance less than 0.1 perms per ASTM F1249 or E96.

1. "STEGO TAPE " or approved equal.

### C. Pipe Boot: Permeance less than 0.01 perms per ASTM F1249 or E96.

1. "STEGO PRE-CUT PIPE BOOTS" or approved equal.

### D. Vapor Proofing Mastic: Permeance less than 0.2 perms per ASTM E96.

1. "STEGO MASTIC" or approved equal.

### E. Perimeter Tape (Wet Application): For use to seal vapor barrier membrane to perimeter of slab while the concrete is place. Permeance less than 0.05 perms. Adhesion peel strength - 16 lbf/in. per ASTM D903. Sheer Adhesion Strength – 49 lbf/in.

1. "STEGO CRETE CLAW TAPE 3"" or approved equal.

### F. Perimeter Tape (Dry Application): For use to seal vapor barrier membrane to perimeter of slab after the concrete has cured. Permeance less than 0.05 perms.

1. "STEGOTACK TAPE" or approved equal.

### G. Under-slab insulation board: For vertical (slab edge) application, adhere to waterproofing membrane with "Stego Mastic" by Stego Industries, LLC.

1. Qualities: 2" (50mm) thick extruded polystyrene
  - a. Normal density: 1.0 lb/ft<sup>3</sup> (16 kg/m<sup>3</sup>).
  - b. Thermal conductivity, K factor: 0.24 at 40°F (5°C), 0.26 at 75°F (24°C).

- c. Thermal resistance, R-value: 5 per 1" (25 mm) of thickness.
2. Product: "FOAMULAR 400" XPS insulation by Owens Corning.

### PART 3 - EXECUTION

#### 3.1 PREPARATION

- A. Installer shall examine conditions of substrates and other conditions under which Work shall be performed and notify Contractor, in writing, of circumstances detrimental to proper completion of Work. Do not proceed with Work until unsatisfactory conditions are corrected.

#### 3.2 INSTALLATION

- A. Install under-slab insulation board per manufacturer's installation instructions.
  1. Stagger seams by at least 40%.
  2. Tape seams per manufacturer's instructions.
  3. Install vertical insulation with mastic at slab edges prior to backfilling.
- B. Install under-slab vapor barrier in accordance with ASTM E1643 and manufacturer's instructions.
  1. Unroll vapor barrier with the longest dimensions parallel with the direction of the concrete pour.
  2. Lap vapor barrier up sides of slab edge formwork and either apply "wet application" perimeter tape or secure to formwork for future installation of "dry application" perimeter tape.
  3. Overlap seams a minimum of 6-inches and seal with seam tape.
  4. Seal penetrations per manufacturer's instructions.
  5. Manufacturer's representative shall inspect the vapor barrier installation prior to pouring concrete slab.
  6. Patch damaged areas per manufacturer's instructions.

#### 3.3 CLEANING AND PROTECTION

- A. Protect completed membrane waterproofing from subsequent construction activities as recommended by manufacturer.

END OF SECTION 072616

## SECTION 074646 – FIBER-CEMENT SIDING

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Factory-finished fiber cement lap siding, panels, shingle, trim, fascia, molding, and accessories; James Hardie HZ5 Engineered for Climate Siding.

#### 1.2 RELATED SECTIONS

- A. Section 061000 - Rough Carpentry.
- B. Section 061200 - Structural Insulated Panels.

#### 1.3 REFERENCES

- A. ASTM C1186 - Standard Specification for Flat Fiber-Cement Sheets
- B. ASTM D3359 - Standard Test Method for Measuring Adhesion by Tape Test, Tool and Tape.
- C. ASTM E136 - Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 degrees C.

#### 1.4 SUBMITTALS

- A. Submit under provisions of contract.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
  - 1. Preparation instructions and recommendations.
  - 2. Storage and handling requirements and recommendations.
  - 3. Installation methods.
- C. Shop Drawings: Provide detailed drawings of atypical non-standard applications of cementitious siding materials which are outside the scope of the standard details and specifications provided by the manufacturer.
- D. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.
- E. Verification Samples: For each finish product specified, two samples, minimum size 4" x 6" (100 mm x 150 mm), representing actual product, color, and patterns.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Minimum of 2 years of experience with installation of similar products.
- B. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
  - 1. Finish areas designated by Owner or Owner's Representative.
  - 2. Do not proceed with remaining work until workmanship, color, and sheen are

- approved by Owner or Owner's Representative.
3. Refinish mock-up area as required to produce acceptable work.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store siding on edge or lay flat on a smooth level surface. Protect edges and corners from chipping. Store sheets under cover and keep dry prior to installing.
- C. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

## 1.7 PROJECT CONDITIONS

- A. 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.

## 1.8 WARRANTY

- A. Product Warranty: Limited, non-pro-rated product warranty.
  1. HardiePlank HZ5 lap siding for 30 years.
  2. HardiPanel HZ5 vertical siding for 30 years.
  3. HardieSoffit HZ5 panels for 30 years.
- B. Product Warranty: Limited, product warranty.
  1. HardieTrim HZ and HZ5 boards for 15 years.
- C. Finish Warranty: Limited product warranty against manufacturing finish defects.
  1. When used for its intended purpose, properly installed and maintained according to James Hardie's published installation instructions, James Hardie's ColorPlus finish with ColorPlus Technology, for a period of 15 years from the date of purchase: will not peel; will not crack; and will not chip. Finish warranty includes the coverage for labor and material.
- D. Workmanship Warranty: Application limited warranty for 2 years.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Basis of Design: James Hardie Building Products, Inc., 26300 La Alameda Suite 400 ; Mission Viejo, CA 92691; Toll Free Tel: 866-274-3464; Email: [request info \(info@jameshardie.com\)](mailto:info@jameshardie.com); Web: [www.jameshardiepros.com](http://www.jameshardiepros.com).
- B. Or approved equal.

### 2.2 SIDING

- A. HardiePlank HZ5 lap siding, HardiPanel HZ5 vertical siding, HardieSoffit HZ5 panels requirement for Materials:
  1. Fiber-cement Siding - complies with ASTM C 1186 Type A Grade II.
  2. Fiber-cement Siding - complies with ASTM E 136 as a noncombustible material.

3. Fiber-cement Siding - complies with ASTM E 84 Flame Spread Index = 0, Smoke Developed Index = 5.
  4. CAL-FIRE, Fire Engineering Division Building Materials Listing - Wildland Urban Interface (WUI) Listed Product.
  5. National Evaluation Report No. NER 405 (BOCA, ICBO, SBCCI, IBC, IRC).
  6. US Department of Housing and Urban Development Materials Release 1263d.
- B. Lap Siding: HardiePlank HZ5 Lap siding with a sloped top, beveled drip edge and nailing line as manufactured by James Hardie Building Products, Inc.
1. Type: Select Cedarmill 8¼" (210 mm) with 7 inches (178 mm) exposure.
- C. Vertical Siding: HardiePanel HZ5 siding as manufactured by James Hardie Building Products, Inc.
1. Type: Cedarmill Vertical siding panel 4 feet by 10 feet (1219 mm by 3048 mm).
- D. Trim:
1. HardieTrim HZ5 boards and HardieTrim HZ boards as manufactured by James Hardie Building Products, Inc.
  2. HardieTrim HZ5 Fascia boards as manufactured by James Hardie Building Products, Inc.
  3. HardieTrim HZ5 boards as manufactured by James Hardie Building Products, Inc.
    - a. Product: Batten Boards, 2½" (63 mm) width.
    - b. Texture: Wood Grained.
    - c. Length: 12 feet (3658 mm).
    - d. Thickness: ¾" (19 mm).

## 2.3 FASTENERS

- A. Wood Framing Fasteners:
1. Wood Framing: 4d common corrosion resistant nails.
  2. Wood Framing: 6d common corrosion resistant nails.
  3. Wood Framing: 8d box ring common corrosion resistant nails.
  4. Wood Framing: 0.089 inch (2.2 mm) shank by 0.221 inch (5.6 mm) head by 2" (51 mm) corrosion resistant siding nails.
  5. Wood Framing: 0.093 inch (2.4 mm) shank by 0.222 inch (5.6 mm) head by 2" (51 mm) corrosion resistant siding nails.
  6. Wood Framing: 0.093 inch (2.4 mm) shank by 0.222 inch (5.6 mm) head by 2 ½" (64 mm) corrosion resistant siding nails.
  7. Wood Framing: 0.091 inch (2.3 mm) shank by 0.221 inch (5.6 mm) head by 1½" (38 mm) corrosion resistant siding nails.
  8. Wood Framing: 0.091 inch (2.3 mm) shank by 0.225 inch (5.7 mm) head by 1½" (38 mm) corrosion resistant siding nails.
  9. Wood Framing: 0.121 inch (3 mm) shank by 0.371 inch (9.4 mm) head by 1¼" (32 mm) corrosion resistant roofing nails.
  10. Wood Framing: No. 11 gauge 1¼" (32 mm) corrosion resistant roofing nails.
  11. Wood Framing: No. 11 gauge 1½" (38 mm) corrosion resistant roofing nails.
  12. Wood Framing: No. 11 gauge 1¾" (44 mm) corrosion resistant roofing nails.

## 2.4 FINISHES

- A. Factory Finish: Refer to Exterior Finish Schedule.
  - 1. Product: ColorPlus Technology by James Hardie.
  - 2. Definition: Factory applied finish; defined as a finish applied in the same facility and company that manufactures the siding substrate.
  - 3. Process:
    - a. Factory applied finish by fiber cement manufacturer in a controlled environment within the fiber cement manufacturer's own facility utilizing a multi-coat, heat cured finish within one manufacturing process.
    - b. Each finish color must have documented color match to delta E of 0.5 or better between product lines, manufacturing lots or production runs as measured by photospectrometer and verified by third party.
  - 4. Protection: Factory applied finish protection such as plastic laminate that is removed once siding is installed
  - 5. Accessories: Complete finishing system includes pre-packaged touch-up kit provided by fiber cement manufacturer. Provide quantities as recommended by manufacturer.
  
- B. Factory Finish Color for Trim, Soffit and Siding Colors:
  - 1. Trim and Soffit: Selected by Owner from manufacturer's standard colors.
  - 2. Vertical Siding and Batten Board: Selected by Owner from manufacturer's standard colors.
  - 3. Lap Siding: Selected by Owner from manufacturer's standard colors.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If framing preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- C. Nominal 2" x 4" (51 mm by 102 mm) wood framing selected for minimal shrinkage and complying with local building codes, including the use of water-resistive barriers or vapor barriers where required. Minimum 1½" (38 mm) face and straight, true, of uniform dimensions and properly aligned.
  - 1. Install water-resistive barriers and claddings to dry surfaces.
  - 2. Repair any punctures or tears in the water-resistive barrier prior to the installation of the siding.
  - 3. Protect siding from other trades.

### 3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Install a water-resistive barrier as required in accordance with local building code requirements.
- D. The water-resistive barrier must be appropriately installed with penetration and junction flashing in accordance with local building code requirements.

- E. Install Engineered for Climate HardieWrap weather barrier in accordance with local building code requirements.
- F. Use HardieWrap Seam Tape and joint and laps.
- G. Install HardieWrap flashing, HardieWrap Flex Flashing, and prefinished metal flashing where shown on drawings – color to be selected by Architect from standard colors.

### 3.3 INSTALLATION - HARDIEPLANK HZ5 LAP SIDING

- A. Install materials in strict accordance with manufacturer's installation instructions.
- B. Starting: Install a minimum ¼” (6 mm) thick lath starter strip at the bottom course of the wall. Apply planks horizontally with minimum 1¼” (32 mm) wide laps at the top. The bottom edge of the first plank overlaps the starter strip.
- C. Allow minimum vertical clearance between the edge of siding and any other material in strict accordance with the manufacturer's installation instructions.
- D. Align vertical joints of the planks over framing members.
- E. Maintain clearance between siding and adjacent finished grade.
- F. Locate splices at least one stud cavity away from window and door openings.
- G. Wind Resistance: Where a specified level of wind resistance is required Hardieplank lap siding is installed to framing members and secured with fasteners described in Table No. 2 in National Evaluation Service Report No. NER-405.
- H. Locate splices at least 12 inches (305 mm) away from window and door openings.

### 3.4 INSTALLATION - HARDIEPANEL HZ5 VERTICAL SIDING

- A. Install materials in strict accordance with manufacturer's installation instructions.
- B. Block framing between studs where HardiePanel siding horizontal joints occur.
- C. Install metal Z flashing and provide a ¼” (6 mm) gap at horizontal panel joints.
- D. Place fasteners no closer than 3/8” (9.5 mm) from panel edges and 2” (51 mm) from panel corners.
- E. Allow minimum vertical clearance between the edge of siding and any other material in strict accordance with the manufacturer's installation instructions.
- F. Maintain clearance between siding and adjacent finished grade.
- G. Specific framing and fastener requirements refer to Tables 2 and 3 in National Evaluation Service Report No. NER-405.
- H. Factory Finish Touch Up: Apply touch up paint to cut edges in accordance with manufacturer's printed instructions.
  - 1. Touch-up nicks, scrapes, and nail heads in pre-finished siding using the manufacturer's touch-up kit pen.
  - 2. Touch-up of nails shall be performed after application, but before plastic protection

- wrap is removed to prevent spotting of touch-up finish.
3. Use touch-up paint sparingly. If large areas require touch-up, replace the damaged area with new pre-finished siding. Match touch-up color to siding color through use of manufacturer's branded touch-up kits.

### 3.5 INSTALLATION - HARDIETRIM HZ5 BOARDS

- A. Install materials in strict accordance with manufacturer's installation instructions. Install flashing around all wall openings.
- B. Fasten through trim into structural framing or code complying sheathing. Fasteners must penetrate minimum  $\frac{3}{4}$ " (19 mm) or full thickness of sheathing. Additional fasteners may be required to ensure adequate security.
- C. Place fasteners no closer than  $\frac{3}{4}$ " (19 mm) and no further than 2" (51 mm) from side edge of trim board and no closer than 1" (25 mm) from end. Fasten maximum 16 inches (406 mm) on center.
- D. Maintain clearance between trim and adjacent finished grade.
- E. Trim inside corner with a single board trim both side of corner.
- F. Outside Corner Board: Attach Trim on both sides of corner with 16 gage corrosion resistant finish nail  $\frac{1}{2}$ " (13 mm) from edge spaced 16 inches (406 mm) apart, weather cut each end spaced minimum 12 inches (305 mm) apart.
- G. Allow  $\frac{1}{8}$ " gap between trim and siding.
- H. Seal gap with high quality, paint-able caulk.
- I. Shim frieze board as required to align with corner trim.
- J. Fasten through overlapping boards. Do not nail between lap joints.
- K. Overlay siding with single board of outside corner board then align second corner board to outside edge of first corner board. Do not fasten HardieTrim boards to HardieTrim boards.
- L. Shim frieze board as required to align with corner trim.
- M. Install HardieTrim Fascia boards to rafter tails or to sub fascia.

### 3.6 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 074646

## SECTION 076100 – SHEET METAL ROOFING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Standing seam metal panel roof assembly, including: metal roof panels, attachment components, related flashing, and accessory components required for a complete weathertight roofing system.
- B. Roof-mounted snow guards.
- C. Vent-through-roof flashing boots.

#### 1.2 RELATED REQUIREMENTS

- A. Section 061200 - Structural Insulated Panels
- B. Section 076200 – Sheet Metal Flashing and Trim.
- C. Section 079200 - Joint Sealants.

#### 1.3 REFERENCES

- A. ASTM A653 – (2019) Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
- B. ASTM A755 – (2018) Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products
- C. ASTM A792 – (2015) Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy Coated by the Hot-Dip Process
- D. ASTM D1014 – (2018) Standard Practice for Conducting Exterior Exposure Tests of Paintings and Coatings on Metal Substrates.
- E. ASTM D5796 – (2015) Standard Test Method for Measurement of Dry Film Thickness of Thin-Film Coil-Coated Systems by Destructive Means Using a Boring Device.
- F. ASTM E1592 – (2017) Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference.
- G. American Iron and Steel Institute (AISI) – Cold Formed Steel Design Manual
- H. SMACNA 1120 – (2012, 7<sup>th</sup> Edition) Architectural Sheet Metal Manual
- I. Underwriters' Laboratories (UL)

#### 1.4 SUBMITTALS

##### A. Informational:

1. Furnish detailed drawings showing profile and gauge of exterior sheets, location and type of fasteners, location, gauges, shape and method of attachment of all trim locations and types of sealants, and any other details as may be required for a weather-tight installation.
2. Provide (3) finish samples of each of the colors specified.

##### B. Action:

1. Shop drawings: Show fabrication and installation layouts of metal roof panels, details of edge conditions, side-seam joints, panel profiles, corners, anchorages, trim, flashings, closures and accessories, and special details. Distinguish between factory and field-assembled work.
2. Coordination Drawings: Roof plans, drawn to scale, on which the following are shown and coordinated with each other, based on input from installer of the items involved:
  - a. Roof panels and attachments
  - b. Roof-mounted items including snow guards and vent-thru-roof flashing boots.

#### 1.5 QUALITY ASSURANCE

- A. Manufacturer and erector shall demonstrate experience of a minimum of five (5) years in this type of project.
- B. Panels shall be factory-produced only. No portable, installer-owned, or installer-rented machines will be permitted.
- C. Factory-finished metal coating system shall carry a 20-year film and color life warranty.

#### 1.6 WARRANTIES

- A. Manufacturer's standard warranty.
- B. Finish warranty: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finish within specified warranty period.
  1. Exposed Panels Finish - deterioration includes 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 a paint to adhere to a bare metal.
  2. Warranty Period: 20 Years from the date of substantial completion.
- C. Applicator shall furnish written warranty for a two (2) year period from date of substantial completion of building covering repairs required to maintain roof and flashings in watertight condition.

## 1.7 DELIVERY, STORAGE AND HANDLING

- A. Ordering: Comply with manufacturer's ordering instruction and lead time requirements to avoid construction delays.
- B. Deliver components, sheets, metal roof panels and other manufactured items so as not to be damaged or deformed. Package metal roof panels for protection during transportation and handling.
- C. Unload, store and erect metal roof panels in a manner to prevent bending, warping, twisting and surface damage.
- D. Stack metal roof panels on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal roof panels to ensure dryness. Do not store metal roof panels in contact with other materials that might cause staining, denting or other surface damage.
- E. Protect strippable protective coating on any metal coated product from exposure to sunlight and high humidity, except to the extent necessary for material installation.

## 1.8 PROJECT CONDITIONS

- A. Weather Limitations: proceed with installation only when existing and forecasted weather conditions permit metal roof panel work to be performed.
- B. Field Measurements: Verify actual dimensions of construction contiguous with metal roof panels by field measurements before fabrication.

## 1.9 COORDINATION

- A. Coordinate sizes and locations of roof penetrations with actual equipment provided.
- B. Coordinate metal roof panels with rain drainage work, flashing, trim and other adjoining work to provide a leakproof, secure and noncorrosive installation.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Petersen Aluminum Corporation (PAC-CLAD), 1005 Tonne Road, Elk Grove Village, IL 60007. Phone (800)722-2523. [www.pac-clad.com](http://www.pac-clad.com), or approved equal.
- B. Products referenced in this Section are manufactured by Petersen Aluminum Corporation (PAC-CLAD), unless specified otherwise.

## 2.2 DESIGN REQUIREMENTS

- A. General Performance: Metal roof panels shall comply with performance requirements without failure due to defective manufacture, fabrication, installation, or other defects in construction.
- B. Loads: Provide exterior panel systems capable of resisting wind pressures acting both inward and outward as determined by International Building Code 2018 basic wind speed 110 mph, Risk Factor B, unless otherwise indicated.
- C. Water Penetration: When tested per ASTM E283/1680 and ASTM E331/1646 there shall be no uncontrolled water penetration or air infiltration through the panel joints.
- D. Wind Uplift: Roof-panel assembly shall comply with UL Standard 580 for UL Class 90 rated assemblies. Panel system shall comply with ASTM E1592 tested and approved.
- E. Impact Resistance: Roof panels shall meet UL Standard 2218.
- F. Fasteners holding together various elements of building panels shall be designed to withstand design load requirements set forth in these Specifications.
- G. System shall accommodate movement of components without buckling, failure of joint seals, undue stress on fasteners, or other detrimental effects, when subject to seasonal temperature ranges.

## 2.3 ROOF PANELS

- A. General: Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips inside laps. Include clips, cleats, pressure plates and accessories required for a weathertight installation.
- B. Roof panel: PAC-CLAD “Snap-Clad” Panels, uninsulated, standing-seam profile metal panel.
  - 1. Design: Smooth Panel, 22-gage G90 hot dipped galvanized steel.
    - a. Panels to be produced with Factory supplied hot melt mastic in the seams.
  - 2. Panel dimensions: 16" (400 mm) wide x 1<sup>3</sup>/<sub>4</sub>" (40 mm) high manufactured in continuous lengths.
  - 3. Panel attachment: Panels to be designed for attachment with concealed fastener clips, spaced as required by the manufacturer to provide for both positive and negative design loads, while allowing for the expansion and contraction of the entire roof system resulting from variations in temperature.
  - 4. Forming: Use continuous end rolling method. No end laps on panels. No portable roll-forming machines will be permitted on this project, no installer-owned or installer-rented machines will be permitted. It is the intent of the Architect to provide Factory-Manufactured panel systems only for this project.
  - 5. Color: Selected by Owner from manufacturer’s standard colors.
  - 6. Finish: Finish shall be Kynar 500 or Hylar 5000 Fluorocarbon coating with a top side film thickness of 0.70 to 0.90 mil over a 0.25 to 0.3 mil prime coat to provide a total dry film thickness of 0.95 to 1.25 mil, to meet AAMA 621. Bottom side shall be coated with a primer with a dry film thickness of 0.25 mil. Finish shall conform to all tests for

adhesions, flexibility and longevity as specified by Kynar 500 or Hylar 5000 finish supplier.

7. If strippable coating to be applied on the pre-finished panels to the top side to protect the finish during fabrication, shipping and handling, film shall be removed before installation.

C. Trim & Flashing:

1. Trim and flashing shall be fabricated of the same material and finish to match the profile and will be press broken in lengths of 10 to 12 feet.
2. Trim and flashing shall be formed only by the manufacturer of their approved dealer.
3. Trim to be erected in overlapped condition. Use lap strips only as indicated on drawings. Miter conditions shall be factory welded material to match the sheeting.

D. Closures: use composition or metal profiled closures at the top of each elevation to close ends of the panels. Metal closures to be made in the same material and finish as face sheet.

E. Fasteners: Fasteners shall be of type, material, size, corrosion resistance, holding power and other properties required to fasten miscellaneous framing members to substrates.

F. Roofing Underlayment:

1. On all surfaces to be covered with roofing material, furnish and install a 40 mil Peel & Stick membrane, required as outlined by metal panel manufacturer. Membrane to be a minimum of 40 mil thickness, smooth, non-granular, high temperature. Basis of design: Grace Construction Products (GCP) Ice & Water Shield HT High Temperature Protection Self Adhering Roofing Underlayment. Other acceptable manufacturers include:
  - a. Owens Corning Titanium PSU30
  - b. Carlisle CCW WIP 300HT
  - c. Owens Corning Titanium PSU
  - d. Tamko TW Tile and Metal Underlayment
2. Underlayment shall be laid in horizontal layers with joints lapped toward the eaves a minimum of 6, and well secured along laps and at ends as necessary to properly hold the felt in place. Underlayment shall be preserved unbroken and whole.
3. Peel and Stick Underlayment shall lap all hips and ridges at least 12 to form double thickness and shall be lapped 6 over the metal of any valley or built-in gutters and shall be installed as required by the Standing Seam Panel Manufacturer to attain the desired 20 Year Weathertightness Warranty.

G. Sealants:

1. Provide two-part polysulfide class B non-sag type for vertical and horizontal joints; or
2. One-part polysulfide not containing pitch or phenolic extenders; or
3. Exterior grade silicone sealant recommended by roofing manufacturer; or
4. One-part non-sag, gun grade exterior type polyurethane recommended by the roofing manufacturer.

H. Closure panels: Same material and finish as respective inside and outside elements of panels.

## 2.4 ACCESSORIES

- A. Snow Guards: PAC-CLAD “ColorGard Snow Retention System” with “S-5!” clamps, or approved equal.
  - 1. Provide (2) rows of snow guards spaced 48” oc starting 12” from roof edge.
- B. Vent-Through-Roof Flashing Boot:
  - 1. One-piece units that conform to metal roof system configuration and slope.
  - 2. Molded of weather resistant EPDM rubber with flexible aluminum ring base and stainless steel fasteners.
  - 3. Use for pipes from ¼” to 10” in diameter.
  - 4. -30°F to +250°F continuous temperature range.
  - 5. Product: Aztec Washer Company’s “35 Year Master Flash”, or approved equal. – Aztec Washer Company, 13821 Danielson St., Poway, CA 92064. Phone: (800)927-4375.  
[www.aztecwasher.com](http://www.aztecwasher.com)

## 2.5 FABRICATION

- A. Comply with dimensions, profile limitations, gauges and fabrication details shown and if not shown, provide manufacturer's standard product fabrication.
- B. Fabricate components of the system in factory, ready for field assembly.
- C. Fabricate components and assemble units to comply with fire performance requirements specified.
- D. Apply specified finishes in conformance with manufacturer's standard, and according to manufacturer's instructions.

## PART 3 - EXECUTION

### 3.1 INSPECTION

- A. Examine surfaces to receive metal panels and notify Owner in writing of any defects.
- B. Proceed with work only after unsatisfactory conditions have been corrected.
- C. Starting of work by Contractor shall constitute acceptance of work of others as satisfactory.

### 3.2 INSTALLATION

- A. Installation of metal panel system shall be performed under experienced supervision and in strict accordance with Shop Drawings and manufacturer's recommended procedures.

- B. Roof panels shall be set plumb and true to line as indicated on Drawings with work properly centered and well secured to adjoining construction, in such manner as to be rigid and watertight. Attachment to structure shall be by approved fastening method.
  - 1. Remove all strippable coating and provide a dry-wipe down cleaning of the panels as they are erected.
  - 2. Erect panels to a tolerance not exceeding 1/4" (6 mm) in runs of 20' (6 m).
  - 3. Fittings shall have required lap width to make work watertight.
  - 4. Limit use of exposed fasteners to extent indicated in manufacturer's data and instructions with fasteners driven and tightened full depth to head.
  - 5. Anchor component parts securely in place, providing for necessary thermal and structural movement without undue distortion or overstressing of any component.
- C. Install metal trim members, flashings, and similar accessory items straight and plumb, level and true, securely fastened, and sealed in place as recommended by panel manufacturer. Trim member lengths as practical, with joints concealed or located in unobjectionable places. Fittings shall have required lap width to make work watertight.
- D. Apply one (1) coat of bituminous paint, concealed, on one or both surfaces wherever dissimilar metals would otherwise be in contact to eliminate possibility of corrosive or electrolytic action between metals.
- E. Install sealants at joints and where sheets adjoin other work, as shown or required to achieve wind and watertight condition with work in accordance with manufacturer's recommendations.
  - 1. Make lap joints in flashing watertight with two (2) beads of sealant.

### 3.3 CLEANING

- A. After installation has been completed, Contractor shall thoroughly clean metal components, interior and exterior, exposed surfaces in a manner acceptable to Engineer. Cleaning procedures shall be in accordance with metal panel manufacturer's recommendations.
- B. Work that is damaged or defective shall be replaced at no additional cost to Owner.

### 3.4 PROTECTION

- A. Installed work shall be carefully protected against disfiguration, contamination, or damage by mechanical abuse or contact with other harmful materials. Wherever exposure to damage is critical, provide protective cover or barriers.

END OF SECTION 076100

## SECTION 076200 – SHEET METAL FLASHING AND TRIM

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Flashings.
- B. Gutters and downspouts.
- C. Miscellaneous closure and trim flashings.

#### 1.2 RELATED REQUIREMENTS

- A. Section 061000 - Rough Carpentry.
- B. Section 076100 – Sheet Metal Roofing
- C. Section 079200 - Joint Sealants.

#### 1.3 REFERENCES

- A. ASTM A653 – (2019) Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
- B. ASTM A755 – (2018) Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products
- C. ASTM A792 – (2015) Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy Coated by the Hot-Dip Process
- D. ASTM D1014 – (2018) Standard Practice for Conducting Exterior Exposure Tests of Paintings and Coatings on Metal Substrates.
- E. ASTM D5796 – (2015) Standard Test Method for Measurement of Dry Film Thickness of Thin-Film Coil-Coated Systems by Destructive Means Using a Boring Device.
- F. American Iron and Steel Institute (AISI) – Cold Formed Steel Design Manual
- G. SMACNA 1120 – (2012, 7<sup>th</sup> Edition) Architectural Sheet Metal Manual
- H. Underwriters' Laboratories (UL)

#### 1.4 SUBMITTALS

##### A. Informational:

1. Furnish detailed drawings showing profile and gauge of exterior sheets, location and type of fasteners, location, gauges, shape, and method of attachment of all trim locations and types of sealants, and any other details as may be required for a weather-tight installation.
2. Provide (3) finish samples of each of the colors specified.

##### B. Action:

1. Shop drawings: Show fabrication and installation layouts of metal roof panels, , details of edge conditions, side-seam joints, panel profiles, corners, anchorages, trim, flashings, closures and accessories, and special details. Distinguish between factory and field-assembled work.

#### 1.5 QUALITY ASSURANCE

A. Comply with Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA) "Architectural Sheet Metal Manual" recommendations for fabrication and installation of the work.

B. Factory-finished metal coating system shall carry a 20-year film and color life warranty.

#### 1.6 WARRANTY

A. Finish warranty: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finish within specified warranty period.

1. Exposed Panels Finish - deterioration includes 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 a paint to adhere to a bare metal.
2. Warranty Period: 20 Years from the date of substantial completion.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

A. Stack preformed and prefinished material to prevent twisting, bending, or abrasion, and to provide ventilation.

B. Prevent contact with materials during storage that may cause discoloration, staining, or damage.

## 1.8 PROJECT CONDITIONS

- A. Weather Limitations: proceed with installation only when existing and forecasted weather conditions permit sheet metal work to be performed.
- B. Field Measurements: Verify actual dimensions of construction contiguous with metal roof panels by field measurements before fabrication.

## 1.9 COORDINATION

- A. Coordinate sizes and locations of roof penetrations with actual equipment provided.
- B. Coordinate metal roof panels with rain drainage work, flashing, trim and other adjoining work to provide a leakproof, secure and noncorrosive installation.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Aluminum sheet: ASTM B209 Alloy 3003, temper as required for forming and performance, with factory-painted finish color, gage indicated.
- B. Galvanized steel sheet: ASTM A526, G90 commercial quality or ASTM A527, G90, lock-forming quality, hot-dip galvanized steel sheet with 0.20% copper, mill phosphatized where indicated for painting, not less than 0.0396" (1 mm) thick, unless otherwise indicated.
- C. Fasteners: Provide same metal as sheet metal or other noncorrosive compatible metal recommended by sheet metal manufacturer. Match finish of exposed heads with materials being fastened.
- D. Metal accessories: Provide sheet metal clips, straps, anchoring devices, and similar accessory units as required for installation of work, matching or compatible with material installed, non-corrosive, size and thickness as required for performance.

### 2.2 FLASHING

- A. Flashing: 24-gage (0.60 mm) galvanized.
- B. Color: To match adjacent materials and selected by Owner from manufacturer's standard colors.
- C. Finish: Finish shall be Kynar 500 or Hylar 5000 Fluorocarbon coating with a top side film thickness of 0.70 to 0.90 mil over a 0.25 to 0.3 mil prime coat to provide a total dry film thickness of 0.95 to 1.25 mil, to meet AAMA 621. Bottom side shall be coated with a primer with a dry film thickness of 0.25 mil. Finish shall conform to all tests for adhesions, flexibility and longevity as specified by Kynar 500 or Hylar 5000 finish supplier.

- D. Accessories: Provide as necessary, including prefabricated corners.
- E. Manufacturer: PAC-CLAD, or equal.

### 2.3 GUTTERS AND DOWNSPOUTS

- A. Type: Rectangular design.
- B. Size: As required by Code for Huron, South Dakota.
- C. Material: 24-gage (0.60 mm) galvanized steel.
- D. Color: Selected by Owner from manufacturer's standard colors.
- E. Accessories: Provide necessary clips, fasteners, hangers, and accessories.
- F. Finish: Finish shall be Kynar 500 or Hylar 5000 Fluorocarbon coating with a top side film thickness of 0.70 to 0.90 mil over a 0.25 to 0.3 mil prime coat to provide a total dry film thickness of 0.95 to 1.25 mil, to meet AAMA 621. Bottom side shall be coated with a primer with a dry film thickness of 0.25 mil. Finish shall conform to all tests for adhesions, flexibility and longevity as specified by Kynar 500 or Hylar 5000 finish supplier.

### 2.4 MISCELLANEOUS FLASHING & TRIM

- A. Type: Base flashing, wall corner trim, wall opening trim, and miscellaneous flashings as shown on Drawings.
- B. Material: 24-gage (0.60 mm) galvanized steel.
- C. Color: To match adjacent material and selected by Owner from manufacturer's standard colors.
- D. Finish: Finish shall be Kynar 500 or Hylar 5000 Fluorocarbon coating with a top side film thickness of 0.70 to 0.90 mil over a 0.25 to 0.3 mil prime coat to provide a total dry film thickness of 0.95 to 1.25 mil, to meet AAMA 621. Bottom side shall be coated with a primer with a dry film thickness of 0.25 mil. Finish shall conform to all tests for adhesions, flexibility and longevity as specified by Kynar 500 or Hylar 5000 finish supplier.

### 2.5 ACCESSORIES

- A. Fastener: Stainless steel or galvanized steel. Finish exposed fasteners same as adjacent construction.

### 2.6 FABRICATION

- A. Form sections true to shape, accurate in size, square, and free from distortion or defects.
- B. Hem exposed edges on underside ½" (13 mm); miter and seam corners.

## PART 3 - EXECUTION

### 3.1 INSPECTION

- A. Verify that roof openings, curbs, pipes, sleeves, or vents through roof are solidly set, and nailing strips located.
- B. Verify that membrane termination and base flashings are in place, sealed, and secure.
- C. Beginning installation means acceptance of existing conditions.

### 3.2 PREPARATION

- A. Field measure Site conditions prior to fabricating Work.
- B. Install starter and edge strips, and cleats before starting installation.
- C. Secure flashings in place using concealed fasteners where exposed to view.
- D. Fit flashings tight in place. Make corners square, surfaces true and straight in planes, and lines accurate to profiles.

### 3.3 INSTALLATION

- A. Surfaces to receive sheet metal shall be plumb and true, clean, even, smooth, dry and free from defects and projections that might affect application. Installation of items not shown in detail or not covered by Specifications shall meet applicable requirements of SMACNA Architectural Sheet Metal Manual.
- B. Neatly form seams straight throughout.
- C. Install flashings in manner to provide for expansion and contraction to provide weathertight joint and avoid straining of metal, joints, or fasteners.
- D. Surfaces to receive flashing shall be smooth, even, and free from defects. Remove dirt, mortar, and foreign objects from surfaces receiving flashing before installation.
- E. Drive nail heads flush with metal.
- F. Separate aluminum from contact with electrolytically dissimilar materials by 2 coats of alkali-resistant bituminous paint or zinc chromate primer on contact surfaces.
- G. Fasteners shall be compatible with type of metal fastened and capable of holding items securely in place.
- H. Where aluminum is to be installed directly on wood substrates, install course of slip-sheet and layer of underlayment.

- I. Separate sheet metal work from dissimilar metals and cementitious materials. Provide roofing felt underlayment and rosin-sized paper slip-sheet over treated wood surfaces.
- J. Provide bead of silicone sealant across lapped joints placed 1" (25 mm) from exposed edge of joint.

#### 3.4 CLEANING

- A. Remove strippable film protection coating and clean exposed prefinished metal surfaces. Touch-up exposed edges and damaged coated surfaces with manufacturer's color matched touch-up paint.
- B. Clean exposed metal surfaces. Remove substances that may cause corrosion of metal and deterioration of finishes.

END OF SECTION 076200

## SECTION 079200 – JOINT SEALANTS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Sealants.
- B. Joint cleaner, primers, and sealants.
- C. Sealant joint backing materials and accessories.

#### 1.2 RELATED REQUIREMENTS

- A. Section 048500 – Natural Thin Veneer Stone.
- B. Section 076100 – Sheet Metal Roofing.
- C. Section 076200 – Sheet Metal Flashing and Trim.
- D. Section 088000 - Glazing: Sealants used in conjunction with glazing methods.
- E. Section 099000 – Painting and Coating

#### 1.3 SUBMITTALS

- A. Information Submittals:
  - 1. Product Data: Submit manufacturer's product data and installation instructions for each type of joint sealant and accessory material required.
- B. Action Submittals:
  - 1. Samples: Sealant colors.

#### 1.4 QUALITY ASSURANCE

- A. Interior sealants and sealant primers: Maximum volatile organic compound content in accordance with SCAQMD Rule 1168.
- B. Provide each type of joint sealant required produced by one manufacturer.

#### 1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in manufacturer's original, unopened, undamaged and labeled containers.

- B. Store, handle and protect materials from damage or contamination from foreign materials in accordance with manufacturer's recommendations.

## 1.6 PROJECT CONDITIONS

- A. Apply joint sealants as late as possible in construction, preceding application of painting and following cleaning operations.
- B. Do not apply joint sealants during inclement weather conditions or when temperature is above or below manufacturer's limitations for installation.

## 1.7 WARRANTY

- A. Contractor and joint sealant applicator shall jointly warranty elastomeric joint sealants work for 2 years from date of final acceptance.
- B. Warranty shall include replacing joints which fail to perform as airtight; or fail in adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration and stain resistance or general durability.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Master Builder Solutions, a brand of MBCC Group - MasterSeal Products.
- B. Pecora Corp.
- C. Tremco, Inc.
- D. Products referenced in this Section are manufactured by Master Builder Solutions - MasterSeal Products, unless noted otherwise.

### 2.2 SEALANTS

- A. Polyurethane, single-component:
  - 1. Type: NP-1.
  - 2. Color: Match adjacent surfaces.
  - 3. Use: Sealant work unless specified otherwise.
- B. Polyurethane, 3-component:
  - 1. Type: NP-2.
  - 2. Color: Match adjacent surfaces.
  - 3. Use: Sealant work unless specified otherwise.

- C. Acrylic latex:
  - 1. Type: NP 520.
  - 2. Single-component, nonstaining, nonbleeding complying with requirements of ASTM C834.
  - 3. Use: Nonmovement joints in interior construction.
  
- D. Sanitary:
  - 1. Type: NP 100.
  - 2. Color: White.
  - 3. Use: Lavatories, plumbing fixtures, and other miscellaneous applications within restroom.
  
- E. Butyl:
  - 1. Type: Tremco Butyl Sealant
  - 2. Color: White, Aluminum Stone, & Black – Select color to match use and visibility.
  - 3. Use: Hidden joints for standing seam metal roofing panels, adjacent to neoprene gaskets, and bedding thresholds.
  
- F. Butyl tape:
  - 1. Type: Tremco ET 675 - 100% Solid, cross-linked, preformed (extruded), butyl tape.
  - 2. Select tape appropriate for installation conditions for use.
  - 3. Size sealant tape to suit requirements.
  - 4. Use: Joints at fasteners for standing seam metal roofing panels where shown.

## 2.3 JOINT CLEANER AND PRIMER

- A. Provide type of cleaning compound recommended by sealant manufacturer for joint surface to be cleaned.
- B. Joint primer: Type recommended by sealant manufacturer; compatible with sealant and sealant backing.

## 2.4 SEALANT BACKING MATERIAL

- A. As recommended by sealant manufacturer, nonbonding to sealant and adjacent surfaces.
- B. Nonstaining and fully compatible with sealant material.
- C. Size: To fit joint width in compression, as recommended by backing manufacturer.
- D. Where joint design or depth will not permit use of backer rod, provide adhesive backed polyethylene bond breaker tape.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install joint sealant materials and accessories in strict accordance with manufacturer's installation instructions.
- B. Install sealant backer rod, except where recommended to be omitted by sealant manufacturer for application indicated. Use rod diameter that will cause compression when installed.
- C. Make joints watertight and airtight.
- D. Apply sealant materials using handguns or pressure equipment with proper nozzle size. Apply joint sealants in uniform, continuous ribbons without gaps or air pockets, with complete "wetting" of joint bond surfaces on both sides. Fill sealant rabbet to slightly concave surface, slightly below adjoining surfaces. At horizontal joints between horizontal surface and vertical surface, fill joint to form slight cove, so joint will not trap moisture and dirt. Hand tool and finish joints.
- E. Apply bond breaker as required or as recommended by sealant manufacturer.
- F. Install joint sealants within recommended temperature ranges and to depths indicated or when not indicated, as recommended by sealant manufacturer.
- G. Protect adjacent surfaces from damage. Clean soiled surfaces immediately. Replace damaged material that cannot be properly cleaned with new materials.

### 3.2 SCHEDULE

- A. Caulk non-moving general interior joints with acrylic latex caulk.
- B. Caulk front of toilet and interface of lavatory with sanitary sealant.
- C. Install sealants at other locations shown, with sealant appropriate for application.

END OF SECTION 079200

## SECTION 081113 – HOLLOW METAL DOORS AND FRAMES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Hollow metal doors and frames.
- B. Frame anchors.

#### 1.2 RELATED REQUIREMENTS

- A. Section 061000 – Rough Carpentry.
- B. Section 087000 – Hardware.
- C. Section 088000 – Glazing.
- D. Section 092116 – Gypsum Board Assemblies.
- E. Section 099000 – Painting and Coating.

#### 1.3 REFERENCES

- A. ANSI A250.3 - (Rev. 2011) Test Procedure and Acceptance Criteria for – Factory Applied Finish Coatings for Steel Doors and Frames.
- B. ANSI A250.4 - (2011) Test Procedures and Accepted Criteria for – Physical Endurance for Steel Doors, Frames, Frame Anchors and Hardware Reinforcing.
- C. ANSI A250.6 - (Rev. 2009) Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames.
- D. ANSI A250.7 - (Rev. 2007) Nomenclature for – Standard Steel Doors and Steel Frames.
- E. ANSI A250.8 - (2017) Recommended Specifications for Standard Steel Doors and Frames.
- F. ANSI A250.10 - (2011) Test Procedure and Acceptance Criteria for – Prime Painted Steel Surfaces for Steel Doors and Frames.
- G. ANSI A250.11 - (2012) Recommended Erection Instructions for Steel Frames.
- H. ASTM A653-19a - (2019) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

- I. ASTM A1008-18 - (2018) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
- J. ASTM E283 - (2019) Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
- K. ASTM E2112-19c - (2019) Standard Practice for Installation of Exterior Windows, Doors, and Skylights.
- L. NFRC 102-2014 - Thermal Performance
- M. NFRC 400 - Air Infiltration Resistance
- N. SDI-107-78 - Hardware on Steel Doors

#### 1.4 SUBMITTALS

- A. Shop Drawings indicating door and frame elevations and sections, materials, gauges and finishes, fabrication and erection details, locations of finish hardware by dimension and locations/details of openings and louvers.

#### 1.5 QUALITY ASSURANCE

- A. Qualifications: Hollow metal distributor shall be qualified by manufacturer of products to be furnished, and have in their regular employment, a knowledgeable person who will be available at reasonable times to consult with Engineer, Contractor, and Owner regarding matters affecting door and frame openings.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver doors and frames cardboard wrapped, crated, palletized, or otherwise protected during transit and site storage.
- B. Inspect doors and frames upon delivery for damage. Minor damages may be repaired provided refinished items are equal to new work and accepted by Engineer; otherwise, remove and replace damaged items.
- C. Store doors and frames at site in dry secure place.
  1. Place units on minimum 4" (100 mm) high wood blocking.
  2. Avoid use of non-vented plastic or canvas shelters that could create humidity chamber.
  3. If cardboard wrapper on door becomes wet, remove carton immediately.
  4. Provide ¼" (6 mm) spaces between stacked doors to promote air circulation.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Mesker Openings Group, 18102 Chesterfield Airport Rd., Unit G, Chesterfield, MO 63005. Phone: (844)463-7537. Website: [www.meskerdoor.com](http://www.meskerdoor.com).
- B. Curries (ASSA Abloy), 1502 12<sup>th</sup> St. NW, Mason City, IA 50401. Phone: (641)423-1334. Website: [www.curries.com](http://www.curries.com).
- C. Pioneer Industries (ASSA Abloy), 111 Kero Rd., Carlstadt, NJ 07072. Phone: (201)933-1900. Website: [www.pioneerindustries.com](http://www.pioneerindustries.com).
- D. Republic Doors and Frames (Allegion), 155 Republic Dr., McKenzie, TN 38201. Phone: (800)733-3667. Website: [www.republicdoor.com](http://www.republicdoor.com).
- E. Steelcraft (Allegion), 9017 Blue Ash Rd., Cincinnati, OH 45242. Phone: (877)671-7011. Website: [www.steelcraft.com](http://www.steelcraft.com).

### 2.2 HOLLOW METAL DOORS

- A. Doors, full flush: Basis of Design – Steelcraft “L-Series Flush Doors”.
  - 1. Face sheet: Flush; smooth, weatherproof, cold-rolled stretcher leveled steel.
  - 2. Face sheet thickness:
    - a. Interior doors: 18-gauge (1.0 mm).
    - b. Exterior doors: 16-gauge (1.5 mm).
  - 3. Top and bottom edge: Flush; continuous steel closure channel, 16-gauge (1.5 mm) minimum, welded to each face.
  - 4. Hardware reinforcement: Manufacturer's standard for hardware specified for each door.
  - 5. Lock and hinge rail edge: Seamless, welded, filled, and ground smooth full height; 14-gauge (2.0 mm) minimum standard rails full height.
  - 6. Lock edge: Beveled.
  - 7. Cores:
    - a. Interior doors: Manufacturer’s standard honeycomb core or solid slab of expanded polystyrene foam permanently bonded to each face skin.
    - b. Exterior doors: Solid slab of polyurethane foam permanently bonded to each face skin.
  - 8. Door thickness: 1<sup>3</sup>/<sub>4</sub>” (45 mm).
  - 9. Size: As shown on Drawings.
- B. Louvers: Stationary.
- C. Fabricate glass light frames in doors of not less than 18-gauge (1.0 mm) galvanized steel.

## 2.3 DOOR FABRICATION

- A. Fabricate all doors in accordance with ANSI/SDI A250.8, except where more stringent requirements are specified.
- B. Exterior doors: Hot-dipped galvanized, zinc-coated commercial quality carbon steel, ASTM A924 with ASTM A653, A60 zinc coating, mill phosphatized. Also galvanize associated reinforcements, stops, and trim.
- C. Reinforce and prepare doors to receive hardware.
- D. Fill surface depressions with metallic paste filler and grind smooth uniform finish.
- E. Touch up areas where galvanized coating has been removed due to sanding or handling.
- F. Chemically treat surfaces and apply manufacturer's standard, baked-on prime coat. Primer coat shall conform to ASTM A250.10.

## 2.4 HOLLOW METAL FRAMES

- A. Types:
  - 1. Interior Frames: Basis of design – Steelcraft “F Series” frame, welded
  - 2. Exterior Frames: Basis of design – Steelcraft “F Series Kerf” frame, welded.
- B. Door bumpers: Manufacturer's standard resilient type; removable for replacement.
- C. Frame profile and jamb depth: As indicated on Drawings.

## 2.5 FRAME FABRICATION

- A. Fabricate frames from 16-gauge steel.
- B. Exterior frames: Hot-dipped galvanized, zinc-coated commercial quality carbon steel, ASTM A924 with ASTM A653, A60 zinc coating, mill phosphatized. Associated stops, anchors, clips, reinforcement, and trim shall also be galvanized.
- C. Accurately form and cut mitered corners of welded type frames. Weld on inside surfaces. Grind welded joints to smooth uniform finish.
- D. Accurately cope and securely weld butt joints of mullions and transoms of glazed lights, and interior screens. Grind welded joints to smooth uniform finish.
- E. Reinforce frames wider than 4' (1200 mm) with 12-gauge (2.6 mm) formed steel channels weld in place, flush with top of frames.
- F. Reinforce, provide cutouts, and prepare frames to receive hardware and electronic devices.

- G. Place minimum of three (3) single bumpers on single door frames. Space equally along strike jambs.
- H. Fill surface depressions of hollow metal frames with metallic paste filler and grind to smooth finish.
- I. Provide removable mullions for double doors where indicated on Drawings. Reinforce head sections where mullions occur.
- J. Touch up areas where galvanized coating has been removed due to sanding or handling.
- K. Chemically treat surfaces and apply manufacturer's standard baked on prime coat.
- L. Coat inside of exterior frames with corrosion-inhibiting bituminous material.

## 2.6 FRAME ANCHORS

- A. Wall anchors for attachment to drywall partitions:
  - 1. Use wood stud anchors sized to accommodate frame jamb depth and face dimension on welded frames.
    - a. Basis of Design: Steelcraft – “Weld-In Wood Stud Anchor”.
- B. Exterior Wood Stud Blocking at SIPs Panel:
  - 1. Manufacturer’s standard anchor for wood stud partitions.
- C. Provide frame jamb anchors; 1 each jamb per 30" (750 mm) of frame height or fraction thereof.
- D. Floor anchors, welded, angle clip type:
  - 1. 16-gauge (1.5 mm) minimum.
  - 2. To receive two (2) fasteners per jamb.
- E. Head struts: For frames not anchored to masonry or concrete construction, provide ceiling struts spot welded to jambs each side extending to building structure.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install doors and frames in accordance with SDI 100, except as amended in this Section.
- B. Install louvers in accordance with manufacturer's recommendations.

- C. Coordinate installation of glass and glazing in doors.
- D. Exterior frames: Fill frames solid with spray foam insulation.

END OF SECTION 081113

## SECTION 081400 – WOOD DOORS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Solid core doors.
- B. Hollow core doors.
- C. Accessories, fabrication, and finish.

#### 1.2 RELATED REQUIREMENTS

- A. Section 081113 – Hollow Metal Doors and Frames.
- B. Section 087000 – Hardware.
- C. Section 088000 – Glazing.
- D. Section 099000 – Painting and Coating.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Product Data indicating door core materials and construction; veneer species, type and characteristics; factory machining criteria, and factory finishing criteria.

#### 1.4 ACTION SUBMITTALS

- A. Shop Drawings illustrating door opening criteria, elevations, sizes, types, swings, undercuts required, flashing required, special beveling, special blocking for hardware, identify cutouts for glazing and louvers.
- B. Samples:
  - 1. Two samples of door construction, 5" x 10" (75 mm x 250 mm) size cut from top corner of door.
  - 2. Three samples of mounted veneer, 8" x 11" (200 mm x 275 mm) size illustrating wood grain, stain color, sheen, and expected color variation.

#### 1.5 QUALITY ASSURANCE

- A. Work shall comply with applicable codes and standard of AWI, NFPA, WDMA, UL, and WH.

- B. Regulatory requirements:
  - 1. Fire door construction: Conform to UL 10B or Warnock Hersey Listing Services (WH).
  - 2. Installed door assembly: Conform to NFPA 80 for fire-rated class as scheduled or as indicated on Drawings.
  - 3. UL labels shall be factory-applied, prior to delivery.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver doors to Site until building is enclosed and “wet work,” grinding, and similar operations which could damage doors is completed.
- B. Accept doors on Site in manufacturer's standard poly-wrapped packaging. Inspect for damage.
- C. Do not store in damp or wet areas; or in areas where sunlight might bleach veneer. Seal top and bottom edges if stored more than 1 week.
- D. Break seal on Site to permit ventilation.

#### 1.7 WARRANTY

- A. Provide manufacturer's written full unlimited warranty, to following terms:
- B. Interior solid core doors: “Life of Original Installation” including rehanging and refinishing if door fails.
- C. Interior hollow core doors: 5 years.
- D. Include coverage for delamination of veneer, warping beyond specified installation tolerances, defective materials, telegraphing core construction.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Algoma Hardwoods, Inc.
- B. Eggers Industries.
- C. Graham Wood Doors.
- D. Marshfield Door Systems.
- E. Oshkosh Door Company.

## 2.2 SOLID CORE DOORS

- A. Type: Flush; size and design as shown on Drawings, meeting WDMA I.S. 1-A Series and AWI Section 1300 SLC-5 or PC5 “Custom Grade” requirements.
- B. Construction:
  - 1. Thickness: 1¾” (45 mm).
  - 2. Face veneers and edge bands: Plain sawn, white oak.
  - 3. Color and pattern: Selected by Owner from manufacturer’s standard selections.
- C. Core:
  - 1. Doors with glazed panels: Solid stave lumber.
  - 2. Other nonrated doors: Solid particleboard.
  - 3. Fire rated doors with label classification of 45 minute, 1 hour, or 1½ hour: Mineral.
  - 4. 20 minute doors: Solid particleboard.
- D. Fire rated doors shall comply with regulatory requirements.

## 2.3 HOLLOW CORE DOORS

- A. Type: Flush, meeting WDMA I.S. 1 A Series and AWI Type SHC “Custom Grade” requirements.
- B. Construction:
  - 1. Thickness: 1¾” (45 mm).
  - 2. Face veneers and edge bands: To match solid core doors.
  - 3. Color and pattern: Selected by Owner from manufacturer’s standard selections.
- C. Core: Standard honeycomb.

## 2.4 ACCESSORIES

- A. Wood louvers:
  - 1. Material and finish: Same species as door, with flat edge.
  - 2. Louver blade: Flat slat blade.
- B. Glazing stops on nonrated doors: Wood of same species as door facing; mitered corners; prepared for countersunk nails.
- C. Glazing stops on rated doors: Wood veneer vision frame system using metal vision frame with mitered corners; prepared for countersunk screws; with wood veneer capping of same species as door facing.
- D. Pocket door system: Flush finish, trimless pocket door system. SlideSet by EZ Concept, or similar. Prepare door to accept system hardware; install and finish opening per manufacturer’s recommendations.

## 2.5 FABRICATION

- A. Fabricate fire-rated and nonrated doors in accordance with specified manufacturer's, WH, or UL requirements. Attach fire rating label to door.
- B. Fire-rated pair doors when both leaves are active: Manufacture pairs so they do not require use of either metal edges or overlapping metal astragal.
- C. Provide particleboard doors with stiles consisting of two 3/4" (19 mm) plies of hardwood with outer ply of same species as face veneer.
- D. Bond stiles and rails to core, then sand entire unit prior to applying crossbanding and face veneers.
- E. Factory machine doors for finish hardware in accordance with hardware requirements and dimensions. Do not factory machine for surface hardware.
- F. Factory pre-fit doors for frame opening dimensions identified on Shop Drawings.
- G. Provide lock blocks for fire doors at top, bottom, and lock edge of door for surface applied hardware reinforcement as required in accordance with hardware schedule.
- H. Fire rated door stiles shall have screw withdrawal performance of 740 lb (335 kg) on average, or greater.
- I. Poly wrap doors.

## 2.6 FINISH

- A. Factory finish doors in accordance with AWI Quality Standards Section 1500, to following finish designation:
- B. Finished doors: AWI System No. 5 performance criteria, transparent, Premium quality, stain color as selected and sheen as 35 gloss.
- C. Unfinished doors: Delivered to Site ready for field finishing.
- D. Plastic laminate: Factory applied, NEMA LD3; general or specific purpose type, minimum 0.05" (1.25 mm) thickness.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify substrate opening conditions.
- B. Verify opening sizes and tolerances are acceptable.

- C. Do not install doors in frame openings that are not plumb or are out of tolerance for size or alignment.

### 3.2 INSTALLATION

- A. Install doors plumb, level, and true-to-line, properly fit to framed openings.
- B. Doors shall be carefully mortised for scheduled hardware.
- C. Hang and trim doors with hardware as specified.
- D. Adjust and align to provide smooth, easy, balanced operation with no binding or rattling when closed.
- E. Damaged, marred, or warped doors will not be accepted.

END OF SECTION 081400

## SECTION 083100 – ACCESS DOORS AND PANELS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Ceiling access door panel.

#### 1.2 RELATED REQUIREMENTS

- A. Section 092116 - Gypsum Board Assemblies: Openings in ceilings.
- B. Section 099000 - Painting and Coating: Field paint finish.

#### 1.3 SUBMITTALS

- A. Submit Shop Drawings or Product Data, providing pertinent dimensioning, general construction, component connections and details, anchorage methods, hardware location, and installation details.
- B. Submit manufacturer's installation instructions.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Access Doors:
  1. Acudor Products Inc: [www.acudor.com](http://www.acudor.com).
  2. Karp Associates, Inc: [www.karpinc.com](http://www.karpinc.com).
  3. Milcor Inc: [www.milcorinc.com](http://www.milcorinc.com).
  4. Or approved equal.

#### 2.2 ACCESS DOORS AND PANELS

- A. Door and Panel Units: Factory fabricated, fully assembled units with corner joints welded, filled, and ground flush; square and without rack or warp; coordinate requirements with the ceiling or wall assemblies in which the units are to be installed.

#### 2.3 WALL AND CEILING UNITS

- A. Door and Frame Units: Formed steel.
  1. Frames and flanges: 0.058 inch steel.
  2. Door panels: 0.070 inch single thickness steel sheet.

3. Sizes:
  - a. Ceilings: 24 x 24 inches.
4. Hardware:
  - a. Hinge: Concealed constant force closure spring type.
  - b. Lock: Cylinder lock with latch, two keys for each unit.
5. Prime coat with alkyd primer.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install units in accordance with manufacturer's instructions.
- B. Install frames plumb and level in openings. Secure rigidly in place.
- C. Position units to provide convenient access to the concealed work requiring access.
- D. Confirm location with the Owner or Owner's Representative prior to framing ceiling.
- E. Contractor shall provide any additional accessories, trims, or support for access doors.

END OF SECTION 083100

## SECTION 083313 – ROLLING COUNTER DOORS

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Rolling Counter Doors, manually operated.

#### 1.2 RELATED REQUIREMENTS

- A. Section 061000 – Rough Carpentry
- B. Section 062000 – Finish Carpentry
- C. Section 087000 – Hardware

#### 1.3 REFERENCES

- A. ASTM A 653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- B. ASTM A 666 - Standard Specification for Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
- C. ASTM A 924 - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.

#### 1.4 SUBMITTALS

- A. Product Data: Manufacturer's data sheets on each product to be used, including:
  - 1. Preparation instructions and recommendations.
  - 2. Storage and handling requirements and recommendations.
  - 3. Details of construction and fabrication.
  - 4. Installation methods.
- B. Shop Drawings: Include detailed plans, elevations, details of framing members, required clearances, anchors, and accessories. Include relationship with adjacent construction.
- C. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm) long, representing actual product, color, and patterns.

#### 1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in performing Work of this section with a minimum of five years of experience in the fabrication and installation of security closures.
- B. Installer Qualifications: Company specializing in performing Work of this section with minimum three years and approved by manufacturer.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Protect materials from exposure to moisture. Do not deliver until after wet work is complete and dry.
- C. Store materials in a dry, warm, ventilated weathertight location.

## 1.7 PROJECT CONDITIONS

- A. 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.

## 1.8 WARRANTY

- A. Warranty: Manufacturer's limited door warranty for two (2) years for all parts and components.
- B. Basis of Design: PowderGuard Finish.
  - 1. PowderGuard Premium Applied to curtain, guides, bottom bar, headplates: Manufacturer's limited Premium Finish warranty for 2 years.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Cookson – CornellCookson, LLC, 1901 South Litchfield Road, Goodyear, AZ 85338. Phone: [877.298.9732](tel:877.298.9732). Web Site: [www.cooksondoor.com](http://www.cooksondoor.com).
- B. Cornell Iron Works, Inc. – CornellCookson, LLC, 24 Elmwood Avenue, Mountain Top, PA 18707. Phone: [800.233.8366](tel:800.233.8366). Web Site: [www.cornelliron.com](http://www.cornelliron.com).
- C. Overhead Door Corporation, 2501 S. State Hwy. 121, Suite 200, Lewisville, TX 75067. Phone: (800) 275-3290. Web Site: [www.overheaddoor.com](http://www.overheaddoor.com). E-mail: [info@overheaddoor.com](mailto:info@overheaddoor.com).
- D. Materials referenced in this Section are manufactured by Overhead Door Corporation, unless noted otherwise.

### 2.2 ROLLING COUNTER DOORS

- A. Galvanized Steel Counter Doors: Basis of Design – Overhead Door Corp., Series 650:
  - 1. Wall Mounting Condition: Face-of-wall mounting.
  - 2. Curtain: Interlocking slats. Type F-128 fabricated of 22 gauge galvanized steel. Endlocks attached to alternate slats to maintain curtain alignment and prevent lateral slat movement.
  - 3. Finish:
    - a. Slats and hood galvanized steel in accordance with ASTM A 653 with rust-inhibitive, roll coating process, including 0.2 mils thick baked-on prime paint, and 0.6 mils thick baked-on polyester (powder coated) topcoat.

- b. Non-galvanized exposed ferrous surfaces for guides, bottom bar and head plates shall receive one coat of rust-inhibitive primer.
- 4. Bottom bar: Single, primed steel angle bottom bar with weatherstrip.
- 5. Guides: Extruded aluminum.
- 6. Brackets: Steel plate to support counterbalance, curtain, and hood.
- 7. Finish: Bottom Bar, Guides, Brackets: Powder coat to match curtain.
- 8. Counterbalance: Helical torsion springs housed in steel pipe barrel.
- 9. Hood: Galvanized primed steel hood with intermediate support brackets.
- 10. Operation: Manual push-up.
- 11. Locks: Two-point dead locks with mortise cylinders.
- 12. Powder coat color: Selected by Owner from manufacturer's standard colors.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Verify opening sizes, tolerances and conditions are acceptable.
- B. Examine conditions of substrates, supports, and other conditions under which this work is to be performed.
- C. If substrate preparation is the responsibility of another installer, notify Owner's Representative of unsatisfactory preparation before proceeding.

#### 3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

#### 3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.
- C. Securely and rigidly brace components suspended from structure. Secure guides to structural members only.
- D. Fit and align assembly including hardware; level and plumb, to provide smooth operation.
- E. Coordinate installation of sealants and backing materials at frame perimeter as specified in Section 079200.
- F. Install perimeter trim and closures.

3.4 ADJUSTING

- A. Test for proper operation and adjust as necessary to provide proper operation without binding or distortion.
- B. Adjust hardware and operating assemblies for smooth and noiseless operation.

3.5 CLEANING

- A. Clean curtain and components using non-abrasive materials and methods recommended by manufacturer.
- B. Remove labels and visible markings.
- C. Touch-up, repair or replace damaged products before Substantial Completion.

3.6 PROTECTION

- A. Protect installed products until completion of project.

END OF SECTION 083313

## SECTION 084113 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Aluminum doors, frames, and storefront framing.
- B. Anchors, brackets, and attachments.
- C. Door hardware.

#### 1.02 RELATED REQUIREMENTS

- A. Section 061000 – Rough Carpentry.
- B. Section 079200 - Joint Sealants.
- C. Section 087000 - Hardware: Door hardware for doors not specified in this Section.
- D. Section 088000 - Glazing.

#### 1.03 INFORMATIONAL SUBMITTALS

- A. Product data for each type of product specified.
- B. Manufacturer's installation instructions.

#### 1.04 ACTION SUBMITTALS

- A. Shop Drawings indicating system and component dimensions, components within assembly, framed opening requirements and tolerances, anchorage, and fasteners, infills, door hardware requirements, and affected related work.
- B. Three samples, 4" x 4" (100 mm x 100 mm) in size, illustrating prefinished aluminum surface.

#### 1.05 QUALITY ASSURANCE

- A. Regulatory requirements: Hardware shall conform to Americans with Disabilities Act (ADA) requirements.

#### 1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Site and store in dry, protected location to prevent damage.
- B. Provide factory-applied strippable coating to protect prefinished aluminum surfaces.

#### 1.07 WARRANTY

- A. Provide 3 year manufacturer's warranty. Warranty shall cover complete system for failure to meet specified requirements.

## PART 2 PRODUCTS

### 2.01 PERFORMANCE REQUIREMENTS

- A. System shall provide for expansion and contraction within system component caused by a cycling temperature range of 170°F (77°C) without causing detrimental effects to system or components.
  - 1. Maximum deflection of 1/175 of span.
  - 2. Allowable stress with safety factor of 1.65.
  - 3. System shall perform these criteria under wind load requirements for construction area.
- B. Design and size members to withstand dead loads and live loads caused by pressure and suction of wind as measured in accordance with ASTM E330.
- C. Limit mullion deflection to L/175, or flexure limit of glass with full recovery of glazing materials, whichever is less.
- D. Drain water entering joints, condensation occurring in glazing channels, or migrating moisture occurring within system, to exterior.
- E. Limit air infiltration through assembly to 0.06 cu ft/min/sq ft (0.3 l/min/m<sup>2</sup>) of assembly surface area, measured at a reference differential pressure across assembly of 0.3" wg (75 Pa), as measured in accordance with ASTM E283.
- F. Water leakage: None when measured in accordance with ASTM E331 with pressure difference of 8 psf (384 PA).
- G. System shall accommodate, without damage to system or components, or deterioration of perimeter seal: Movement within system; movement between system and perimeter framing components; dynamic loading and release of loads; and deflection of structural support framing.

### 2.02 MATERIALS

- A. Extruded aluminum: ASTM B221; 6063-T5 alloy and temper.
- B. Sheet aluminum: ASTM B209.
- C. Sheet steel: ASTM A446; galvanized.
- D. Steel sections: ASTM A36; shapes to suit mullion sections.
- E. Fasteners: Stainless steel.

### 2.03 FRAMING SYSTEMS

- A. Specified systems shall include all required accessories, consisting of, but not limited to, the following: All anchorage devices, shims, fasteners, trim and flashing materials. Extended sills shall be included at window units where indicated. Metal sills shall be thermally broken.
- B. Type 1: Nominal 2" (51 mm) wide by 6" (153 mm) deep framing system.
  - 1. "Trifab VersaGlaze 651T Framing System" by Kawneer Co., Inc., an ARCONIC company.
  - 2. "T24650 Series" by Tubelite Inc., an Apogee company.
  - 3. "Series 2202 Curtain Wall System" by CRL – U.S. Aluminum, a CRH company.

## 2.04 DOORS

- A. Type: 2" (50 mm) nominal thick, medium stile, with snap-in type glazing stops with glazing gaskets for 1" (25 mm) glazing.

## 2.05 HARDWARE

- A. As shown in Section 087000 – Hardware.

## 2.06 FABRICATION

- A. Fabricate doors and frames allowing for minimum clearances and shim spacing around perimeter of assembly yet enabling installation.
- B. Rigidly fit and secure joints and corners. Make joints and connections flush, hairline, and weatherproof.
- C. Develop drainage holes with moisture pattern to exterior.
- D. Prepare components to receive anchor devices. Fabricate anchorage items.
- E. Arrange fasteners, attachments, and jointing to ensure concealment from view.
- F. Prepare components with internal reinforcement for door hardware.
- G. Reinforce and prepare doors and frames for hardware and other electronic devices.

## 2.07 FINISHES

- A. Exposed aluminum surfaces: Anodized – color as selected by Owner from manufacturer's standard colors.
- B. Concealed steel items: Galvanized in accordance with ASTM A386.
- C. Apply 1 coat of bituminous paint to concealed aluminum and steel surfaces in contact with cementitious or dissimilar materials.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Verify wall openings and adjoining air and vapor seal materials are ready to receive framing materials.
- B. Beginning of installation means acceptance of adjacent conditions.

### 3.02 INSTALLATION

- A. Install doors, hardware, and frames in accordance with manufacturer's instructions.
- B. Use anchorage devices to securely attach frame assembly to structure.
- C. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.

- D. Coordinate attachment and seal of air and vapor barrier materials. Install sill flashings.
- E. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.
- F. Install hardware using templates provided.
- G. Adjust operating hardware.

### 3.03 TOLERANCES

- A. Variation from plane: 0.03"/ft (0.78 mm/m) maximum or 0.25"/30', whichever is less.
- B. Misalignment of two adjoining members abutting in plane: 0.015".

### 3.04 CLEANING

- A. Remove protective material from prefinished aluminum surfaces.
- B. Wash down exposed surfaces using a solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.
- C. Remove excess sealant by moderate use of mineral spirits or other solvent acceptable to sealant manufacturer.

END OF SECTION 084113

## SECTION 084523 – FIBERGLASS SANDWICH PANEL ASSEMBLIES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Section includes the insulated translucent sandwich panel system and accessories as shown and specified. Work includes providing and installing:
  - 1. 2¾" thick, flat factory prefabricated structural insulated translucent sandwich panels
  - 2. Aluminum installation system
  - 3. Aluminum sill flashing

#### 1.2 RELATED REQUIREMENTS

- A. Section 061000 - Rough Carpentry.
- B. Section 076200 - Sheet Metal Flashing and Trim.
- C. Section 079200 - Joint Sealants.
- D. Section 088000 – Glazing.

#### 1.3 SUBMITTALS

- A. Submit manufacturer's product data. Include construction details, material descriptions, profiles and finishes of components.
- B. Submit shop drawings. Include elevations and details.
- C. Submit manufacturer's color charts showing the full range of colors available for factory-finished aluminum.
  - 1. When requested, submit samples for each exposed finish required, in same thickness and material indicated for the work and in size indicated below. If finishes involve normal color variations, include sample sets consisting of two or more units showing the full range of variations expected.
    - a. Sandwich panels: 14" x 28" units
    - b. Factory finished aluminum: 5" long sections
- D. Submit Installer Certificate, signed by installer, certifying compliance with project qualification requirements.
- E. Submit product reports from a qualified independent testing agency indicating each type and class of panel system complies with the project performance requirements, based on comprehensive testing of current products. Previously completed reports will be acceptable if for current manufacturer and indicative of products used on this project.
  - 1. Reports required are:
    - a. International Building Code Evaluation Report
    - b. Flame Spread and Smoke Developed (UL 723) – Submit UL Card
    - c. Burn Extent (ASTM D635)
    - d. Color Difference (ASTM D2244)
    - e. Impact Strength (UL 972)
    - f. Bond Tensile Strength (ASTM C 297 after aging by ASTM D1037)
    - g. Bond Shear Strength (ASTM D1002)
    - h. Beam Bending Strength (ASTM E72)

- i. Insulation U-Factor (NFRC 100)
- j. NFRC System U-Factor Certification (NFRC 700)
- k. Solar Heat Gain Coefficient (NFRC or Calculations)
- l. Condensation Resistance Factor (AAMA 1503)
- m. Air Leakage (ASTM E 283)
- n. Structural Performance (ASTM E330)
- o. Water Penetration (ASTM E331)
- p. 1200°F Fire Resistance (SWRI)

#### 1.4 QUALITY ASSURANCE

##### A. Manufacturer's Qualifications

1. Material and products shall be manufactured by a company continuously and regularly employed in the manufacture of specified materials for a period of at least ten consecutive years and which can show evidence of those materials being satisfactorily used on at least six projects of similar size, scope, and location. At least three of the projects shall have been in successful use for ten years or longer.
2. Panel system must be listed by an ANSI accredited Evaluation Service, which requires quality control inspections and fire, structural and water infiltration testing of sandwich panel systems by an accredited agency.
3. Quality control inspections shall be conducted at least once each year and shall include manufacturing facilities, sandwich panel components and production sandwich panels for conformance with AC177 “Translucent Fiberglass Reinforced Plastic (FRP) Faced Panel Wall, Roof and Skylight Systems” as issued by the ICC-ES.

B. Installer’s Qualifications: Installation shall be by an experienced installer, which has been in the business of installing specified panel systems for at least two consecutive years and can show evidence of satisfactory completion of projects of similar size, scope and type.

##### C. Sustainable design requirements:

1. Products shall meet the following requirements where applicable:
  - a. RCRA section 6002
  - b. FSRIA section 9002
  - c. GSA Green Procurement Compilation, as applicable
2. Products shall avoid use of ozone depleting compounds (ODC) and high global warming potential (GWP) chemicals.

#### 1.5 PERFORMANCE REQUIREMENTS

##### A. Manufacturer shall be responsible for the configuration and fabrication of the complete panel system.

1. When requested, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
2. Standard panel system shall have less than 0.01 cfm/ft<sup>2</sup> air leakage by ASTM E283 at 6.24 PSF (50 mph) and no water penetration by ASTM E331 at 15 PSF; and structural testing by ASTM E330.
3. Structural Loads; Provide system capable of handling the following loads:
  - a. Positive Wind Load: 45 PSF
  - b. Negative Wind Load: 45 PSF

#### 1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver panel system, components, and materials in manufacturer's standard protective packaging.

- B. Store panels on the long edge; several inches above the ground, blocked and under cover in accordance with manufacturer's storage and handling instructions.

## 1.7 WARRANTY

- A. Submit manufacturer's and installer's written warranty agreeing to repair or replace panel system work, which fails in materials or workmanship within one year of the date of delivery. Failure of materials or workmanship shall include leakage, excessive deflection, deterioration of finish on metal in excess of normal weathering, defects in accessories, insulated translucent sandwich panels and other components of the work.
- B. Extended Warranty: 5 Year Materials & Workmanship
- C. KCRF Metal Finish: 10 Year Limited Warranty

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Kalwall Corporation - 1111 Candia Road, PO Box 237, Manchester NH, 03105. Phone: (800) 258-9777. Email: [info@kalwall.com](mailto:info@kalwall.com).
- B. Major Industries, Inc. - 7120 Stewart Ave, Wausau, WI 54401. Phone: (888) 759-2678. Email: [info@majorskylights.com](mailto:info@majorskylights.com).
- C. Or approved equal.
- D. Basis of Design: Products manufactured by Kalwall Corporation.

### 2.2 PANEL COMPONENTS

- A. Face Sheets
  - 1. Translucent faces: Manufactured from glass fiber reinforced thermoset resins, formulated specifically for architectural use.
    - a. Thermoplastic (e.g. polycarbonate, acrylic) faces are not acceptable.
    - b. Face sheets shall not deform, deflect, or drip when subjected to fire or flame.
  - 2. Interior face sheets:
    - a. Flame spread: Underwriters Laboratories (UL) listed, which requires periodic unannounced retesting, with flame spread rating no greater than 50 and smoke developed no greater than 250 when tested in accordance with UL 723.
    - b. Burn extent by ASTM D635 shall be no greater than 1".
  - 3. Exterior face sheets:
    - a. Color stability: Full thickness of the exterior face sheet shall not change color more than 3 CIE Units DELTA E by ASTM D2244 after 5 years outdoor South Florida weathering at 5° facing south, determined by the average of at least three white samples with and without a protective film or coating to ensure long-term color stability. Color stability shall be unaffected by abrasion or scratching.
    - b. Strength: Exterior face sheet shall be uniform in strength, impenetrable by handheld pencil and repel an impact minimum of 70 ft. lbs. without fracture or tear when impacted by a 3¼" diameter, 5 lb. free-falling ball per UL 972.
  - 4. Appearance:
    - a. Exterior face sheets: Smooth 0.070 thick and Crystal in color.
    - b. Interior face sheets: Smooth 0.045 thick and Crystal in color.
    - c. Face sheets shall not vary more than ± 10% in thickness and be uniform in color.

## B. Grid Core

1. Thermally broken I-beam grid core shall be of 6063-T6 or 6005-T5 alloy and temper with provisions for mechanical interlocking of muntin-mullion and perimeter. Width of I-beam shall be no less than 7/16”.
2. I-beam Thermal break: Minimum 1”, thermoset fiberglass composite.

## C. Laminate Adhesive

1. Heat and pressure resin type adhesive engineered for structural sandwich panel use, with minimum 25-years field use. Adhesive shall pass testing requirements specified by the International Code Council “Acceptance Criteria for Sandwich Panel Adhesives”.
2. Minimum tensile strength of 750 PSI when the panel assembly is tested by ASTM C297 after two exposures to six cycles each of the aging conditions prescribed by ASTM D1037.
3. Minimum shear strength of the panel adhesive by ASTM D1002 after exposure to four separate conditions:
  - a. 50% Relative Humidity at 68° F: 540 PSI
  - b. 182° F: 100 PSI
  - c. Accelerated Aging by ASTM D1037 at room temperature: 800 PSI
  - d. Accelerated Aging by ASTM D1037 at 182° F: 250 PSI

## 2.3 PANEL CONSTRUCTION

- A. Provide sandwich panels of flat fiberglass reinforced translucent face sheets laminated to a grid core of mechanically interlocking I-beams. The adhesive bonding line shall be straight, cover the entire width of the I-beam and have a neat, sharp edge.
  1. Thickness: 2¾”
  2. Light transmission: 35%
  3. Solar heat gain coefficient 0.27
  4. Panel U-factor by NFRC certified laboratory: 2¾” thermally broken grid 0.23U
  5. Complete insulated panel system shall have NFRC certified U-factor of 0.28U
  6. Grid pattern: pattern Shoji
- B. Standard panels shall deflect no more than 1.9” at 30 PSF in 10’ 0” span without a supporting frame by ASTM E 72.
- C. Standard panels shall withstand 1200° F fire for minimum one hour without collapse or exterior flaming.
- D. Thermally broken panels: Minimum Condensation Resistance Factor of 80 by AAMA 1503 measured on the bond line.

## 2.4 BATTENS AND PERIMETER CLOSURE SYSTEM

- A. Closure system: Thermally broken extruded aluminum 6063-T6 and 6063-T5 alloy and temper clamp-tite screw type closure system.
- B. Sealing tape: Manufacturer's standard, pre-applied to closure system at the factory under controlled conditions.
- C. Fasteners: 300 series stainless steel screws for aluminum closures, excluding final fasteners to the building.
- D. Finish:

1. Manufacturer's factory applied finish, which meets the performance requirements of AAMA 2604. Color to be cream on exterior (final color to be selected from manufacturer's standards by Architect).
2. Project to consist of (2) colors to be chosen by the owner, one for the exterior and one for the interior dark bronze finish.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Installer shall examine substrates, supporting structure and installation conditions.
- B. Do not proceed with panel installation until unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

- A. Metal Protection:
  1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.
  2. Where aluminum will contact concrete, masonry or pressure treated wood, protect against corrosion by painting contact surfaces with bituminous paint or method recommended by manufacturer.

#### 3.3 INSTALLATION

- A. Install the panel system in accordance with the manufacturer's suggested installation recommendations and approved shop drawings.
  1. Anchor component parts securely in place by permanent mechanical attachment system.
  2. Accommodate thermal and mechanical movements.
  3. Set perimeter framing in a full bed of sealant compound, or with joint fillers or gaskets to provide weather-tight construction.
- B. Install joint sealants at perimeter joints and within the panel system in accordance with manufacturer's installation instructions.

#### 3.4 CLEANING

- A. Clean the panel system interior and exterior, immediately after installation.
- B. Refer to manufacturer's written recommendations.

END OF SECTION 084523

## SECTION 085413 – FIBERGLASS CASEMENT WINDOWS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Fiberglass casement windows.

#### 1.2 RELATED SECTIONS

- A. Section 079200 - Joint Sealants: Sealants and caulking.

#### 1.3 REFERENCES

- A. American Architectural Manufacturers Association (AAMA):
  1. AAMA 502 - Voluntary Specification for Field Testing of Windows and Sliding Doors.
  2. AAMA 624-10 - Voluntary Performance Requirements and Test Procedures for Organic Coatings on Fiber Reinforced Thermoset Profiles.
- B. American Society for Testing and Materials (ASTM):
  1. ASTM C 1036 - Flat Glass.
  2. ASTM C 1048 - Heat-Treated Flat Glass--Kind HS, Kind FT Coated and Uncoated Glass.
  3. ASTM E 283 - Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors Under Specified Pressure Difference Across the Specimen.
  4. ASTM E 330 – Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
  5. ASTM E 547 - Water Penetration of Exterior Windows, Curtain Walls and Doors by Cyclic Static Air Pressure Differential.
  6. ASTM E 1105 – Standard Test Method for Field Determination of Water Penetration of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
- C. Window and Door Manufacturers Association (WDMA):
  1. ANSI/AAMA/NWDA 101/I.S.2 - Voluntary Specifications for Aluminum, Vinyl (PVC) and Wood Windows and Glass Doors.
- E. Screen Manufacturers Association (SMA):
  1. SMA 1201 – Specifications for Insect Screens for Windows, Sliding Doors and Swinging Doors.
- F. Window and Door Manufacturers Association (WDMA):
  1. AAMA/WDMA/CSA 101/I.S.2/A440 – North American Fenestration Standard/Specification for Windows, Doors, and Skylights.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Windows shall meet Rating C-LC-PG specifications in accordance with ANSI/AAMA/NWDA 101/I.S.2/A440-08 or ANSI/AAMA/WDMA 101/I.S.2/A440-11.
- B. Window Air Leakage, ASTM E 283: Window air leakage when tested at 1.57 psf (25 mph) shall be 0.05 cfm/ft<sup>2</sup> of frame or less.
- C. Window Water Penetration, ASTM E 547: No water penetration through window when tested under static pressure of 7.5 psf (54 mph) after 4 cycles of 5 minutes each, with water being applied at a rate of 5 gallons per hour per square foot.

#### 1.5 SUBMITTALS

- A. Submit in accordance with Division 1 requirements.
- B. Product Data: Submit manufacturer's product data, including installation instructions.
- C. Shop Drawings: Submit manufacturer's shop drawings, indicating dimensions, construction, component connections and locations, anchorage methods and locations, hardware locations, and installation details.
- D. Samples: Submit full-size or partial full-size sample of window illustrating glazing system, quality of construction, and color of finish.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials to site undamaged in manufacturer's or sales branch's original, unopened containers and packaging, with labels clearly identifying manufacturer and product name. Include installation instructions.
- B. Storage:
  - 1. Store materials in accordance with manufacturer's instructions.
  - 2. Store materials off ground and under cover.
  - 3. Protect materials from weather, direct sunlight, and construction activities.
- C. Handling: Protect materials and finish during handling and installation to prevent damage.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURER

- A. Pella Corporation, 102 Main Street, Pella, Iowa 50219. Toll Free (800) 54-PELLA. Phone (641) 621-1000. Website [www.pella.com](http://www.pella.com).
- B. Substitutions of equivalent products are permitted with approval.

## 2.2 FIBERGLASS CASEMENT WINDOWS

- A. Casement Windows: Pella Impervia. Factory-assembled fiberglass windows with outward-opening sash installed in frame.
- B. Frame and Sash Material: Duracast. 5-layer, pultruded-fiberglass material, reinforced with interlocking mat.
- C. Frame:
  - 1. Type: Block frame.
  - 2. Interior and Exterior Frame: Pultruded, fiberglass composite with foam inserts.
  - 3. Overall Frame Depth: 3-1/4 inches.
  - 4. Nominal Wall Thickness of Fiberglass Members: 0.050 inch to 0.090 inch.
  - 5. Frame Corners:
    - a. Mitered.
    - b. Joined and bonded with neutral-cure room temperature vulcanizing silicone hot-melt adhesive, with corner lock.
  - 6. Jambs: Contain factory-drilled installation screw holes.
- D. Sash:
  - 1. Sash Corners:
    - a. Mitered.
    - b. Bonded and sealed with injected neutral-cure room temperature vulcanizing silicone hot-melt adhesive.
- E. Glazing:
  - 1. Float Glass: ASTM C 1036, Quality 1.
  - 2. Type: Polyurethane reactive (PUR) hot-melt glazed, 11/16"-inch thick, insulating glass, multi-layer Low-E coated with argon.

## 2.3 FIBERGLASS FIXED FRAME WINDOW

- A. Fixed Frame Windows: Pella Impervia. Factory-assembled fixed frame window.
- B. Frame Material: Duracast. 5-layer, pultruded-fiberglass material, reinforced with interlocking mat.
- C. Frame:
  - 1. Type: Block frame.
  - 2. Interior and Exterior Frame: Pultruded, fiberglass composite with foam inserts.
  - 3. Overall Frame Depth: 3-1/4 inches.
  - 4. Nominal Wall Thickness of Fiberglass Members: 0.050 inch to 0.090 inch.
  - 5. Frame Corners:
    - a. Mitered.
    - b. Joined and bonded with nylon corner lock, and mechanical fasteners, and injected with polyurethane adhesive sealant.
  - 6. Weep system at sill to channel incidental moisture to the exterior.
  - 7. Head, Jambs and Sill: Contain factory drilled installation screw holes.

- D. Glazing:
  - 1. Float Glass: ASTM C 1036, Quality 1.
  - 2. Type: Polyurethane reactive (PUR) hot-melt glazed, 11/16"-inch thick, insulating glass, multi-layer Low-E coated with argon.

## 2.4 OPTIONS

- A. Insect Screens:
  - 1. Compliance: ASTM D 3656 and SMA 1201.
  - 2. Screen Cloth: Black Vinyl-coated fiberglass, 18/16 mesh.
  - 3. Set in aluminum frame fitted to inside of window.
  - 4. Complete with necessary hardware.
  - 5. Screen Frame Finish: Baked enamel.
    - a. Color: Selected by Owner from manufacturer's standard colors.

## 2.5 HARDWARE

- A. Roto operator assembly.
  - 1. Steel worm-gear sash operator with hardened gears.
  - 2. Operator Base: Zinc die cast with painted finish.
  - 3. Operator Linkage, Hinge Slide, and Hinge Arms: 300 series stainless steel.
  - 4. Exposed Fasteners: Stainless steel.
  - 5. External Hardware Salt Spray Exposure, ASTM B 117: Exceed 1,000 hours.
- B. Crank Handle Finish.
  - 1. Integrated Folding Crank: Brown.
- C. Locking System: Multi-lock System.
  - 1. Single-handle locking system.
  - 2. Operate positive-acting arms that reach out and pull sash into locked position.
  - 3. Casement Windows: One installed on sash 27.5 inches and smaller in frame height, 2 unison operating locks installed on sash over 27.5 inches in frame height.
  - 4. Lock Handle Finish: Selected by Owner from manufacturer's standard colors.

## 2.6 TOLERANCES

- A. Windows shall accommodate the following opening tolerances:
  - 1. Vertical Dimensions Between High and Low Points: Plus 1/4-inch, minus 0 inch.
  - 2. Width Dimensions: Plus 1/4-inch, minus 0 inch.
  - 3. Building Columns or Masonry Openings: Plus or minus 1/4-inch from plumb.

## 2.7 FINISH

- A. Exterior and Interior Duracast Finish: Factory-applied powder-coat paint, comply with AAMA 624-10.
  - 1. Color: Selected by Owner from manufacturer's standard colors.

## 2.8 INSTALLATION ACCESSORIES

- A. Flashing/Sealant Tape: Pella SmartFlash.
  - 1. Aluminum-foil-backed butyl window and door flashing tape.
  - 2. Maximum Total Thickness: 0.013 inch.
  - 3. UV resistant.
  - 4. Verify sealant compatibility with sealant manufacturer.
- B. Interior Insulating-Foam Sealant: Low-expansion, low-pressure polyurethane insulating window and door foam sealant.
- C. Exterior Perimeter Sealant: "Pella Window and Door Installation Sealant" or equivalent high quality, multi-purpose sealant as specified in the joints sealant section.
- D. Block Frame Installation Accessories: Offset vinyl installation fin.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas to receive windows. Notify Architect of conditions that would adversely affect installation or subsequent use. Do not proceed with installation until unsatisfactory conditions are corrected.

### 3.2 INSTALLATION

- A. Install windows in accordance with manufacturer's instructions.
- B. Install windows to be weather-tight.
- C. Maintain alignment with adjacent work.
- D. Secure assembly to framed openings, plumb and square, without distortion.

### 3.3 CLEANING

- A. Clean window frames and glass in accordance with Division 1 requirements.
- B. Do not use harsh cleaning materials or methods that would damage finish or glass.
- C. Remove labels and visible markings.

3.4 PROTECTION

- A. Protect installed windows to ensure that, except for normal weathering, windows will be without damage or deterioration at time of substantial completion.

END OF SECTION 085413

## SECTION 087000 – HARDWARE

### PART 1 - GENERAL

#### 1.1 CONDITIONS

- A. Conditions of the contract (General and Supplementary Conditions) and Division 01 - General Requirements, govern the work of this section.
- B. This section includes all material, and related service necessary to furnish all finish hardware indicated on the drawings or specified herein.
- C. Furnish UL listed hardware for all labeled and 20 min. openings in conformance with the requirements for the class of opening scheduled. Underwriters' requirements shall have precedence over specification where conflicts exist.
- D. All work shall be in accordance with all applicable state and local building codes. Code requirements shall have precedence over this specification where conflicts exist.

#### 1.2 WORK INCLUDED

- A. This section includes the following:
  - 1. Furnish door hardware (for hollow metal, wood and aluminum doors) specified herein, listed in the hardware schedule, and/or required by the drawings.
  - 2. Cylinders for Aluminum Doors
  - 3. Thresholds and Weather-stripping (Aluminum frame seals to be provided by aluminum door supplier)
  - 4. Electro-Mechanical Devices
- B. Where items of hardware are not definitely or correctly specified and is required for the intended service, such omission, error or other discrepancy should be directed to the Architect prior to the bid date for clarification by addendum. Otherwise furnish such items in the type and quantity established by this specification for the appropriate service intended.

#### 1.3 RELATED WORK IN OTHER SECTIONS

- A. This section includes coordination with related work in the following sections:
  - 1. Division 06 Section "Finish Carpentry".
  - 2. Division 08 Section "Hollow Metal Doors and Frames".
  - 3. Division 08 Section "Wood Doors"
  - 4. Division 08 Section "Aluminum Entrances and Storefronts"
  - 5. Division 26 Sections "Electrical"
  - 6. Division 28 Sections "Electronic Safety and Security".

#### 1.4 REFERENCES

- A. Publications of agencies and organizations listed below form a part of this specification section to the extent referenced.
  - 1. DHI - Recommended Locations for Builders' Hardware.
  - 2. NFPA 80 - Standards for Fire Doors and Windows.

3. NFPA 101 - Code for Safety to Life from Fire in Buildings and Structures.
4. UL - Building Material Directory.
5. DHI - Door and Hardware Institute
6. WHI - Warnock Hersey
7. BHMA - Builders Hardware Manufacturers Association
8. ANSI – American National Standards Institute
9. IBC - International Building Code 2018 Edition (as adopted and amended by local building code)

## 1.5 SUBMITTALS

- A. Within ten days after award of contract, submit detailed hardware schedule in quantities as required by Division 01 - General Requirements.
- B. Schedule format shall be consistent with recommendations for a vertical format as set forth in the Door & Hardware Institute's (DHI) publication "Sequence and Format for the Hardware Schedule". Hardware sets shall be consolidated to group multiple door openings which share similar hardware requirements. Schedule shall include the following information:
  1. Door number, location, size, handing, and rating.
  2. Door and frame material, handing.
  3. Degree of swing.
  4. Manufacturer
  5. Product name and catalog number
  6. Function, type and style
  7. Size and finish of each item
  8. Mounting heights
  9. Explanation of abbreviations, symbols, etc.
  10. Numerical door index, indicating the hardware set/ group number for each door.
- C. When universal type door closers are to be provided, the schedule shall indicate the application method to be used for installation at each door: (regular arm, parallel arm, or top jamb).
- D. The schedule will be prepared under the direct supervision of a certified Architectural Hardware Consultant (AHC), or certified Door Hardware Consultant (DHC) employed by the hardware distributor. The hardware schedule shall be signed and embossed or stamped with the DHI certification seal of the supervising AHC or DHC. The supervising AHC or DHC shall attend any meetings related to the project when requested by the architect.
- E. Check the specified hardware for suitability and adaptability to the details and surrounding conditions.
- F. Review drawings from related trades as required to verify compatibility with specified hardware. Indicate unsuitable or in compatible items, and proposed substitutions in the hardware schedule.
- G. Provide documentation for all hardware to be furnished on labeled fire doors indicating compliance with positive pressure fire testing UL 10C.
- H. Furnish manufacturers' catalog data for each item of hardware in quantities as required by Division 01 - General Requirements.

- I. Submit a sample of each type of hardware requested by the architect. Samples shall be of the same finish, style, and function as specified herein. Tag each sample with its permanent location so that it may be used in the final work.
- J. Furnish with first submittal, a list of required lead times for all hardware items.
- K. After final approved schedule is returned, transmit corrected copies for distribution and field use in quantities as required by Division 01 - General Requirements.
- L. Furnish approved hardware schedules, template lists, and pertinent templates as requested by related trades.
- M. Furnish necessary diagrams, schematics, voltage and amperage requirements for all electro-mechanical devices or systems as required by related trades. Wiring diagrams shall be opening specific and include both a riser diagram and point to point diagram showing all wiring terminations.
- N. After receipt of approved hardware schedule, Hardware supplier shall initiate a meeting including the owner's representative to determine keying requirements. Upon completion of initial key meeting, hardware supplier shall prepare a proposed key schedule with symbols and abbreviations as set forth in the door and hardware institute's publication "Keying Procedures, Systems, and Nomenclature". Submit copies of owner approved key schedule for review and field use in quantities as required by Division 01 - General Requirements. Wiring diagrams shall be included in final submittals transmitted for distribution of field use.

#### 1.6 QUALITY ASSURANCE

- A. Manufacturers and model numbers listed are to establish a standard of function and quality. Similar items by approved manufacturers that are equal in design, function, and quality, may be considered for prior approval of the architect, provided the required data and physical samples are submitted for approval as set forth in Division 01 - General Requirements.
- B. Where indicated in this specification, products shall be independently certified by ANSI for compliance with relevant ANSI/BHMA standards A156.1 - A156.36 – Standards for Hardware and Specialties. All products shall meet or exceed certification requirements for the respective grade indicated within this specification. Supplier shall provide evidence of certification when requested by the architect.
- C. Obtain each type of hardware (hinges, latch & locksets, exit devices, closers, etc.) from a single manufacturer, although several may be indicated as offering products complying with requirements.
- D. Electrical drawings and electrical specifications are based on the specific electrified hardware components specified in hardware sets. When electronic hardware components other than those indicated in hardware sets are provided, the supplier shall be responsible for all costs incurred by the design team and their consultants to review and revise electrical drawings and electrical specifications. Supplier shall also be responsible for any additional costs associated with required changes in related equipment, materials, installation, or final hook up to ensure the system will operate and function as indicated in the construction documents, including hardware set operational / functional descriptions.

- E. All hardware items shall be manufactured no earlier than 6 months prior to delivery to site.
- F. Hardware supplier shall be factory trained and certified by the manufacturer to provide and support all computer managed locks and system components.
- G. Installation of hardware shall be installed or directly supervised and inspected by a skilled installer certified by the manufacturer of locksets, door closers, and exit devices used on the project, or with not less than 3 years' experience in successful completion of projects similar in size and scope.
- H. Provide hardware for all labeled fire doors, which complies with positive pressure fire testing UL 10C.
- I. Comply with all applicable provisions of the standards referenced within section 1.4 of this specification.
- J. Hardware supplier shall participate when reasonably requested to meet with the contractor and or architect to inspect any claim for incorrect or non-functioning materials; following such inspection, the hardware supplier shall provide a written statement documenting the cause and proposed remedy of any unresolved items.

#### 1.7 DELIVERY, STORAGE AND HANDLING

- A. Hardware supplier shall deliver hardware to the job site unless otherwise specified.
- B. All hardware shall be delivered in manufacturers' original cartons and shall be clearly marked with set and door number.
- C. Coordinate with contractor prior to hardware delivery and recommend secure storage and protection against loss and damage at job site.
- D. Contractor shall receive all hardware and provide secure and proper protection of all hardware items to avoid delays caused by lost or damaged hardware. Contractor shall report shortages to the Architect and hardware supplier immediately after receipt of material at the job site.
- E. Coordinate with related trades under the direction of the contractor for delivery of hardware items necessary for factory installation.

#### 1.8 PRE-INSTALLATION MEETING

- A. Schedule a hardware pre-installation meeting on site to review and discuss required door operating clearances and the installation of continuous hinges, locksets, door closers, exit devices, overhead stops, and electromechanical door hardware.
- B. Meeting attendees shall be notified 7 days in advance and shall include: Architect, Contractor, Door Hardware Installers (including low voltage hardware), Manufacturers representatives for above hardware items, and any other effected subcontractors or suppliers.
- C. All attendees shall be prepared to distribute installation manuals, hardware schedules, templates, and physical hardware samples.

#### 1.9 WARRANTY

- A. All hardware items shall be warranted against defects in material and workmanship as set forth in Division 01 - General Requirements.
- B. Repair, replace, or otherwise correct deficient materials and workmanship without additional cost to owner.

PART 2 - PRODUCTS

2.1 FASTENERS

- A. All exposed fasteners shall be Phillips head or as otherwise specified and shall match the finish of the adjacent hardware. All fasteners exposed to the weather shall be non-ferrous or stainless steel. Furnish correct fasteners to accommodate surrounding conditions.
- B. Coordinate required reinforcements for doors and frames. Seek approval of the architect prior to furnishing through-bolts. Furnish through-bolts as required for materials not readily reinforced.

2.2 BUTT HINGES

- A. Acceptable manufacturers and respective catalog numbers:

	<u>Ives</u>	<u>Stanley</u>	<u>Hager</u>	<u>McKinney</u>
1. Standard Weight, Plain Bearing	5PB1	F179	****	T2714
2. Standard Weight, Ball Bearing	5BB1	BB179	BB1279	TB2714
3. Standard Weight, Ball Bearing, Non-Ferrous	5BB1	FBB191	BB1191	TB2314
4. Heavy Weight, Ball Bearing	5BB1HW	FBB168	BB1168	T4B3786
5. Heavy Weight, Ball Bearing, Non-Ferrous	5BB1HW	FBB199	BB1199	T4B3386

- B. Hinges shall be independently certified by ANSI for compliance with ANSI A156.1 (2006). Hinges shall meet or exceed the following ANSI grade requirements as indicated below:

- 1. Standard Weight, Plain Bearing Hinges: Grade 3
- 2. Standard Weight, 2 Ball Bearing Hinges: Grade 2
- 3. Heavy Weight, 4 Ball Bearing Hinges: Grade 1

- C. Unless otherwise specified, furnish the following hinge quantities for each door leaf.

- 1. 3 hinges for doors up to 90 inches.
- 2. 1 additional hinge for every 30 inches on doors over 90 inches.
- 3. 4 hinges for Dutch door applications.

- D. Unless otherwise specified, top and bottom hinges shall be located as specified in Division 08 Section "Hollow Metal Doors and Frames". Intermediate hinges shall be located equidistant from others.

- E. Unless otherwise specified, furnish hinge weight and type as follows:

- 1. Standard weight: plain bearing hinge 5PB1 or ball bearing hinge 5BB1 for interior openings through 36 inches wide without a door closer.
- 2. Standard weight: ball bearing hinge 5BB1 for interior opening over 36 through 40 inches wide without a door closer, and for interior openings through 40 inches wide with a door closer.
- 3. Heavyweight: 4 ball bearing hinge 5BB1HW for interior openings over 40 inches wide, and for all vestibule doors.

4. Heavyweight: 4 ball bearing hinge 5BB1HWss for exterior openings unless otherwise listed in groups.
  5. Heavyweight: 4 ball bearing hinge 5BB1HWss 5" for all exterior doors or 4 ball bearing hinge 5BB1HW 5" for interior doors, that have an automatic operator.
- F. Unless otherwise specified, furnish hinges for exterior doors, fabricated from brass, bronze, or stainless steel. Unless otherwise specified, hinges for interior doors may be fabricated from steel.
- G. Unless otherwise specified, furnish hinges in the following sizes:
1. 5" x 5" 2-1/4" thick doors
  2. 4-1/2" x 4-1/2" 1-3/4" thick doors
  3. 3-1/2" x 3-1/2" 1-3/8" thick doors
- H. Furnish hinges with width to accommodate trim and allow for 180-degree swing.
- I. Unless otherwise specified, furnish hinges with flat button tips with non-rising pins at interior doors, non-removable loose pins (NRP) at exterior, and out-swinging lockable interior doors.
- J. Unless otherwise specified, furnish all hinges to template standards.

### 2.3 CONTINUOUS PIN AND BARREL HINGES

- A. Acceptable manufacturers and respective catalog numbers:
- |   |             |               |                |
|---|-------------|---------------|----------------|
|   | <u>Ives</u> | <u>Markar</u> | <u>Stanley</u> |
| 1. Edge Mount Pin & Barrel Stainless Steel Continuous Hinge | 700 Series  | 300 Series    | 650 Series     |
- B. Hinges shall be independently certified by ANSI for compliance with ANSI A156.26, Grade 1 (2012).
- C. Continuous hinges shall be full height pin and barrel type hinge providing full height door support up to 600 lbs. Edge mount (unless noted otherwise).
- D. Construct hinges of heavy-duty 14-gauge material. The stainless internal pin shall have a diameter of 0.25 and the exterior barrel diameter of 0.438.
- E. Hinge shall be non-handed with symmetrical template hole pattern and factory drilled. Hinge must accept a minimum of 21 fasteners on the door and 21 fasteners on the frame.
- F. Each knuckle to be 2 inches, including split nylon bearing at each separation for quiet, smooth, self-lubricating operation.
- G. Hinge to be able to carry Warnock Hersey Int. or UL for fire rated doors and frames up to 3 hours.
- H. Provide machine screws for doors which have been reinforced to accept machine screws.
- I. Note: Fire label for doors and frames should be placed on the header and top rail of fire rated doors and frames.

### 2.4 POWER TRANSFERS

- A. Acceptable manufacturers and respective catalog numbers:
- |                       |                   |             |            |
|-----------------------|-------------------|-------------|------------|
|                       | <u>Von Duprin</u> | <u>ASSA</u> | <u>ABH</u> |
| 1. Concealed Ten Wire | EPT-10            | CEPT-10     | ****       |
- B. Door cords shall be armored cable with screw on caps.
- C. Concealed power transfers shall be concealed in the door and frame when the door is closed.
- D. Concealed power transfers shall have a steel tube to protect wires from being cut.
- E. Concealed power transfers with spring tubes shall be rejected.
- F. Concealed power transfers shall be supplied with a mud box to house all terminations.

## 2.5 FLUSH BOLTS AND DUST PROOF STRIKES

- A. Acceptable manufacturers and respective catalog numbers:
- |  |             |                      |              |
|--|-------------|----------------------|--------------|
|  | <u>Ives</u> | <u>Door Controls</u> | <u>Hager</u> |
| 1. Dust Proof Strike                   | DP2         | 80                   | 280X         |
| 2. Auto Flush Bolt (Metal Door)        | FB31P       | 842                  | 292D         |
| 3. Auto Flush Bolt (Wood Door)         | FB41P       | 942                  | 291D         |
| 4. Constant Latching Bolt (Metal Door) | FB51P       | 845                  | 293D         |
| 5. Constant Latching Bolt (Wood Door)  | FB61P       | 945                  | 294D         |
| 6. Manual Flush Bolt                   | FB458       | 780                  | 282D         |
- B. Unless otherwise specified, provide 12" rods for manual flush bolts for door 7'6" or less, 24" top rods for doors over 7'6" to 8'6".
- C. Unless otherwise specified, provide doors over 8'6" with automatic top bolts.
- D. Provide automatic flush bolts where required to maintain fire door listing and or egress requirements on pairs of doors.
- E. All flush-bolt applications shall be UL listed to be installed with top flush-bolt only. Provide auxiliary fire bolt as required for fire rated openings where less bottom bolt has been specified.
- F. Provide all bottom flush bolts with non-locking dust proof strikes.

## 2.6 EXIT DEVICES

- A. Acceptable manufacturers and respective catalog numbers:
- |  |                    |                 |                           |
|--|--------------------|-----------------|---------------------------|
|  | <u>Von Duprin</u>  | <u>Sargent</u>  | <u>Detex</u>              |
| 1. Wide Stile, Push Pad                  | 98 / 99 Series     | GL-43-80 Series | Advantex (Wide Stile)     |
| 2. Wide Stile, Electric Latch Retraction | QEL 98 / 99 Series | 43-56-80 Series | Advante-ER x (Wide Stile) |
| 3. Lever Trim                            | 996 Series         | 740 ET          | "D/DM" Trim               |
| 4. Pull Trim                             | 990 Series         | 800 MAL         | "C" Trim                  |
- A. Exit devices shall be independently certified by ANSI for compliance with ANSI A156.3, Grade 1 (2008).

- B. Obtain exit devices from a single manufacturer, although several may be indicated as offering products complying with requirements.
- C. Quiet Electric Latch Retraction shall be accomplished using a motor driven assembly, and shall incorporate the following features:
  - 1. Motor shall retract both the push pad assembly and latchbolt.
  - 2. Automatic calibration of latch throw and pull.
  - 3. Built-in time delay.
  - 4. On-board installation and troubleshooting diagnostics built into power supply and device.
  - 5. Retry mode if device does not pull on the first try.
- D. All exit devices shall be provided with flush end caps to reduce potential damage from impact.
- E. All exit devices shall be provided with dead-locking latch bolts to ensure security.
- F. All exit devices shall be U.L. listed for accident hazard. Exit device for use on fire doors shall also be U.L. listed for fire exit hardware.
- G. Provide optional strikes, special length rods, and adapter plates to accommodate door and frame conditions. Provide narrow style series devices in lieu of wide stile series devices where optional strikes will not accommodate door and frame conditions.
- H. Coordinate with related trades to ensure adequate clearance and reinforcement is provided in doors and frames. Provide thru bolts as required.
- I. Refer to hardware groups for exit device applications utilizing the option of: "less bottom rod and floor strike" (LBR)
- J. All exit devices shall be provided with optional trim designs to match other lever and pull designs used on the project.
- K. Provide glass bead kits as required to accommodate door conditions. Screws shall not be visible through full glass doors.
- L. Where specified, provide compatible keyed mullions with cylinder for pairs of doors.
- M. Provide Von Duprin #154 or equivalent mullion/frame stabilizers at the following application(s):
  - 1. Lockable exterior or vestibule paired openings with a fixed or removable hollow metal or aluminum mullion.
  - 2. Lockable exterior or vestibule single doors in aluminum frames.
- N. Provide reinforced crossbars for all traditional style exit devices applied to doors over 36" wide.

## 2.7 LOCKS AND LATCHES

- A. Acceptable manufacturers and respective catalog numbers:
 

	<u>Schlage</u>	<u>Falcon</u>	<u>Best</u>	<u>Corbin</u>
1. Grade 1 Mortise	L Series 06A	MA Series DG	45H Series 15H	ML2000 NSA

- B. Mortise locks shall be independently certified by ANSI for compliance with ANSI A156.13 (2012).
- C. Unless otherwise specified, all locks and latches to have:
  - 1. 2-3/4" Backset
  - 2. 1/2" minimum throw latchbolt
  - 3. 1" throw deadbolt
  - 4. ANSI A115.2 strikes
- D. Provide guarded latch bolts for all locksets, and latch bolts with throw to maintain fire rating of both single and paired door assemblies.
- E. Provide strike with lip length adequate to clear surrounding trim.
- F. Provide wrought boxes for strikes at inactive doors, wood frames, and metal frames without integral mortar covers.
- G. Provide Von Duprin #154 or equivalent mullion/frame stabilizers at the following application(s) unless provided with deadbolt:
  - 1. Lockable exterior or vestibule paired openings with a fixed or removable hollow metal or aluminum mullion.
  - 2. Lockable exterior or vestibule single doors in aluminum frames.

2.8 PULLS, PUSH BARS, PUSH/PULL PLATES

- A. Acceptable manufacturers and respective catalog numbers:

	<u>Burns</u>	<u>Hager</u>	<u>Ives</u>
1. Straight Pull (1" dia., 10" CTC)	26C	4J	8103-0
2. Straight Pull (3/4" dia., 8" CTC)	25B	3G	8102-8
3. Offset Door Pull (1" dia., 10" CTC)	39C	12J	8190-0
4. Offset Pull (1" dia., 18" CTC Pull)	39G	23Q	8190-18
5. Pull / Push-Bar (1" dia., 10" CTC Pull)	422 x 26C	153	9103-0
6. Offset Pull / Push-Bar (1" dia., 10" CTC Pull)	422 x 39C	159	9190-0
7. Offset Pull / Push-Bar (1" dia., 18" CTC Pull)	422 x 39G	161	9190-18
8. Push Plate (.050 4"X 16")	54	30S 4 x 16	8200 4 x 16
9. Push Plate (.050 6"X 16")	56	30S 6 x 16	8200 6" X 16"

- A. Adjust dimensions of push plates to accommodate stile and rail dimensions, lite and louver cutouts, and adjacent hardware. Where required by adjacent hardware, push plates shall be factory drilled for cylinders or other mortised hardware. All push plates shall be beveled 4 sides and counter sunk.
- B. Where possible, provide back-to-back, and concealed mounting for pulls and push bars. Push bar length shall be 3" less door width, or center of stile to center of stile for stile & rail or full glass doors.

2.9 CLOSERS

- A. Acceptable manufacturers and respective catalog numbers:

	<u>LCN</u>	<u>Yale</u>	<u>Sargent</u>
1. 4050A / 4050A EDA	R4400 / PR4400	350 / 351 P10	

- B. Door closers shall be independently certified by ANSI for compliance with ANSI A156.4, Grade 1 (2013).
- C. Obtain door closers from a single manufacturer, although several may be indicated as offering products complying with requirements.
- D. Provide extra heavy-duty arm (EDA / HD) when closer is to be installed using parallel arm mounting.
- E. Hardware supplier shall coordinate with related trades to ensure aluminum frame profiles will accommodate specified door closers.
- F. Closers shall use aluminum cylinders.
- G. Closers for fire-rated doors shall be provided with temperature stabilizing fluid that complies with standards UL10C.
- H. Unless otherwise specified, all door closers shall have full covers and separate adjusting valves for sweeps, latch, and backcheck.
- I. Provide closers for all labeled doors. Provide closer series and type consistent with other closers for similar doors specified elsewhere on the project.
- J. Provide closers with adjustable spring power. Size closers to ensure exterior and fire rated doors will consistently close and latch doors under existing conditions. Size all other door closers to allow for reduced opening force not to exceed 5 lbs.
- K. Install closers on the room side of corridor doors, stair side of stairways and interior side of exterior doors.
- L. Closers shall be furnished complete with all mounting brackets and cover plates as required by door and frame conditions, and by adjacent hardware.
- M. Door closers shall be provided with a powder coat finish to provide superior protection against the effects of weathering. Powder coat finish shall successfully pass a 100-hour salt spray test.

## 2.10 LOW ENERGY ELECTRO-HYDRAULIC AUTOMATIC OPERATORS

- A. Acceptable manufacturers and respective catalog numbers:
 

	<u>LCN</u>	<u>Besam</u>
1. Electro-Hydraulic Operator	4640	Power Swing
- B. Low energy operators shall be independently certified by ANSI for compliance with ANSI A156.19 (2002).
- C. Where low kinetic energy, as defined by ANSI/BHMA Standard A156.19, power operators are indicated for doors required to be accessible to the disabled, provide electrically powered operators complying with the ADA for opening force and time to close standards.
- D. The closing action shall be controlled by modern type cast iron door closer cylinder filled with a flat viscosity fluid, stable from +120F to -30F that would require no seasonal adjustments. The

closer shall have field adjustable spring power; have two independent closing speed adjustment valves, and hydraulic back-check.

- E. Full closing force shall be provided when the power or assist cycle ends.
- F. All power operator systems shall include the following features and functions:
  - 1. Provisions for separate conduits to carry high and low voltage wiring in compliance with the National Electrical Code, section 725-31.
  - 2. The operator will be designed with an electronically controlled mechanical clutching mechanism to prevent damage to the operator if the system is actuated while the door is latched or if the door is forced closed during the opening cycle.
  - 3. All covers, mounting plates and arm systems shall be powder coated and successfully pass a minimum of 100 hours testing as outlined in ANSI/BHMA Standard A156.18.
  - 4. UL listed for use on labeled doors.
  - 5. All operators shall be non-handed with spring power over a range of at least four sizes; either 1 through 4 or 2 through 5.
  - 6. The power operator shall incorporate microprocessor controlled digital controls including factory default memory settings, on-board diagnostics, non-volatile memory, and integrated delay and relay for controlling door release devices.
  - 7. Provisions in the control box or module shall provide control {inputs and outputs} for; electric strike delay, auxiliary contacts, sequential operation, fire alarms systems, actuators, swing side sensors, and stop side sensors.
  - 8. Exterior switches shall be weather resistant and mount on a single gang electrical box furnished by Division 26.
- G. All electrically powered operators shall include the following features or functions:
  - 1. When an obstruction or resistance to the opening swing is encountered, the operator will pause at that point, then attempt to continue opening the door. If the obstruction or resistance remains, the operator will again pause the door.
  - 2. Easily accessible main power and maintain hold open switches will be provided on the operator.
  - 3. An electronically controlled clutch to provide adjustable opening force.
  - 4. A microprocessor to control all motor and clutch functions.
  - 5. An on-board power supply capable of delivering both 12V and 24V outputs up to a maximum of 1.0 ampere combined load.
  - 6. All input and output power wiring shall be protected by slow blow fuses. These fuses shall be easily replaceable without special tools or component replacement.
  - 7. If electrical failure occurs, the unit shall operate as a standard door closer.
- H. Power Operators shall be warranted by the manufacture to be free from defects in material and workmanship for a period of two years.

## 2.11 KICK PLATES AND MOP PLATES

- A. Furnish protective plates as specified in hardware groups.
- B. Where specified, provide 10" kick plates, 34" armor plates, and 4" mop plates. Unless otherwise specified, metal protective plates shall be .050" thick; plastic plates shall be 1/8" thick.

- C. Protective plates shall be 2" less door width, or 1" less door width at pairs. All protective plates shall be beveled 4 sides and counter sunk.
- D. Protection plates over 16" shall not be provided for labeled doors unless specifically approved by door manufacturers listing. When protection plates over 16" are provided for labeled doors, the plate shall be labeled.
- E. Where specified, provide surface mounted door edges. Edges shall butt to protective plates. Provide edges with cutouts as required adjacent hardware.
- F. Adjust dimensions of protection plates to accommodate stile and rail dimensions, lite and louver cutouts, and adjacent hardware. Where required by adjacent hardware, protection plates shall be factory drilled for cylinders or other mortised hardware.

2.12 OVERHEAD STOPS

- A. Acceptable manufacturers and respective catalog numbers:
 

	<u>Glynn-Johnson</u>	<u>Rixson</u>	<u>Sargent</u>
1. Heavy Duty Surface Mount	GJ900 Series	9 Series	590
2. Heavy Duty Concealed Mount	GJ100 Series	1 Series	690
- B. Unless otherwise specified, furnish GJ900 series overhead stop for hollow metal or 1-3/4" solid core doors equipped with regular arm surface type closers that swing more than 140 degrees before striking a wall, for hollow metal or 1-3/4" solid core doors that open against equipment, casework, sidelights, or other objects that would make wall bumpers inappropriate, and as specified in hardware groups.
- C. Furnish sex bolt attachments for wood and mineral core doors unless doors are supplied with proper reinforcing blocks.
- D. Do not provide holder function for labeled doors.

2.13 WALL STOPS AND HOLDERS

- A. Acceptable manufacturers and respective catalog numbers:
 

	<u>Ives</u>	<u>Hager</u>	<u>Burns</u>
1. Wrought Convex Wall Stop	WS406CVX	232W	570
2. Wrought Concave Wall Stop	WS406CCV	236W	575
- B. Furnish a stop or holder for all doors. Furnish floor stops or hinge pin stops only where specifically specified.
- C. Provide concave style wall stop at all adjacent integral push button locks; provide convex style wall stop at all other locations.
- D. Where wall stops are not applicable, furnish overhead stops.
- E. Do not provide holder function for labeled doors.

2.14 WEATHERSTRIP, GASKETING

- A. Acceptable manufacturers and respective catalog numbers:

	<u>Zero</u>	<u>Pemko</u>	<u>NGP</u>	<u>Reese</u>
1. Weatherstrip	429	2891_PK	700NA	755
2. Adhesive Gasket	188	S88	5050	797
3. Sweep w/ drip	8198	345_N	C627	354
4. Drip Cap	142	346	16	R201

- B. Weatherstrip and gasketing shall be independently certified by ANSI for compliance with ANSI A156.22 (2005).
- C. Where specified in the hardware groups, furnish the above products unless otherwise detailed in groups.
- D. Provide weatherstripping all exterior doors and where specified.
- E. Provide intumescent and other required edge sealing systems as required by individual fire door listings to comply with positive pressure standards UL 10C.
- F. Provide Zero 188 smoke gaskets at all fire rated doors and smoke and draft control assemblies.
- G. Provide gasketing for all meeting edges on pairs of fire doors. Gasketing shall be compatible with astragal design provided by door supplier as required for specific fire door listings.

## 2.15 THRESHOLDS

- A. Acceptable manufacturers and respective catalog numbers:

	<u>Zero</u>	<u>Pemko</u>	<u>NGP</u>	<u>Reese</u>
1. Saddle Thresholds	8655	171	425	S205
2. Half Saddle Thresholds	1674	227	324	S239
3. Interlocking Threshold	74A	114	442-5	T550

- A. Thresholds shall be independently certified by ANSI for compliance with ANSI A156.21 (2001).
- B. Hardware supplier shall verify all finish floor conditions and coordinate proper threshold as required to ensure a smooth transition between threshold and interior floor finish.
- C. Threshold Types:
  - 1. Unless otherwise specified, provide saddle threshold similar to Zero 8655 for all exterior openings with an interior floor finish less than or equal to 1/4" in height.
  - 2. Unless otherwise specified, provide half saddle threshold similar to Zero 1674 for all exterior openings with an interior floor finish greater than 1/4" in height. Threshold height shall match thickness of interior floor finish.

## 2.16 FINISHES AND BASE MATERIALS

- A. Unless otherwise indicated in the hardware groups or herein, hardware finishes shall be applied over base metals as specified in the following finish schedule:

<u>HARDWARE ITEM</u>	<u>BHMA FINISH AND BASE MATERIAL</u>
1. Butt Hinges: Exterior, or Non-Ferrous	630 (US32D - Satin Stainless Steel)
2. Butt Hinges: Interior	652 (US26D - Satin Chromium)

3. Continuous Hinges	630 (US32D - Satin Stainless Steel)
4. Flush Bolts	626 (US26D - Satin Chromium)
5. Exit Devices	626 (US26D - Satin Chromium)
6. Locks and Latches	626 (US26D - Satin Chromium)
7. Pulls and Push Plates/Bars	630 (US32D - Satin Stainless Steel)
8. Closers	689 (Powder Coat Aluminum)
9. Protective Plates	630 (US32D - Satin Stainless Steel)
10. Overhead Stops	630 (US32D - Satin Stainless Steel)
11. Wall Stops and Holders	630 (US32D - Satin Stainless Steel)
12. Thresholds	719 (Mill Aluminum)
13. Weather-strip, Sweeps Drip Caps (wood and hollow metal doors)	Aluminum Anodized
14. Weather-strip, Sweeps Drip Caps (aluminum doors)	Match finish of aluminum doors.
15. Miscellaneous	626 (US26D - Satin Chromium)

## 2.17 KEYING

- A. Acceptable manufacturers and respective catalog numbers:
- |                |               |             |
|----------------|---------------|-------------|
| <u>Schlage</u> | <u>Corbin</u> | <u>Best</u> |
| 1. Everest 29  | Access        | Cormax      |
- B. Provide all locks and cylinders utilizing a patented keyway to prevent manufacturing and distribution of aftermarket key blanks by anyone other than factory authorized dealers.
- C. All locks under this section shall be keyed as directed by the owner to a new Restricted Patented Grand Master Key System.
- D. Keying shall be by lock manufacturer where permanent records shall be kept.
- E. Furnish a total of 2 keys per cylinder. Actual cut keys to be determined by owner.
- F. Master keys and control keys to be delivered by registered mail to the owner. Change keys shall be delivered in a set up key cabinet. Construction keys shall be delivered to the contractor.

## 2.18 KEY CABINETS

- A. Acceptable manufacturers and respective catalog numbers:
- |                 |                    |               |
|-----------------|--------------------|---------------|
| <u>Lund</u>     | <u>Key Control</u> | <u>Telkee</u> |
| 1. 1200-1205 AA | M228-2480          | RWC-AWC       |
- B. Furnish 1 each model 1200 or 1205 AA key cabinet with a capacity 1.5 times the number of key sets.
- C. Provide one key cabinet with at least one hook for each key set, plus additional hooks for 50% expansion.
- D. Furnish key cabinet complete with cam lock, permanent key tags, and change key cards.
- E. Hardware supplier shall prepare all key change index records, tag all keys and place permanent file keys in cabinet.

## 2.19 FIRE DEPARTMENT ACCESS BOX

- A. Acceptable manufacturers, subject to compliance with specified requirements, acceptable manufacturers and products are:
  - 1. Dama, S3 (surface-mount)
  - 2. Dama, R3 (recessed mount)
  - 3. Knox-Box, 3200 Series
  - 4. Tru-Lock (recessed mount), Eau Claire, WI
- B. Verify manufacturer is acceptable to local Fire Department.
- C. Requirements:
  - 1. Coordinate keying requirements with the authority having jurisdiction.
  - 2. Verify surface or flush mount box with E/A.
  - 3. Finish: Corrosion resistant.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Prior to installation of hardware, installer shall examine door frame installation to ensure frames have been set square and plumb. Installer shall examine doors, door frames, and adjacent wall, floor, and ceiling for conditions, which would adversely affect proper operation and function of door assemblies. Do not proceed with hardware installation until such deficiencies have been corrected.

### 3.2 INSTALLATION

- A. Before hardware installation, general contractor/construction manager shall coordinate a hardware installation seminar with a 1 week notice to all parties involved. The seminar is to be conducted on the installation of hardware, specifically of locksets, closers, exit devices, continuous hinges and overhead stops. Manufacturer's representative of the above products to present seminar. Seminar to be held at the job site and attended by installers of hardware (including low voltage hardware) for aluminum, hollow metal and wood doors. Training to include use of installation manuals, hardware schedule, templates and physical products samples.
- B. Shim doors as required to maintain proper operating clearance between door and frame.
- C. Install all hardware in accordance with the approved hardware schedule and manufacturer's instructions for installation and adjustment.
- D. Set units level, plumb and true to the line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.
- E. Provide blocking or reinforcement for all hardware mounted to drywall construction, including wall mounted door stops and holders.
- F. Drill and countersink units which are not factory-prepared for anchorage fasteners. Space fasteners and anchors in accord with industry standards.

- G. Drill appropriate size pilot holes for all hardware attached to wood doors and frames.
- H. Unless otherwise specified, locate all hardware in accordance with the recommended locations for builders hardware for standard doors and frames as published by the Door and Hardware Institute.
- I. Use only fasteners supplied by or approved by the manufacturer for each respective item of hardware.
- J. Mortise and cut to close tolerance and conceal evidence of cutting in the finished work.
- K. Conceal push and pull bar fasteners where possible. Do not install through bolts through push plates.
- L. Install hardware on UL labeled openings in accordance with manufacturer's requirements to maintain the label.
- M. Apply self-adhesive gasketing on frame stop at head & latch side and on rabbet of frame at hinge side.
- N. Install hardware in accordance with supplemental "S" label instructions on all fire rated openings.
- O. Install wall stops to contact lever handles or pulls. Do not mount wall stops on casework, or equipment.
- P. Where necessary, adjust doors and hardware as required to eliminate binding between strike and latchbolt. Doors should not rattle.
- Q. Overhead stops used in conjunction with electrified hold open closers shall be templated and installed to coincide with engagement of closer hold open position.
- R. Install door closers on corridor side of lobby doors, room side of corridor doors, and stair side of stairways.
- S. Adjust spring power of door closers to the minimum force required to ensure exterior and fire rated doors will consistently close and latch doors under existing conditions. Adjust all other door closers to ensure opening force does not to exceed 5 lbs.
- T. Adjust "sweep", "latch", & "back check" valves on all door closers to properly control door throughout the opening and closing cycle. Adjust total closing speed as required to comply with all applicable state and local building codes.
- U. Install "hardware compatible" (bar stock) type weatherstripping continuously for an uninterrupted seal. Adjust templating for parallel arm door closers, exit devices, etc., as required to accommodate weatherstripping.
- V. Unless otherwise specified or detailed, install thresholds with the bevel in vertical alignment with the outside door face. Notch and closely fit thresholds to frame profile. Set thresholds in full bed of sealant.

- W. Compress sweep during installation as recommended by sweep manufacturer to facilitate a water-resistant seal.
- X. Deliver to the owner 1 complete set of installation and adjustment instructions, and tools as furnished with the hardware.

### 3.3 FIELD QUALITY CONTROL

- A. After installation has been completed, the hardware supplier and manufacturers representative for locksets, door closers, exit devices, and overhead stops shall check the project and verify compliance with installation instructions, adjustment of all hardware items, and proper application according to the approved hardware schedule. Hardware supplier shall submit a list of all hardware that has not been installed correctly.
- B. After installation has been completed, the hardware supplier and manufacturers representative shall meet with the owner to explain the functions, uses, adjustment, and maintenance of each item of hardware. Hardware supplier shall provide the owner with a copy of all wiring diagrams. Wiring diagrams shall be opening specific and include both a riser diagram and point to point diagram showing all wiring terminations.

### 3.4 ADJUSTMENT AND CLEANING

- A. At final completion, and when H.V.A.C. equipment is in operation, installer shall make final adjustments to and verify proper operation of all door closers and other items of hardware. Lubricate moving parts with type lubrication recommended by the manufacturer.
- B. All hardware shall be left clean and in good operation. Hardware found to be disfigured, defective, or inoperative shall be repaired or replaced.

### 3.5 HARDWARE SCHEDULE

- A. The following schedule of hardware groups are intended to describe opening function. The hardware supplier is cautioned to refer to the preamble of this specification for a complete description of all materials and services to be furnished under this section.

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HW SET: 01

1	EA	CONT. HINGE	700	IVE
1	EA	STOREROOM LOCK	L9080	SCH
1	EA	OH STOP	100S	GLY
1	EA	SURFACE CLOSER	4050A EDA	LCN
1	EA	RAIN DRIP	142	ZER
1	EA	WEATHERSTRIP	BY DR/FR SUPPLIER	
1	EA	DOOR SWEEP W/DRIP	8198	ZER
1	EA	THRESHOLD	PROFILE AS REQUIRED	ZER

FUNCTION: STOREROOM LOCK

LATCHBOLT RETRACTED BY KEY OUTSIDE OR BY LEVER INSIDE. OUTSIDE LEVER ALWAYS INOPERATIVE. AUXILIARY LATCH DEADLOCKS LATCHBOLT WHEN DOOR IS CLOSED.

HW SET: 02

1	EA	CONT. HINGE	700	IVE
1	EA	CONT. HINGE	700 EPT	IVE
1	EA	POWER TRANSFER	EPT10	VON
1	EA	REMOVABLE MULLION	KR4954 STAB	VON
1	EA	PANIC HARDWARE	CD-99-EO	VON
1	EA	ELEC PANIC HARDWARE	CD-LX-99-NL-OP	VON
4	EA	IC CYLINDER	AS REQUIRED	SCH
2	EA	90 DEG OFFSET PULL	8190 10"	IVE
2	EA	OH STOP	100S	GLY
1	EA	SURFACE CLOSER	4050A EDA	LCN
1	EA	SURF. AUTO OPERATOR	4642	LCN
2	EA	ACTUATOR	8310-856	LCN
1	EA	RAIN DRIP	142	ZER
1	EA	WEATHERSTRIP	BY DR/FR SUPPLIER	
2	EA	DOOR SWEEP W/DRIP	8198	ZER
1	EA	THRESHOLD	PROFILE AS REQUIRED	ZER
1	EA	ELEVATION DRAWING		
1	EA	WIRE DIAGRAM	POINT TO POINT	

FUNCTION: (NL) LATCHBOLT RETRACTED INSIDE BY EXIT DEVICE PUSH PAD AND OUTSIDE BY KEY IN CYLINDER. DOOR LOCKS WHEN KEY IS REMOVED AND DOOR IS CLOSED. ACCESS FROM EXTERIOR WHEN EXIT DEVICE PUSH PAD IS DOGGED DOWN. FUNCTION: (EO) LATCHBOLT RETRACTED INSIDE BY EXIT DEVICE PUSH PAD. ACCESS FROM EXTERIOR WHEN EXIT DEVICE PUSH PAD IS DOGGED DOWN. ACTUATORS ARE ACTIVE TO OPEN DOOR WHEN LATCHBOLT MONITOR DETECTS THAT THE PANIC HARDWARE IS DOGGED.

HW SET: 03

2	EA	CONT. HINGE	700 EPT	IVE
2	EA	POWER TRANSFER	EPT10	VON
1	EA	REMOVABLE MULLION	KR4954 STAB	VON
1	EA	PANIC HARDWARE	LD-99-L	VON
1	EA	ELEC PANIC HARDWARE	SD-LX-QEL-99-L	VON
4	EA	IC CYLINDER	AS REQUIRED	SCH
2	EA	OH STOP	100S	GLY
1	EA	SURFACE CLOSER	4050A EDA	LCN
1	EA	SURF. AUTO OPERATOR	4642	LCN
2	EA	ACTUATOR	8310-856	LCN
1	EA	RAIN DRIP	142	ZER
1	EA	WEATHERSTRIP	BY DR/FR SUPPLIER	
2	EA	DOOR SWEEP W/DRIP	8198	ZER
1	EA	THRESHOLD	PROFILE AS REQUIRED	ZER
1	EA	ELEVATION DRAWING		
1	EA	WIRE DIAGRAM	POINT TO POINT	
	EA	HINGE SIDE CONDUIT	BY OTHERS. FOR FUTURE WIRING THRU EPT @ INACTIVE LEAF	BYO
	EA	RACEWAY IN DOOR	FOR FUTURE USE @ INACTIVE LEAF	

FUNCTION: (L) LATCHBOLT RETRACTED BY DEPRESSING THE ACTUATION BAR.  
 ENTRANCE BY LEVER. KEY LOCKS OR UNLOCKS LEVER.  
 OUTSIDE ACTUATOR IS ACTIVE TO MOMENTARILY RETRACT LATCH THEN OPEN DOOR  
 WHEN LATCHBOLT MONITOR DETECTS THAT THE PANIC HARDWARE IS DOGGED.  
 INSIDE ACTUATOR IS ALWAYS ACTIVE TO MOMENTARILY RETRACT LATCH THEN OPEN  
 DOOR. AUTO OPERATOR POWERS THE ELECTRIC LATCH RETRACTION.  
 INACTIVE LEAF POWER TRANSFER AND HINGE SIDE CONDUIT ARE FOR FUTURE WIRING.

HW SET: 04

1	EA	CONT. HINGE	700	IVE
1	EA	CONT. HINGE	700 EPT	IVE
1	EA	POWER TRANSFER	EPT10	VON
1	EA	REMOVABLE MULLION	KR4954 STAB	VON
1	EA	PANIC HARDWARE	LD-99-L	VON
1	EA	ELEC PANIC HARDWARE	SD-LX-QEL-99-L	VON
4	EA	IC CYLINDER	AS REQUIRED	SCH
2	EA	OH STOP	100S	GLY
1	EA	SURFACE CLOSER	4050A EDA	LCN
1	EA	SURF. AUTO OPERATOR	4642	LCN
2	EA	ACTUATOR	8310-856	LCN
1	EA	ELEVATION DRAWING		
1	EA	WIRE DIAGRAM	POINT TO POINT	

FUNCTION: (L) LATCHBOLT RETRACTED BY DEPRESSING THE ACTUATION BAR. ENTRANCE BY LEVER. KEY LOCKS OR UNLOCKS LEVER. OUTSIDE ACTUATOR IS ACTIVE TO RETRACT LATCH AND OPEN DOOR WHEN LATCHBOLT MONITOR DETECTS THAT THE PANIC HARDWARE IS DOGGED. INSIDE ACTUATOR IS ALWAYS ACTIVE TO MOMENTARILY RETRACT LATCH THEN OPEN DOOR. AUTO OPERATOR POWERS THE ELECTRIC LATCH RETRACTION.

HW SET: 05

1	EA	HINGE	AS REQUIRED	IVE
1	EA	STOREROOM LOCK	L9080	SCH
1	EA	OH STOP	90S	GLY
1	EA	SURFACE CLOSER	4050A EDAW/62G ST-5004	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	IVE
1	EA	RAIN DRIP	142	ZER
1	SET	WEATHERSTRIP	429	ZER
1	EA	DOOR SWEEP W/DRIP	8198	ZER
1	EA	THRESHOLD	PROFILE AS REQUIRED	ZER

FUNCTION: STOREROOM LOCK  
 LATCHBOLT RETRACTED BY KEY OUTSIDE OR BY LEVER INSIDE. OUTSIDE LEVER ALWAYS INOPERATIVE. AUXILIARY LATCH DEADLOCKS LATCHBOLT WHEN DOOR IS CLOSED.

HW SET: 06

	EA	HINGE	AS REQUIRED	IVE
1	EA	STOREROOM LOCK	L9080	SCH
1	EA	OH STOP	90S	GLY
1	EA	SURFACE CLOSER	4050A EDAW/62G ST-5004	LCN
1	EA	ARMOR PLATE	8400 34" X 2" LDW B-CS	IVE
1	EA	RAIN DRIP	142	ZER
1	SET	WEATHERSTRIP	429	ZER
1	EA	DOOR SWEEP W/DRIP	8198	ZER
1	EA	THRESHOLD	PROFILE AS REQUIRED	ZER
	EA	STRIKE SIDE CONDUIT	BY OTHERS. FOR FUTURE ELECTRIC STRIKE.	BYO

FUNCTION: STOREROOM LOCK

LATCHBOLT RETRACTED BY KEY OUTSIDE OR BY LEVER INSIDE. OUTSIDE LEVER ALWAYS INOPERATIVE. AUXILIARY LATCH DEADLOCKS LATCHBOLT WHEN DOOR IS CLOSED.

HW SET: 07

	EA	HINGE	AS REQUIRED	IVE
2	EA	MANUAL FLUSH BOLT	FB458	IVE
1	EA	DUST PROOF STRIKE	DP2	IVE
1	EA	STOREROOM LOCK	L9080	SCH
1	EA	OH STOP	90S	GLY
1	EA	SURFACE CLOSER	4050A SCUSH	LCN
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS	IVE
1	EA	RAIN DRIP	142	ZER
1	EA	OVERLAPPING ASTRAGAL	BY DOOR MFR	B/O
2	EA	DOOR SWEEP W/DRIP	8198	ZER
1	EA	THRESHOLD	PROFILE AS REQUIRED	ZER

FUNCTION: STOREROOM LOCK

LATCHBOLT RETRACTED BY KEY OUTSIDE OR BY LEVER INSIDE. OUTSIDE LEVER ALWAYS INOPERATIVE. AUXILIARY LATCH DEADLOCKS LATCHBOLT WHEN DOOR IS CLOSED.

HW SET: 08

	EA	HINGE	AS REQUIRED	IVE
1	EA	PASSAGE SET	L9010	SCH
1	EA	OH STOP	90S	GLY

FUNCTION: PASSAGE LATCH

LATCHBOLT RETRACTED BY LEVER FROM EITHER SIDE AT ALL TIMES.

HW SET: 09

	EA	HINGE	AS REQUIRED	IVE
1	EA	PRIVACY LOCK	L9040	SCH
1	EA	WALL STOP	WS406/407CCV	IVE
1	EA	GASKETING	188S	ZER

FUNCTION: PRIVACY LOCK

LATCHBOLT RETRACTED BY LEVER FROM EITHER SIDE UNLESS OUTSIDE IS LOCKED BY INSIDE THUMBTURN. TURNING INSIDE LEVER OR CLOSING DOOR UNLOCKS OUTSIDE LEVER. TO UNLOCK FROM OUTSIDE, REMOVE EMERGENCY BUTTON, INSERT EMERGENCY TURN (FURNISHED) IN ACCESS HOLE AND ROTATE.

HW SET: 10

	EA	HINGE	AS REQUIRED	IVE
1	EA	OFFICE/ENTRY LOCK	L9050	SCH
1	EA	WALL STOP	WS406/407CCV	IVE

FUNCTION: OFFICE AND INNER ENTRY LOCK

LATCHBOLT RETRACTED BY LEVER FROM EITHER SIDE UNLESS OUTSIDE IS MADE INOPERATIVE BY KEY OUTSIDE OR BY TURNING INSIDE THUMBTURN. WHEN OUTSIDE IS LOCKED, LATCHBOLT IS RETRACTED BY KEY OUTSIDE OR BY LEVER INSIDE. OUTSIDE LEVER REMAINS LOCKED UNTIL THUMBTURN IS RETURNED TO VERTICAL OR UNLOCKED BY KEY. AUXILIARY LATCH DEADLOCKS LATCHBOLT WHEN DOOR IS CLOSED.

HW SET: 11

	EA	HINGE	AS REQUIRED	IVE
1	EA	CLASSROOM LOCK	L9070	SCH
1	EA	WALL STOP	WS406/407CCV	IVE

FUNCTION: CLASSROOM LOCK

LATCHBOLT RETRACTED BY LEVER FROM EITHER SIDE UNLESS OUTSIDE IS LOCKED BY KEY. UNLOCKED FROM OUTSIDE BY KEY. INSIDE LEVER ALWAYS FREE FOR IMMEDIATE EXIT. AUXILIARY LATCH DEADLOCKS LATCHBOLT WHEN DOOR IS CLOSED..

HW SET: 12

	EA	HINGE	AS REQUIRED	IVE
1	EA	CLASSROOM LOCK	L9070	SCH
1	EA	OH STOP	90S	GLY

FUNCTION: CLASSROOM LOCK

LATCHBOLT RETRACTED BY LEVER FROM EITHER SIDE UNLESS OUTSIDE IS LOCKED BY KEY. UNLOCKED FROM OUTSIDE BY KEY. INSIDE LEVER ALWAYS FREE FOR IMMEDIATE EXIT. AUXILIARY LATCH DEADLOCKS LATCHBOLT WHEN DOOR IS CLOSED.

HW SET: 13

	EA	HINGE	AS REQUIRED	IVE
1	EA	STOREROOM LOCK	L9080	SCH
1	EA	WALL STOP	WS406/407CCV	IVE

FUNCTION: STOREROOM LOCK

LATCHBOLT RETRACTED BY KEY OUTSIDE OR BY LEVER INSIDE. OUTSIDE LEVER ALWAYS INOPERATIVE. AUXILIARY LATCH DEADLOCKS LATCHBOLT WHEN DOOR IS CLOSED.

HW SET: 14

	EA	HINGE	AS REQUIRED	IVE
1	EA	STOREROOM LOCK	L9080	SCH
1	EA	SURFACE CLOSER	4050A EDA	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	IVE
1	EA	WALL STOP	WS406/407CCV	IVE
1	EA	GASKETING	188S	ZER

FUNCTION: STOREROOM LOCK

LATCHBOLT RETRACTED BY KEY OUTSIDE OR BY LEVER INSIDE. OUTSIDE LEVER ALWAYS INOPERATIVE. AUXILIARY LATCH DEADLOCKS LATCHBOLT WHEN DOOR IS CLOSED.

HW SET: 15

	EA	HARDWARE	BY DOOR MFR
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END OF SECTION 087000

## SECTION 088000 - GLAZING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Glass types.
- B. Glazing materials and accessories.

#### 1.2 RELATED REQUIREMENTS

- A. Section 079200 – Joint Sealants.
- B. Section 081113 – Hollow Metal Doors and Frames.
- C. Section 084113 – Aluminum Framed Entrances and Storefronts

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Product Data.

#### 1.4 ACTION SUBMITTALS

- A. Samples of glazing and components.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Guardian Industries – 2300 Harmon Road, Auburn Hills, MI 48326. Phone: (855) 584-5277. Website: [www.guardianglass.com/us/en](http://www.guardianglass.com/us/en).
- B. Pilkington North America - 811 Madison Avenue, Toledo, OH 43604-5684. Phone: (800) 221-0444. Website: [www.pilkington.com/en/us](http://www.pilkington.com/en/us). Email: [BuildingProducts.PNA@nsg.com](mailto:BuildingProducts.PNA@nsg.com).
- C. Vitro Architectural Glass – 400 Guys Run Road, Cheswick, PA 15024. Phone: (855) 887-6457. Website: [www.vitroglass.com](http://www.vitroglass.com).
- D. Viracon, Inc. - 800 Park Drive, Owatonna, MN 55060. Phone: (800) 533-2080. Email: [glass@viracon.com](mailto:glass@viracon.com).
- E. Materials referenced in this Section are manufactured by Vitro Architectural Glass, unless noted otherwise.

## 2.2 GLASS TYPES

- A. Type 1:
  - 1. Clear, heat-strengthened float.
  - 2. Quality: q<sup>3</sup> glazing select.
  - 3. Thickness: 1/4".
  - 4. Use: As shown on Drawings.
  
- B. Type 2:
  - 1. Solar Control, Low-E, Tinted, Insulating Glass
  - 2. Exterior Lite: "Solargray" Glass by Vitro Architectural Glass, sputter coated on surface two (2).
  - 3. Interior Lite: Clear (transparent) float glass. Use clear (transparent) tempered glass in lites below 36" above finished floor.
  - 4. Low-E Coating: "Solarban 60" by Vitro Architectural Glass, sputter coated on surface two (2).
  - 5. Outdoor Appearance: Cool light-gray.
  - 6. Thickness: 1" total thickness. 1/4" (6 mm) glass + 1/2" (13 mm) air space + 1/4" (6 mm) glass
  - 7. Use: As shown on Drawings.
  
- C. Type 3:
  - 1. Laminated safety/security glass.
  - 2. Clear, 0.157" (4 mm) tempered glass, .060" (1.5 mm) PVB interlayer, clear, 0.157" (4 mm) tempered glass.
  - 3. Overall Thickness: 3/8" (9.5 mm).
  
- D. Glass for fiberglass windows by window manufacturer as shown in Section 085413 - Fiberglass Casement Windows.

## 2.3 GLAZING MATERIALS

- A. Glazing compound: Modified oil type, nonhardening, knife grade consistency; white color.
- B. Butyl sealant: Single-component; Shore A durometer hardness of 10-20; black color; non-skinning.
- C. Silicone sealant: Single-component, solvent curing; capable of water immersion without loss of properties; nonbleeding; non-staining; color: white.
- D. Extruded neoprene or EPDM gaskets.
- E. Confirm compatibility of glazing sealants with glass manufacturer.

## 2.4 GLAZING ACCESSORIES

- A. Material and size as recommended by glazing and frame manufacturers.
- B. Spacer shims: Material and size as recommended by glazing and frame manufacturers.
- C. Glazing tape: Preformed butyl-compound with integral resilient tube spacing device; coiled on release paper; black color.
- D. Glazing clips: Manufacturer's standard type.

## PART 3 - EXECUTION

### 3.1 INSPECTION

- A. Verify surfaces of glazing channels or recesses are clean, free of obstructions, and ready for Work.
- B. Beginning of installation means acceptance of substrate.

### 3.2 PREPARATION

- A. Clean contact surfaces with solvent and wipe dry.
- B. Seal porous glazing channels or recesses.
- C. Prime surfaces scheduled to receive sealant, if recommended by sealant manufacturer.

### 3.3 INSTALLATION

- A. Comply with CPSC 16 CFR C1, FGMA Glazing Manual and SIGMA standards.
- B. Install glass in frames in accordance with manufacturer's recommendations.
- C. Completed installation shall be weathertight and secure, withstanding normal temperature changes, wind loads and live loads, without failure, including glass breakage and component failure.
- D. Do no outside glazing in damp or dusty weather or when temperature is below 40°F (4°C).
- E. Protect glass from breakage.

### 3.4 CLEANING

- A. Remove non-permanent labels, wash, and polish both faces of glass. Comply with glass product manufacturer's recommendations for final cleaning.
- B. Remove and replace any damaged or defective glass.

END OF SECTION 088000

## SECTION 089000 – LOUVERS AND VENTS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Stationary louvers.

#### 1.2 RELATED REQUIREMENTS

- A. Section 079200 - Joint Sealants.

#### 1.3 REFERENCES

- A. AMCA 500 - Laboratory Methods of Testing Louvers for Rating.
- B. AMCA 511 - Certified Ratings Program For Air Control Devices.
- C. ASHRAE 52-76 - Method of Testing Air Cleaning Devices Used In General Ventilation For Removing Particulate Matter.
- D. ASTM A36 - Structural Steel.
- E. ASTM B22 - Bronze Castings for Bridges and Turntables.
- F. ASTM B209 - Aluminum-Alloy Sheet and Plate.
- G. ASTM B221 - Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.

#### 1.4 SUBMITTALS

- A. Shop Drawings indicating, in large scale, profile of frame and installation details, relation to adjacent construction, flashing, blade configuration, connections to duct work, construction materials, finishes, bird screens, free-air, pressure drop, and water penetration.
- B. Samples:
  - 1. Indicate, in large scale, profile of frame and installation details, relation to adjacent construction, flashing, blade configuration, connections to duct work, construction materials, finishes, bird screens, free-air, pressure drop, and water penetration.
  - 2. Color as selected, minimum size 3" x 6" (75 mm x 150 mm).

#### 1.5 QUALITY ASSURANCE

- A. Stationary louver performance: Rate in accordance with AMCA 500, latest edition.
- B. Operable louver performance: Rate in accordance with AMCA 511, latest edition.

## PART 2 - PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Air Balance, Inc.
- B. Construction Specialties, Inc.
- C. Greenheck.
- D. Ruskin Company.
- E. Materials referenced in this Section are manufactured by Ruskin Company, unless noted otherwise. Equivalent products from other manufacturers are acceptable.

### 2.2 STATIONARY LOUVERS

- A. Designation: LVR.
- B. Size: As scheduled on Drawings.
- C. Type: 6" (150 mm) stationary louver with 37.5° blade angle and hidden mullions.
- D. Material: Extruded aluminum with minimum 0.081" frame and blade thickness.
- E. Provide intermediate structural supports required to withstand wind load of 20 lb/sq ft (98 kg/sq m).
- F. Finish: Kynar; color – to match adjacent exterior construction material, selected by Owner from manufacturer's standard colors.
- G. Accessories: Aluminum bird screen.
- H. Performance: As scheduled on Drawings for maximum face velocity and maximum static pressure drop.
- I. Water penetration: 0.01 oz/sq ft (0.3 ml/sq m) maximum at 1023 fpm.
- J. Manufacturer: Ruskin Company Model ELF6375DX.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Take site dimensions affecting Work.
- B. Ensure openings affecting this Work are properly prepared and that flashings are correctly located to divert moisture to exterior.

### 3.2 INSTALLATION

- A. Install louvers in openings properly aligned and level.
- B. Secure louver rigidly with fasteners of noncorrosive metals to suit materials being encountered.
- C. Coordinate installation method with mechanical work.
- D. Set and tie into flashings to ensure diversion of moisture to exterior.
- E. Install bird screens fixed to interior.
- F. Blank off unused portions of louvers with 1¼" (31 mm) thick polyisocyanurate insulated panel by Mapes Industries, or equal.
- G. Louver sizes too large for shipping shall be built by Contractor from factory-assembled louver sections to provide overall sizes required.

### 3.3 FINISH

- A. Apply finishes in accordance with manufacturer's instructions.
- B. Exterior: Kynar finish or as required to match louver.
- C. Interior: Galvanized steel or as required to match ductwork.
- D. Edges: Either factory-enclosed with like materials or field-enclosed with galvanized sheet metal to match panel.

### 3.4 PROTECTION

- A. Protect louvers and finishes from damage during delivery and installation.
- B. Protect adjacent surfaces, finishes, and materials from damage during installation of louvers.

END OF SECTION 089000

## SECTION 092116 – GYPSUM BOARD ASSEMBLIES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Gypsum board.
- B. Cementitious board.
- C. Fasteners and accessories.
- D. Joint materials.
- E. Finish materials.
- F. Sound insulation.

#### 1.2 RELATED REQUIREMENTS

- A. Section 061000 - Rough Carpentry.
- B. Section 072100 – Thermal Insulation: Thermal and acoustical insulation.
- C. Section 079200 – Joint Sealants.
- D. Section 099000 - Painting and Coating.

#### 1.3 REFERENCES

- A. ASTM C475 - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
- B. ASTM C514 - Standard Specification for Nails for the Application of Gypsum Board.
- C. ASTM C834 - Standard Specification for Latex Sealants.
- D. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board.
- E. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
- F. ASTM C1280 - Standard Specification for Application of Gypsum Sheathing.
- G. ASTM C1396 - Specification for Gypsum Board.
- H. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
- I. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.

- J. GA 214 - Recommended Levels of Gypsum Board Finish.
- K. GA 216 - Application and Finishing of Gypsum Board.
- L. UL - Fire Resistance Directory.
- M. WH - Certification Listings.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver manufactured materials in their original packages and containers bearing name of manufacturer and brand.
- B. Store in protected area according to manufacturer's recommendations.
- C. Do not store materials on damp or wet surfaces. Remove from premises and replace damaged materials.
- D. Store gypsum board flat. Do not deliver to building in which application is to be made until windows are in and glazed, and exterior doors are hung.

#### 1.5 ENVIRONMENTAL REQUIREMENTS

- A. In cold weather and during gypsum board joint finishing, maintain temperatures in building within range of 55°F to 70°F (13°C to 21°C). Provide adequate ventilation to carry off excess moisture.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. CertainTeed Corp.
- B. Georgia-Pacific Corp.
- C. Gold Bond Building Products, National Gypsum Co.
- D. U. S. Gypsum Co. (USG)
- E. Materials referenced in this Section are manufactured by USG, unless noted otherwise.

#### 2.2 GYPSUM BOARD

- A. Gypsum drywall panels: "Sheetrock" SW gypsum panels, with tapered edges on face side; ASTM C1396; 5/8" (16 mm) or 1/2" (13 mm) thick.
- B. Fire-rated gypsum panels: Comply with ASTM C1396 for Type X gypsum board. "Sheetrock FireCode C" gypsum panels, with tapered edges; 5/8" (16 mm) thick.
- C. Water-resistant gypsum drywall: ASTM C1396; "Sheetrock W/R" gypsum panels, with tapered edges; 5/8" (16 mm) thick.

- D. Abuse-resistant gypsum panel: “Abuse-Resistant” gypsum panels with tapered edges; 5/8” (16 mm) thick.
- E. Cementitious backerboard: “Durock” portland cement backerboard, with woven glass fiber mesh front and back; 1/2” (13 mm) thick. Use: Backing for ceramic tile and thin veneer stone.

### 2.3 FASTENERS

- A. Screw type: Self-drilling, self-tapping, bugle head, for use with power-driven tool.
- B. Drywall-to-wood; drywall-to-drywall; or cementitious board to wood framing: As recommended by wallboard manufacturer.
- C. Length and spacing: As recommended by wallboard manufacturer.

### 2.4 ACCESSORIES

- A. Provide accessories necessary for complete installation. Plastic trim accessories not acceptable.
- B. Corner beads: Galvanized steel, Dur-A-Bead No. 103, or equal.
- C. Control joints: Galvanized steel control joint No. 093, or equal.
- D. Casing beads: Galvanized steel, Metal Trim No. 200-A, or equal.
- E. Galvanized steel furring channels, furring channel clips, 1-1/2” (38 mm) cold-rolled channels, 8-gage (4 mm) hanger wire, 16-gage (1.5 mm) tie wire and miscellaneous trim required for complete installation.

### 2.5 JOINT MATERIALS

- A. Adhesives and joint compound materials shall be as recommended by manufacturer of gypsum board for type best suited to prevailing partition or wall materials and conditions.
- B. Joint reinforcement tapes and joint compounds shall be capable of producing finished joints between gypsum wallboard panels that are free of cracks and form smooth, unobtrusive surfaces suitable for painting.
- C. Materials shall be moisture-resistant and not affected by humidity after final hardening.

### 2.6 SOUND INSULATION

- A. Material shall be of width required to fill space between studs without slippage or sag.

### 2.7 FINISH MATERIALS

- A. Prime coat, wall, or ceiling: “Sheetrock First Coat” flat latex base coat paint with high solids content, or equal.
- B. Aggregated non-asbestos powder for ceiling application: Imperial “QT Spray Texture Finish” with Latex additive.

## PART 3 - EXECUTION

### 3.1 INSTALLATION - GENERAL

- A. Install materials as recommended by manufacturer of gypsum board, and in accordance with ASTM C840.
- B. Verify wood studs, furring, and miscellaneous framing accessories are properly installed and ready to receive gypsum wallboard.
- C. Verify insulations and vapor barriers are in place.
- D. Complete installation shall be plumb and true, without waves or buckles, and rigid with members fastened securely together.
- E. Use approved UL construction system for fire-rated walls and ceiling.

### 3.2 CONTROL JOINTS

- A. Installation in wall and ceiling membranes shall include breaking gypsum boards behind control joint.
- B. In ceiling construction, framing shall be broken, and in partitions, use separate studs on each side of control joints.
- C. Position joints to intersect light fixtures, air diffusers, door openings and other areas of stress concentration.
- D. Isolate gypsum construction with control joints when:
  - 1. Partitions or ceilings of dissimilar construction meet and remain in same plane.
  - 2. Wings of "L"-, "U"-, and "T"- shaped ceiling areas are joined.
  - 3. Expansion or control joints occur in base wall construction and/or building structure.
- E. Use in face of gypsum partitions and ceilings when size of surface exceeds following control joint spacings:
  - 1. Partitions: 30' (10 m) maximum in either direction.
  - 2. Interior ceilings (with perimeter relief): 50' (16.5 m) maximum in either direction.
  - 3. Interior ceilings (without perimeter relief): 30' (10 m) maximum in either direction.
  - 4. Exterior ceilings: 30' (10 m) maximum in either direction.
- F. Ceiling-height door frames may be used as vertical control joints for partitions. Door frames of lesser height may only be used as control joints if standard control joints extend to ceiling from both corners of top of door frame.
- G. In ceilings, locate to intersect column penetrations.

### 3.3 GYPSUM BOARD INSTALLATION

- A. Where possible, install single sheets full distance across space, perpendicular, to minimize end joints. Long edges of board shall be at right angles to framing members.

- B. Abutting ends or edge joints shall occur over surface of framing member; fit neatly and accurately into corner conditions.
- C. Locate and install control joints.
- D. Secure to supports and along abutting ends with screws of type and spacing recommended by manufacturer and as specified.
- E. Fasteners shall be not less than 3/8" (10 mm) from edges or ends.
- F. Stagger joints between layers at multiple-layer installation.
- G. Insert sound insulation full width between studs and extend above finish ceilings as shown on Drawings. Friction fit between wall studs.
- H. Set gypsum board at base of partitions in acoustical sealant to seal joint at floor. Set exterior gypsum board in bed of acoustical sealant, continuous at floor. Calk at top of partitions at structure above with acoustical sealant. Apply 1/4" (6 mm) minimum round single bead on each side of partition and around cut-outs. Acoustical sealant shall be Sheetrock Brand Acoustical Sealant meeting ASTM C919 and ASTM C834.
- I. After trim has been applied, and prior to decoration, correct surface damage and defects as required to leave work smooth and without blemish.
- J. Apply gypsum board to suspended ceilings with long dimension at right angle to furring channels. Fasten board to channels with approved fasteners.
- K. Gypsum board shall be continuously protected from weather and damage by dampness or any other means.

### 3.4 CEMENT BOARD INSTALLATION

- A. Stagger panel joints and fasten to framing with fasteners and spacing as recommended by manufacturer.
- B. Joint treatment: Prefill joints with tile-setting mortar or adhesive and then immediately embed tape and level joints.

### 3.5 ACCESSORIES INSTALLATION

- A. Fasten corner beads, control joints and other accessories securely in place and build around them with 3 coats of feathered-out joint compound and sand smooth.
- B. Reinforcement: Use reinforcement tape around openings to reduce stresses on drywall at these points; cover with feathered-out joint compound and sand smooth.

### 3.6 JOINT FINISH APPLICATION - WALL AND CEILINGS

- A. Finishing: In accordance with GA-214, as follows.

B. Level 4:

1. Joints and interior angles shall have tape embedded in joint compound and 3 separate coats of joint compound applied over joints, angles, fastener heads, and accessories. Joint compound shall be smooth and free of tool marks and ridges.
2. Location: Exposed gypsum board surfaces unless noted otherwise.

END OF SECTION 092116

## SECTION 092216-13 – NONSTRUCTURAL METAL STUD FRAMING

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Nonstructural metal framing system for suspended gypsum board ceilings.

#### 1.02 RELATED REQUIREMENTS

- A. Section 061000 - Rough Carpentry: Wood blocking.
- B. Section 092116 - Gypsum Board Assemblies.

### PART 2 PRODUCTS

#### 2.01 MATERIALS

- A. Framing system components: ASTM C645.
- B. Channels, furring, and bracing members:
  - 1. Channels:
    - a. 16-gage (1.5 mm) cold-rolled galvanized steel channels.
    - b. Sizes:
      - 1) Runner channels: 3/4" (19 mm) with 1/2" (13 mm) flange.
      - 2) Carrying channels: 1-1/2" (38 mm) with 19/32" (15 mm) flange.
      - 3) As indicated on Drawings or as required to suit design and construction conditions.
- C. Resilient channels: Minimum 25-gage (0.50 mm), 1-1/2" (38 mm) wide, 1/2" (13 mm) deep. Fasteners: GA 203.
- D. Wall furring brackets, clips, and hanger wire: Manufacturer's standard.

### PART 3 EXECUTION

#### 3.01 ERECTION

- A. Installation shall be in strict conformance to manufacturer's instructions.
- B. Suspended framing:
  - 1. Space 8-gage hanger wires 48" (1200 mm) oc along carrying channels and within 6" (150 mm) of ends of carrying channel runs. Secure hanger wires to structure above.
  - 2. Install 1-1/2" (38 mm) carrying channels 48" (1200 mm) oc and within 6" (150 mm) of parallel walls or partitions. Secure with hanger wires saddle-tied along channel. Provide 1" (25 mm) clearance between carrying channels and abutting walls or partitions.
  - 3. Erect runner channels at right angles to carrying channels, spaced 24" (600 mm) oc, and within 6" (150 mm) of parallel walls or partitions. Provide 1" (25 mm) clearance between runner ends and abutting walls or partitions. Secure to carrying channels with clips or saddle-tie with double strand 16-gage (1.5 mm) tie wire.

END OF SECTION 092216-13

## SECTION 093000 – TILING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Wall tiles.
- B. Setting materials.

#### 1.2 RELATED REQUIREMENTS

- A. Section 079200 – Joint Sealants.
- B. Section 092116 – Gypsum Board Assemblies: Cementitious board.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Maintenance data including cleaning methods, cleaning solutions recommended, stain removal methods, and polishes and waxes recommended.

#### 1.4 ACTION SUBMITTALS

- A. Shop Drawings indicating tile patterns and color arrangement.
- B. Samples of not less than 4 tiles of each color and type selected.

#### 1.5 QUALITY ASSURANCE

- A. Conform to ANSI A137.1.
- B. Comply with TCNA Handbook for Ceramic Tile Installation.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prevent damage to materials by water, freezing, or other causes.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers meeting requirements as set forth by ANSI A137.1 as listed under article “Tile Materials” below shall be acceptable. Manufacturers other than those listed shall meet specified colors and textures.

## 2.2 WALL TILE MATERIALS

- A. Wall tile Type 1: Standard grade conforming to ANSI A137.1 standards for ceramic tile.
  - 1. Manufacturer: Daltile.
  - 2. Series and description: Gaineswood, large format glazed porcelain plank.
  - 3. Size: 6" x 24" x 5/16".
  - 4. Color: Selected by Owner from manufacturer's standard colors.
  - 5. Finish: Matte.
- B. Wall tile Type 2: Standard grade conforming to ANSI A137.1 standards for ceramic tile.
  - 1. Manufacturer: Daltile.
  - 2. Series and description: Idyllic Blends/Random Linear, mixed stone/glass mosaic; backed.
  - 3. Size: 14" x 12" (sheet) x 3/16".
  - 4. Color: Selected by Owner from manufacturer's standard colors.
  - 5. Finish: Honed.
- C. Wall tile Type 3: Standard grade conforming to ANSI A137.1 standards for ceramic tile.
  - 1. Manufacturer: Daltile.
  - 2. Series and description: Glazed ceramic wall tile.
  - 3. Size: 6" x 6" x 5/16".
  - 4. Color: Selected by Owner from manufacturer's standard colors..
  - 5. Finish: Gloss.
- D. Wall trim:
  - 1. Per Finish Legend on Drawings.

## 2.3 ADHESIVE MATERIALS

- A. Organic adhesive: ANSI A136.1, thinset bond type.

## 2.4 GROUT TYPE

- A. Grout: Latex-portland cement grout; ANSI 118.6, color to be selected after award of Contract; resistant to shrinking.

## 2.5 ACCESSORIES

- A. Thresholds and edge strips: Provide to adjust between tile and other floor surfaces.
- B. Sealants: Silicone rubber type conforming to FS TT S 001543, Class A or B (COM NBS).
- C. Grout joint sealer: Acrylic type.
- D. Cementitious backer boards: As specified in Section 092116.
- E. Other materials not specifically described herein but required for complete and proper installation shall be as recommended by manufacturer of materials being used as approved and meeting standards as set forth by ANSI and TCNA.

## PART 3 - EXECUTION

### 3.1 SURFACE PREPARATION

- A. Prepare surfaces to receive tile in accordance with recommendations of TCNA.
- B. Surfaces to be tiled shall be free of coatings, curing compounds, dirt, dust, oil, grease, and wax.

### 3.2 MORTAR MIX AND GROUT

- A. Mix and proportion cementitious materials for site-made mortar bed and bond coat.

### 3.3 INSTALLATION

- A. Maintain temperatures at not less than 50F in areas to be tiled during installation and for 7 days after completion unless higher temperatures are required by manufacturer's instruction.
- B. Install tile and grout in accordance with applicable requirements of ANSI A108.1 thru A108.13 and TCNA Handbook recommendations.
- C. Tile installation methods and materials: Conform to applicable methods and materials currently referenced in TCNA Handbook for Ceramic Tile Interior Wall Installation.
- D. Set tile in manner producing solid bedding, smooth even surfaces, and uniform joints, accurately aligned and symmetrically arranged; avoid use of tile less than half size; cut tile neatly; grind rough exposed edges; terminate tile at center lines of doors where no thresholds are specified.
- E. Lay tile to pattern indicated.
- F. Establish lines of borders where applicable, prior to spreading setting bed, centering field work in both directions. Lay surfaces without borders from center line outward with adjustments made at junction with other floor or wall surface.
- G. Extend tile into recesses and under and behind equipment and fixtures, except where otherwise shown. Fit tile to electrical outlets, piping, fixtures, and other penetrations so plates or covers overlap.
- H. Joint width: As recommended by manufacturer for tile(s) specified.
- I. Allow tile to set for minimum of 48 hours prior to grouting.
- J. Provide damp curing of grout.
- K. Keep expansion/contraction and control joints free of mortar or grout.
- L. Expansion joints, interior:
  - 1. Provide expansion joints at following locations:
    - a. Floor edges where floor structure is not rigidly joined to wall.
    - b. Over control joints, expansion and contraction joints, and isolation joints in base materials.
    - c. Changes in types of base materials.

- d. In large surfaces so that no unbroken distance in either direction exceeds 24' (7.3 m).
  - e. Tile exposed to direct sunlight or moisture shall be limited to 8' (2.5 m) maximum distance in both directions.
  - 2. Conform generally to expansion joint details indicated in TCNA Handbook for Ceramic Tile Installation.
  - 3. Use silicone rubber type sealant in expansion joints.
- M. Apply grout joint sealer in accordance with manufacturer.

#### 3.4 CLEANING

- A. Clean tile surfaces after installation as recommended by tile manufacturer.
- B. Use no acid, metal cleaning tools, or harsh abrasive on tile.
- C. Replace damaged or unsound surfaces before final acceptance.

END OF SECTION 093000

## SECTION 095100 - ACOUSTICAL CEILINGS

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Fibrous acoustical tiles and panels.
- B. Metal suspension systems.
- C. Acoustical insulation above ceilings.

#### 1.02 RELATED REQUIREMENTS

- A. Section 092116 – Gypsum Board Assemblies.
- B. Section 233300 – Duct Accessories.
- C. Section 265100 – Interior Lighting.

#### 1.03 QUALITY ASSURANCE

- A. Qualifications: Provide seismic design of suspended ceiling under direct supervision of professional engineer experienced in design of this Work and licensed at Project location. .

#### 1.04 ENVIRONMENTAL REQUIREMENTS

- A. Do not install acoustical ceilings until building is enclosed, sufficient heat is provided, dust-generating activities have terminated, and overhead mechanical work is completed, tested, and approved.
- B. Permit wet work to dry prior to commencement of installation.
- C. Maintain uniform temperatures of 60°F to 85°F (15°C to 29°C) and maximum humidity of 70% prior to, during, and after installation.

### PART 2 PRODUCTS

#### 2.01 MANUFACTURERS

- A. Armstrong World Industries, Inc.
- B. Celotex Corp.
- C. Chicago Metallic Corp.
- D. USG Interiors, Inc.
- E. Materials referenced in this Section are manufactured by Armstrong World Industries, Inc., unless indicated otherwise.

## 2.02 MATERIALS

### A. Type 1:

1. Brand name: "Cirrus" No. 584.
2. Material: Wet formed mineral fiber.
3. Surface finish: Factory-applied vinyl latex paint.
4. Size: 24" x 48" x 3/4" (600 mm x 1200 mm x 19 mm) thick.
5. Edge description: Angled tegular for lay-in.
6. Noncombustibility: 0-25 Flame Spread Rating, ASTM E1264 Class A, UL labeled.
7. Suspension system: Exposed grid.
8. Color: White.
9. Use: Where shown on Drawings.

### B. Metal suspension systems:

1. Conform to ASTM C635, either intermediate duty systems or heavy-duty systems as required to support the ceiling, lighting fixtures, sound insulation, and air diffusers specified. Provide necessary metal trim, including angles for attachment to diffusers for support of ceiling panels.
2. Types:
  - a. "Prelude XL:
    - 1) Material: Double-web, hot-dipped galvanized steel with steel cap.
    - 2) Face dimension: 15/16" (24 mm).
    - 3) Profile: Exposed tee.
    - 4) Surface finish: Baked polyester paint.
    - 5) Color: White.
    - 6) Use: All areas requiring suspended ceiling system.
3. Ceiling system shall bear UL label for compliance with requirements for fire-rating.
4. Carrying channels and hangers: Material, size, and type to suit application and to rigidly secure complete finished ceiling system with maximum deflection of 1/360.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Install suspension system in accordance with ASTM C636 and manufacturer's recommendations.
- B. In seismic zones, install system in accordance with ASTM E580.
- C. Use centerlines of room as starting point for grid or panel layout, unless otherwise shown on Drawings.
- D. Upon completion of installation, clean components of acoustical treatment system in accordance with manufacturer's recommendations.
- E. Adjust any sags or twists that develop in ceiling system and replace any part that is damaged or faulty.

END OF SECTION 095100

## SECTION 096513 – RESILIENT BASE AND ACCESSORIES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Wall base.
- B. Accessories.

#### 1.2 RELATED REQUIREMENTS

- A. Section 092116 – Gypsum Board Assemblies.

#### 1.3 ACTION SUBMITTALS

- A. Samples:
  - 1. Provide (3) samples of wall base material, color, and pattern selected.

#### 1.4 MAINTENANCE MATERIALS

- A. Extra stock: Deliver 25 ft (8 m) of each color of wall base material required for Project, for maintenance use. Clearly identify each box or roll.

#### 1.5 QUALITY ASSURANCE

- A. Regulatory requirements: Resilient wall base materials shall comply with the following criteria.
  - 1. Flame spread classification: 0.45 watts/cm<sup>2</sup> or less when tested by ASTM E648/NFPA 253 method.
  - 2. Smoke density factor: 450 or less, when tested by ASTM E662/NFPA 258 method.

#### 1.6 ENVIRONMENTAL REQUIREMENTS

- A. Maintain minimum 70°F (21°C) air temperature at flooring installation area for 3 days prior to, during, and for 24 hours after installation.
- B. Store flooring materials in area of application. Allow 3 days for material to reach temperature equivalent to surrounding area.

#### 1.7 WARRANTY

- A. Provide manufacturer's standard warranty for resilient wall base provided.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Vinyl wall base products:
  - 1. Armstrong World Industries, Inc.
  - 2. Tarkett

3. VPI Corporation
4. Roppe Corp.

- B. Rubber flooring products:
1. Armstrong World Industries, Inc.
  2. Tarkett
  3. VPI Corporation
  4. Roppe Corp.

## 2.2 MATERIALS

- A. Resilient wall base:
1. Rubber cove base, FS SS-W-40, Type I, with matching end stops and preformed or molded corner units.
  2. 4" (100 mm) height in 1/8" (3 mm) gage.
  3. Color: Selected by Owner from manufacturer's standard colors.
- B. Accessories: Homogeneous vinyl or rubber (to match).
- C. Adhesives (cements): Waterproof, stabilized type as recommended by flooring manufacturer to suit material and substrate conditions.

## PART 3 - EXECUTION

### 3.1 INSPECTION

- A. Ensure wall surfaces are smooth and flat with maximum variation of 1/8" (3 mm) in 10' (3 m).
- B. Ensure gypsum board walls are dry and free of dust.

### 3.2 WALL BASE INSTALLATION

- A. Install coved wall base at hard flooring surfaces.
- B. Fit joints tight and vertical. Maintain minimum measurement of 18" (450 mm) between joints.
- C. Miter internal corners. Use premolded sections for external corners and exposed ends.
- D. Install base on solid backing. Adhere tightly to wall and floor surfaces.
- E. Scribe and fit to door frames and other obstructions.
- F. Install straight and level to variation of  $\pm 1/8$ " (3 mm) over 10' (3 m).

### 3.3 PROTECTION

- A. Prohibit locating furniture and equipment against wall base for 48 hours after installation.

3.4 CLEANING

- A. Remove excess adhesive from base and wall surfaces without damage.
- B. Clean base surfaces in accordance with manufacturer's instructions.

END OF SECTION 096513

## SECTION 096800 – CARPETING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Carpet.
- B. Edge strips.

#### 1.2 INFORMATIONAL SUBITTALS

- A. 3 copies of carpet manufacturer's maintenance recommendations for each type and quality of carpet installed in Project.

#### 1.3 ACTION SUBMITTALS

- A. Shop Drawings indicating location of seams, method of joining seams, direction of carpet, type of adhesive to be used, method of integrating edge strips with carpet, and installation procedures.
- B. Samples:
  - 1. Each carpet to be used, sufficiently sized to clearly indicate construction.
  - 2. One 6" long sample of each type of edge stripping to be used.

#### 1.4 MAINTENANCE MATERIALS

- A. One “Service Master” spotting kit with directions for removing all types of stains.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver carpeting to Site in original wrappings, clearly marked with proper identification of material and manufacturer.
- B. Store in protected area under conditions same as those of area in which installation will be accomplished.
- C. Protect from damage, dirt, stains, and moisture while in transit or storage.

## 1.6 QUALITY ASSURANCE

- A. Regulatory requirements: Carpeting materials shall comply with following criteria:
  - 1. Flame spread classification: 0.45 watts/cm<sup>2</sup> or less when tested by ASTM E648/NFPA 253 methods.
  - 2. Smoke density factor: 450 or less, when tested by ASTM E662/NFPA 258 methods.

## 1.7 WARRANTY

- A. Provide manufacturer's standard wear warranty.
- B. Materials and workmanship shall be warranted for period of 1 year from date of installation.
- C. Repair and/or replace any unsatisfactory installation by reason of faulty workmanship or faulty materials.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Karastan/Bigelow Commercial Carpets.
- B. Lees Commercial Carpets.
- C. Mohawk Commercial Carpet.
- D. Shaw Commercial Carpets.
- E. Stratton Commercial Carpets.

### 2.2 CARPET

- A. Type 1: Shaw Altered; Analog Tile or approved equal.
  - 1. Tile size: 18" x 36", ashlar plank install.
  - 2. Color: Selected by Owner from manufacturer's standard colors.

### 2.3 ACCESSORIES

- A. Adhesive: Type recommended by carpet manufacturer to suit application and expected service.
- B. Edge strips: As shown on drawings.
  - 1. Color: To be selected by Owner from manufacturer's standard colors.

## PART 3 - EXECUTION

### 3.1 INSPECTION

- A. Floors shall be level with maximum surface variation of 1/4" in 10', noncumulative.
- B. Concrete floors shall be free from scaling and irregularities and exhibit neutrality relative to acidity and alkalinity.
- C. Beginning preparation and installation activities will constitute acceptance of substrate. Any discrepancies or irregularities detrimental to installation shall be submitted in writing to Engineer and corrections deemed necessary made prior to beginning Work.

### 3.2 PREPARATION

- A. Clean floors of dust, dirt, solvents, oil, grease, paint, plaster, and other substances detrimental to proper performance of adhesive and carpet.
- B. Cracks 1/8" or more, holes, and unevenness shall be filled using latex base floor filler, and high spots leveled. Sweep floor clean, then wet mop with warm water and again. Allow floor to thoroughly dry.

### 3.3 ENVIRONMENTAL REQUIREMENTS

- A. Do not start carpet installation until painting and finishing work is complete and ceilings and overhead work has been tested, approved, and completed.
- B. Maintain room temperature at minimum 60°F (16°C) for at least 24 hours prior to installation, and relative humidity at approximately that at which area is to be maintained.
- C. Provide adequate lighting in areas during carpet installation.

### 3.4 CARPET INSTALLATION

- A. Check matching of carpet before cutting. There shall be no visible variation between adjacent pieces of carpet or dye lots.
- B. Cut carpet, where required, in manner to allow proper seam and pattern match. Cuts shall be straight and true and unfrayed.
- C. Lay carpet with minimum of seams.
- D. Where possible and practical, locate seams in areas of least amount of traffic.

- E. Join seams in recommended manner and so as not to detract from appearance of carpet installation and decrease its life expectancy. Seams shall be straight, not overlapped or peaked, and free of gaps.
- F. Vacuum substrate clean. Spread adhesive in quantity recommended by manufacturer after primer application to ensure proper adhesion over full area of installation. Apply only enough adhesive to permit proper adhesion of carpet before initial set.
- G. Lay carpet on floors with run of pile in same direction of anticipated traffic.
- H. Do not change run of pile in any one room or from one room to next where continuous through wall opening.
- I. Cut and fit carpet neatly around projections through floor and to walls and other vertical surfaces. Fit carpet snugly to walls or other vertical surface where no base is scheduled, leaving no gaps.
- J. Do not place heavy objects such as furniture on carpeted surfaces for minimum 24 hours or until adhesive has set.
- K. Entire carpet installation shall be laid tight and flat to subfloor, be well fastened at edges, and present uniform pleasing appearance. Provide monolithic color, pattern, and texture match within any one area.
- L. Install edge strips where carpet terminates at other floor coverings. Use full length pieces only. Butt tight to vertical surfaces. Where splicing cannot be avoided, butt ends tight and flush.

### 3.5 CLEANING AND PROTECTION

- A. Upon completion of installation, remove waste and excess material, and tools and equipment. Thoroughly vacuum clean.
- B. Leave excess usable carpet pieces not necessary to complete Work on job site and place in an orderly manner in an area designated by Owner.
- C. Protect completed installation for 24 hours curing period before subjecting it to traffic, moving of furniture, or other heavy equipment.

END OF SECTION 096800

## SECTION 099000 – PAINTING AND COATING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. On-site surface preparation and painting.

#### 1.2 RELATED REQUIREMENTS

- A. Section 033000 – Cast-In-Place Concrete
- B. Section 092116 – Gypsum Board Assemblies

#### 1.3 REFERENCES

- A. ACGIH-02 - American Conference of Governmental Industrial Hygienists: Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices
- B. ASTM E84 - Test Methods for Surface Burning Characteristics of Building Materials.
- C. NFPA 258 - Research Test - Smoke Generation of Solid Materials.
- D. SSPC-SP-16 – Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals.

#### 1.4 SUBMITTALS

- A. Product Data:
  - 1. Schedule of products proposed for each system.
  - 2. Product data sheets, if other than products specified in schedule.
- B. Samples: Duplicate 6” x 8” (150 mm x 200 mm) samples of paint and stain colors when requested by Engineer. When possible, apply finishes on identical type materials to which they will be applied on job. Identify each sample as to finish type, formula, color name and number, and gloss.

#### 1.5 MAINTENANCE MATERIALS

- A. Extra stock: Leave on premises, where directed by Owner, usable partial cans of paint. Containers shall be tightly sealed and clearly labeled for identification.

#### 1.6 HEALTH AND SAFETY REQUIREMENTS

- A. Work shall comply with applicable federal, state, and local laws and regulations including analyses of potential impact of painting operations on painting personnel and on others involved in and adjacent to work zone.
- B. Worker exposures: Exposure of workers to chemical substances shall not exceed limits as established by American Conference of Governmental Industrial Hygienists: Threshold Limit

Values for Chemical Substances and Physical Agents and Biological Exposure Indices, ACGIH-02 or as required by a more stringent applicable regulation.

- C. Toxic compounds: Toxic compounds having ineffective physiological properties, such as odor or irritation levels, shall not be used unless approved by Owner.
- D. Training: Workers having access to affected work area shall be informed of contents of manufacturer's current printed product description, Material Safety Data Sheets (MSDS) and technical data sheets for each coating system and shall be informed of potential health and safety hazard and protective controls associated with materials used on Project. Affected work area is one that may receive mists and odors from painting operations. Workers involved in preparation, painting and clean-up shall be trained in safe handling and application, and exposure limit, for each material which worker will use in Project. Personnel having a need to use respirators and masks shall be instructed in use and maintenance of such equipment.
- E. Provide paints for interior use that contain no mercurial mildewcide or insecticide. Provide paint containing not more than 0.06% lead.
- F. Provide documentation stating that paints proposed for use meet Volatile Organic Compound (VOC) regulations of local air pollution control districts having jurisdiction over geographical area in which Project is located.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver paint materials in sealed original labeled containers, bearing manufacturer's name, type of paint, brand name, color designation and instructions for mixing and/or reducing. All paint containers shall have batch dates printed on the cans or labels. Also, no paint or coating will be allowed for application if batch date has surpassed expiration.
- B. Provide adequate storage facilities. Store paint materials at minimum ambient temperature of 45°F (7°C) in well ventilated area.
- C. Take precautionary measures to prevent fire hazards and spontaneous combustion.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Benjamin Moore & Co., 101 Paragon Drive, Montvale, NJ 07645. Phone: (855)724-6802. Website: [www.benjaminmoore.com](http://www.benjaminmoore.com).
- B. PPG Industries, Inc., One PPG Place, Pittsburgh, PA 15272. Phone: (800)441-9695. Website: [www.ppgpaints.com](http://www.ppgpaints.com). Email: [techservice@ppg.com](mailto:techservice@ppg.com).
- C. The Sherwin-Williams Co., 101 W. Prospect Ave., Cleveland, OH 44115. Phone: (800)474-3794. Website: [www.sherwin-williams.com](http://www.sherwin-williams.com).
- D. Diamond Vogel, 1110 Albany Place SE, P.O. Box 380, Orange City, IA 51041. Phone: (800)728-6435. Website: [www.diamondvogel.com](http://www.diamondvogel.com). Email: [info@diamondvogel.com](mailto:info@diamondvogel.com).

- E. Or approved equal.
- F. Materials and colors referenced in this Section are as manufactured by The Sherwin-Williams Co., unless noted otherwise.

## 2.2 MATERIALS

- A. Paint accessory materials: Linseed oil, shellac, turpentine and other materials not specifically indicated herein but required to achieve finishes specified of high quality and approved manufacturer.
- B. Paints: Ready-mixed, except field catalyzed coatings. Pigments fully ground maintaining soft paste consistency, capable of readily and uniformly dispersing to complete homogeneous mixture.
- C. Paints to have good flowing and brushing properties and be capable of drying or curing free of streaks or sags.
- D. Dry mil thickness of paint shall comply with manufacturer's recommendations for materials specified for prevailing substrates and Project conditions.
- E. Paints containing lead greater than 0.06% by weight of total nonvolatile content (calculated as lead metal) shall not be used.
- F. Paints containing zinc chromate or strontium chromate pigments shall not be used.
- G. VOC content: Paints shall comply with applicable state and local laws enacted to ensure compliance with Federal Clean Air Standards and shall conform to restrictions of local air pollution control authority.

## PART 3 - EXECUTION

### 3.1 INSPECTION

- A. Thoroughly examine surfaces scheduled to be painted prior to commencement of Work. Report in writing to Engineer, any condition that may potentially affect proper application. Do not commence until such defects have been corrected.
- B. Correct defects and deficiencies in surfaces that may adversely affect work of this Section.

### 3.2 PROTECTION

- A. Protect adjacent surfaces from paint and damage. Repair damage due to inadequate or unsuitable protection.
- B. Furnish drop cloths, shields, and protective equipment to prevent spray or droppings from fouling surfaces not being painted. Take specific care to protect surfaces within storage and preparation areas.
- C. Place cotton waste, cloths, and material that may constitute a fire hazard in closed metal containers and remove daily from site.

- D. Remove electrical plates, surface hardware, fittings and fastenings, prior to painting operations. These items are to be carefully stored, cleaned, and replaced on completion of work in each area. Do not use solvent to clean hardware that may remove permanent lacquer finish.

### 3.3 PREPARATION

- A. Remove mildew, by scrubbing with solution of tri-sodium phosphate and bleach. Rinse with clean water and allow surface to dry completely.
- B. Aluminum surfaces: Remove surface contamination by steam, high-pressure water, or solvent washing. Apply etching primer or acid etch. Apply paint immediately if acid etching.
- C. Asphalt, creosote, or bituminous surfaces: Remove dirt, oil, grease, and sand if necessary to provide adhesion key. Apply compatible sealer or primer.
- D. New concrete floors: Remove contamination, acid etch, and rinse with clear water per International Concrete Repair Institutes surface prep standards. Ensure required acid-alkali balance is achieved. Allow to thoroughly dry.
- E. Copper surfaces requiring paint finish: Remove contamination by steam, high-pressure water, or solvent washing. Apply vinyl etch primer or acid etch. Apply paint immediately if acid etching.
- F. Copper surfaces required to be oxidized: Remove contamination. Apply oxidizing solution of copper acetate and ammonium chloride in acetic acid. Rub on repeatedly for correct effect. Once attained, rinse surfaces well with clear water and allow to dry.
- G. Gypsum board surfaces: Remove contamination and repair defects, if any.
- H. Galvanized surfaces: Remove surface contamination and oils and wash with solvent. Apply coat of etching type primer. Prepare large, galvanized, steel members in accordance with SSPC-SP-16.
- I. Zinc coated surfaces: Remove surface contamination and oils and prepare for priming in accordance with metal manufacturer's recommendations.
- J. Concrete and concrete masonry:
  - 1. Remove dirt, loose mortar, scale, powder, and other foreign matter. Remove oil and grease with solution of trisodium phosphate, rinse well and allow to thoroughly dry.
  - 2. Remove stains caused by weathering of corroding metals with solution of sodium metasilicate after being thoroughly wetted with water. Allow to thoroughly dry.
- K. Plaster surfaces: Fill hairline cracks, small holes, and imperfections with patching plaster. Smooth off to match adjacent surfaces. Wash and neutralize high alkali surfaces where they occur.
- L. Iron and steel surfaces:
  - 1. Cleaning methods: Conform to applicable requirements of SSPC and NACE:
    - a. Solvent cleaning: SSPC-SP1.
    - b. Power tool cleaning: SSPC-SP3.
    - c. Commercial blast cleaning: SSPC-SP6 or NACE 3.

- d. Power tool cleaning to bare metal: SSPC-SP11.
- e. Near white blast cleaning: SSPC-SP10 or NACE 2.
- f. White metal blast cleaning: SSPC-SP5 or NACE 1.
- 2. Blast cleaning requirements: Non-submerged shall be SSPC-SP6 or SSPC-11 for areas where abrasive blast is prohibited.
- 3. Cleaning for other field painting: SSPC-SP3.
- 4. Removal of materials such as grease and oil: SSPC-SP1. Apply treatment of phosphoric acid solution, ensuring weld joints, bolts and nuts are similarly cleaned. Prime surfaces to indicate defects, if any. Paint after defects have been remedied.
- 5. Surface irregularities from blasting shall be approximately 25% of total paint system dry mil thickness.
- 6. Sand and scrape shop primed steel surfaces to remove loose primer and rust. Feather out edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces.

M. Ductile Iron

- 1. Cleaning methods: conform to applicable requirements of NAPF 500-03:
  - a. Solvent cleaning: NAPF 500-03-01.
  - b. Hand tool cleaning: NAPF 500-03-02.
  - c. Power tool cleaning: NAPF 500-03-03.
  - d. Abrasive blast cleaning for ductile iron pipe: NAPF 500-03-04.
  - e. Abrasive blast cleaning for cast ductile iron fittings: NAPF 500-03-05.

N. Wood surfaces: Wipe off dust and grit from miscellaneous wood items and millwork prior to priming. Spot coat knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried and sand between coats.

O. Prepare surfaces to be finished in conformance to recommendations of finish manufacturer.

### 3.4 ENVIRONMENTAL REQUIREMENTS

- A. Ensure surface temperatures and surrounding air temperature is above 45°F (7°C) before applying finishes. Minimum application temperatures for latex paints are 45°F (7°C) for interior work and 50°F (10°C) for exterior work. Minimum application temperature for varnish finish is 65°F (18°C).
- B. Do no exterior painting while surfaces are damp or during rainy or frosty weather.
- C. Do no exterior spray painting while wind velocity is above 13 mph (20 km/h).
- D. Provide adequate continuous ventilation and heating facilities capable of maintaining temperatures above 45°F (7°C) for 24 hours before, during and 48 hours after application of finishes.
- E. Provide adequate lighting on surfaces to be finished.

### 3.5 APPLICATION

- A. Apply each coat at proper consistency. Materials shall be evenly spread and applied smoothly without runs or sags, by skilled workers. Paint under conditions suitable to production of high-quality work. Follow manufacturer's directions on container label.

- B. Each coat of paint shall be slightly darker than preceding coat unless otherwise approved by Architect.
- C. Sand lightly between coats to achieve smooth finish on wood or metal surfaces.
- D. Do not apply finishes on surfaces that are not sufficiently dry.
- E. Allow each coat of finish to dry before following coat is applied, unless directed otherwise by manufacturer.
- F. Where clear finishes are specified, ensure tint fillers match wood. Work fillers well into grain before set. Wipe excess from surface.
- G. Prime top and bottom edges of metal doors when they are to be painted.
- H. Where interior or exterior metal materials are primed in mill or shop, material shall be that specified for such surfaces and shall be used in accordance with manufacturer's directions for first or prime coat. In such cases, no additional prime coats will be required. Provide touch-up as required to surfaces damaged during the Work.

### 3.6 MECHANICAL AND ELECTRICAL EQUIPMENT

- A. Refer to mechanical and electrical sections for painting and finishing requirements of non-prefinished equipment, pipes, conduits, and ductwork.
- B. Remove grilles, covers, and access panels for mechanical and electrical systems from location and paint separately.
- C. Finish paint primed equipment to color selected.
- D. In finished areas of building, prime and paint insulated and bare pipes, conduits, boxes, insulated and bare ducts, hangers, brackets, collars and supports, except where items are plated or covered with prefinished coating. Color and texture to match adjacent surfaces unless otherwise directed.
- E. Replace identification markings on mechanical or electrical equipment when painted over or spattered.
- F. Paint interior surfaces of air ducts, convector, and baseboard heating cabinets that are visible through grilles and louvers with 1 coat of flat black paint, to limit of sight line. Paint dampers exposed immediately behind louvers, grilles, convector, and baseboard cabinets to match face panels.
- G. Paint both sides and edges of plywood backboards for electrical equipment before installing backboards and mounting equipment on them.
- H. Color code equipment, piping, conduit and exposed ductwork in accordance with requirements indicated. Color banding and identification (flow arrows, naming, numbering, etc.)

### 3.7 CLEANING

- A. As Work proceeds and upon completion, promptly remove paint where spilled, splashed, or spattered.
- B. During progress of Work, keep premises free from any unnecessary accumulation of tools, equipment, surplus materials and debris.
- C. Upon completion of Work, leave premises neat and clean.

### 3.8 SURFACES EXCLUDED FROM PAINTING

- A. Surfaces not requiring painting:
  - 1. Surfaces above suspended ceilings.
  - 2. Surfaces concealed inside mechanical and electrical chases.
- B. Surfaces on which painting is prohibited:
  - 1. Sprinkler heads.
  - 2. Fire detection elements.
  - 3. Anodized aluminum surfaces.
  - 4. Glass and mirror surfaces.
  - 5. Chrome and stainless steel hardware items.
  - 6. Plumbing fixtures.
  - 7. Electrical fixtures or wiring devices.
  - 8. Floor finishes, excluding concrete floor staining, unless specified otherwise.
  - 9. Wall base materials.
  - 10. Door and window hardware items.
  - 11. Factory finished items, unless specified otherwise.

### 3.9 PAINT SYSTEMS SCHEDULE

- A. System A: Metals, exterior.
  - 1. Primer, on ferrous metals, galvanized metal, and aluminum: Pro Industrial "Pro-Cryl" Universal Primer, B66-310 Series. Primer, on zinc-rich shop-primed surfaces: Compatible zinc-rich primer as furnished for materials requiring touch-up. Finish coats: 2 coats "Sher-Cryl" HPA High Performance Acrylic, B66-350 Series.
- B. System B: Wood surfaces, exterior, to be stained.
  - 1. Stain: 1-2 coats "SuperDeck" Waterborne Semi-Transparent Exterior Stain.
    - a. Color as selected by Client after bid award.
- C. System C: Gypsum Board surfaces, interior.
  - 1. Primer, on gyp. board: "ProMar" 200 Interior Latex Primer Zero VOC B28W02600.
  - 2. Finish coats: 2 coats "ProMar" 200 Interior Latex Eg-Shel Zero VOC, B30W12651 Series.
    - a. Use Semi-Gloss finish at toilet rooms and service areas.
- D. System E: Wood surfaces, interior.
  - 1. Primer, on wood: "ProMar" 200 Interior Latex Primer Zero VOC B28W02600. Finish coats: 2 coats "ProMar" 200 Interior Latex Eg-Shel Zero VOC, B30W12651 Series.

- E. System F: Wood surfaces, interior, to be stained.
  - 1. Stain: 1 coat “Wood Classics” Interior Oil Stain, A49-200 Series. Do not stain if clear finish.
  - 2. Finish coats: 2 coats “Wood Classics” Waterbourne Polyurethane Varnish, Satin, A68 Series.
  
- F. System G: Metals, interior.
  - 1. Primer and touch-up on shop-primed surfaces, on ferrous metals, galvanized metal and aluminum: Pro-Industrial “Pro-Cryl” Universal Primer, B66-310 Series.
  - 2. Finish coats: 2 coats “ProMar” 200 Interior Alkyd Semi-Gloss, B34W08251 Series.
  
- G. System H: Overhead Gypsum Board surfaces, interior.
  - 1. Primer, on gyp. board: Pro-Industrial “Pro-Cryl” Universal Primer, B66-310 Series.
  - 2. Finish coats: 2 coats Pro-Industrial Waterborne Acrylic Dry Fall, B42 Series.
  
- H. System I: Concrete, interior, stain.
  - 1. Stain: UDT Concrete Dye, installed per manufacturer specification.
  - 2. Finish Coats: Concrete dye manufacturer’s recommended sealer.

3.10 PAINT SCHEDULE

- A. Colors: As shown on Drawing Finish Schedule.

Item Description	System
Exterior Hollow metal doors and frames	A
Exterior Galvanized Steel	A
Gypsum Board	C
Interior Wood (painted)	E
Interior Wood (stained)	F
Interior Hollow metal doors and frames	G
Interior Galvanized and aluminum	G
Overhead Gypsum Board	H
Concrete floor (stained)	I

END OF SECTION 099000

## SECTION 102813 – TOILET ACCESSORIES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Toilet and bath accessories including mounting hardware.

#### 1.2 RELATED REQUIREMENTS

- A. Section 061000 – Rough Carpentry
- B. Section 092116 – Gypsum Board Assemblies

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Schedule of accessories.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver accessories to site until rooms in which they are to be installed are ready to receive them.
- B. Pack accessories individually in manner to protect accessory and its finish.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. American Specialties, Inc.
- B. Bobrick Washroom Equipment, Inc.
- C. Bradley Corporation.
- D. Georgia-Pacific.
- E. Materials referenced in this Section are manufactured by Bobrick Washroom Equipment, Inc., unless noted otherwise.

#### 2.2 MATERIALS

- A. Accessories: Satin finish stainless steel when available, otherwise chrome-plated brass.
- B. Mounting hardware:
  - 1. Provide necessary mounting hardware.
  - 2. Use concealed theftproof-type brackets.
  - 3. Fasteners, screws, and bolts: Stainless steel.
  - 4. Expansion shields: Fiber, lead, or rubber as recommended by accessory manufacturer for prevailing conditions.

- C. Mirrors: Stainless steel angle framed 1/4" (6 mm) plate glass, electrolytically copper-plated and protected against scratches. Provide 15-year guarantee against silver spoilage.
- D. Washroom accessories shall meet barrier-free washroom guidelines as established by ADA accessibility guidelines and applicable building codes.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Deliver inserts and rough-in frames to job Site at appropriate time for building in. Provide templates and rough-in measurements as required.
- B. Before starting work, notify Architect in writing of any conflicts detrimental to installation or operation of units.
- C. Verify with Architect exact location and anchorage method required for accessories.

3.2 INSTALLATION

- A. Install fixtures, accessories and items in accordance with manufacturer's instructions.
- B. Install true, plumb, and level, securely and rigidly anchored to substrate.
- C. Install accessories in locations shown on Drawings and at mounting heights recommended by manufacturer. Handicap mounting heights are required and shall conform to ADA guidelines and applicable building codes.

3.3 PROTECTION

- A. Protect adjacent or adjoining finished surfaces and Work from damage during installation of Work of this Section.

3.4 ACCESSORY SCHEDULE

Item	Model			Quantity
	Bobrick	Bradley	American Specialties	
Mirror	B-290, 24" wide x 36" high	780-2436	0600	4
Automatic Soap Dispenser, Wall-Mounted: American Specialties Inc #0361				4
Automatic Paper Towel Dispenser: Kimberly Clark #48856 (white)				0
Electric Hand Dryer: Excel XLERATOReco Hand Dryer #XL-W-ECO				4
Waste receptacle	B-2250	377	0810	0
Toilet Tissue Dispenser (double)	B-274	5241	0264-1A	4
Grab Bar, toilet, rear	B-6806 x 36"	812-001-36"	3200-01-36"	4

Item	Model			Quantity
Grab Bar, toilet, side	B-6806 x 42"	812-001-42"	3200-02-42"	4
Grab Bar, toilet, vertical	B-6806 x 18"	812-001-18"	3200-03-18"	4
Baby Changing Station	KB200	9632	9012	2
Robe Hook	B-672	9125	10-7345-B	4

END OF SECTION 102813

## SECTION 104400 – FIRE PROTECTION SPECIALTIES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Fire extinguishers.
- B. Fire extinguisher cabinets.
- C. Automatic external defibrillator (AED) cabinets.

#### 1.2 QUALITY ASSURANCE

- A. Provide portable fire extinguishers, cabinets, and accessories by a single company.
- B. Regulatory requirements
  - 1. Provide new, portable fire extinguishers that are UL-listed and bear UL “Listing Mark” for type, rating, and classification of extinguisher indicated.
  - 2. Conform to NFPA 10 requirements for portable fire extinguishers.
  - 3. Conform to Americans with Disabilities Act on maximum cabinet projection in corridors.

#### 1.3 DELIVERY, STORAGE AND HANDLING

- A. Package, handle, deliver and store products in a manner that will avoid damage.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. J. L. Industries.
- B. Larsen's Manufacturing Co.
- C. Potter-Roemer.
- D. Materials referenced in this Section are manufactured by J. L. Industries, unless noted otherwise. Equivalent products from other manufacturers are acceptable.

#### 2.2 FIRE EXTINGUISHERS

- A. Model: ”Cosmic 5E” multi-purpose dry chemical.
- B. Shell: Enameled steel.

- C. Quantity: As indicated on Drawings.
- D. Use: All fire extinguishers.

### 2.3 FIRE EXTINGUISHER CABINETS

- A. Series: "Cosmopolitan" stainless steel.
- B. Trim style: 2½" (55 mm) rolled-edge trim.
- C. Door style: G - full with Saf-T-Lok glass.
- D. Door glazing: 17 - ¼" (6 mm) clear tempered glass.
- E. Door and frame finish: Stainless steel.
- F. Tub: White powder coat.
- G. Handle: Flush pull.
- H. Size: Provide size of cabinet to match extinguisher specified.
- I. Quantity: As indicated on Drawings.

### 2.4 AUTOMATIC EXTERNAL DEFIBRILLATOR (AED) CABINETS

- A. Series: "Lifestart 1400" stainless steel.
- B. Style: Semi-Recessed.
- C. Door Style: Full acrylic with lock and concealed hinges.
- D. Trim Style: 3" rolled edge.
  - 1. Frame and Door: 1¾" trim on face, and 1¼" trim on door.
- E. Tub: Steel with white powder coat.
- F. Accessories:
  - 1. "Commander" alarm: Ensure 85 dB horn sounds when door is opened and stops when door closes.
    - a. Keyed Alarm: On/Off.
    - b. Horn Power: 9 Volt DC battery.
- G. Identification:
  - 1. Identify defibrillator cabinets in accordance with ANSI/NFPA 10, using silk screen print on inside of acrylic, decals, or die-cut lettering.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install in accordance with manufacturer's recommendations.
- B. Prepare recesses in walls for fire extinguisher and AED cabinets as required by type and size of cabinet and style of trim.
- C. Securely fasten cabinets to structure, square and plumb.
- D. Install cabinets so top of extinguisher or defibrillator will be no more than 4'-6" (1350 mm) above floor.
- E. Check extinguishers for proper charge operation. Units shall be in proper operating condition at completion of installation.

END OF SECTION 104400

## SECTION 105100 – LOCKERS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Metal lockers including benches, accessories, and finishes.

#### 1.2 INFORMATIONAL SUBMITTALS

- A. Shop Drawings indicating locker types, sizes, configurations, layout of groups of lockers, accessories, and numbering plan.
- B. Color chart for review and selection.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Interior Steel Equipment Co.
- B. Lyon Metal Products, Inc.
- C. Penco Products, Inc.
- D. Republic Storage Systems, Inc.
- E. Materials referenced in this Section are manufactured by Penco Products, Inc., unless noted otherwise.

#### 2.2 LOCKERS

- A. Type: Stadium steel lockers, 6WFD02-021, or approved equal.
- B. Style: Single-tier.
- C. Size: 18" wide x 18" deep x 76" high, overall size.
- D. Mounting: Free-standing.
- E. Base: 4" high integral metal base.
- F. Top: Standard flat.

- G. Bodies: Formed and flanged with stiffener ribs; all welded. Lockable footlocker doubles as a bench and secure storage compartment.
- H. Provide end panels, closures, fillers, and finishing strips to close off openings.
- I. Provide ventilation openings at sides of each locker.
- J. Finish edges smooth without burrs.

### 2.3 ACCESSORIES

- A. Provide each locker with full width open top shelf, a coat rod and two coat hooks.

### 2.4 FINISHES

- A. Color: Selected by Owner from manufacturer's standard colors.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install lockers secure, plumb, square, and in line. Doors shall operate smoothly, closing tightly, and properly latching.
- B. Anchor lockers with appropriate anchor devices to suit materials encountered.
- C. Bolt adjoining locker units together to provide rigid installation.
- D. Install end panels, filler panels, sloped tops, and bases to completely close off openings.

### 3.2 PROTECTION

- A. Protect locker finishes and adjacent surfaces from damage during and after installation.

END OF SECTION 105100

## SECTION 107500 – FLAGPOLES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Flagpoles and accessories.

#### 1.2 PERFORMANCE REQUIREMENTS

- A. Flagpole without flag: Resistant without permanent deformation to 50 miles/hr (km/hr) wind velocity; non-resonant, safety design factor of 2.5.

#### 1.3 SUBMITTALS

- A. Shop Drawings: Indicate detailed dimensions, base attachment details, anchor requirements, and imposed loads and wiring diagram.
- B. Product Data: Pole, accessories, and configurations.
- C. Samples: Two 4" x 4" (100 mm x 100 mm) in size illustrating pole material, color, and finish.
- D. Closeout submittals: Operation and maintenance data.

#### 1.4 QUALITY ASSURANCE

- A. Design flagpole foundation and supports under direct supervision of professional engineer experienced in design of this Work and licensed in the project's State.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Spiral wrap flagpole with protective covering and pack in protective shipping tubes or containers.
- B. Protect flagpole and accessories from damage or moisture.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. American Flagpole.
- B. Baartol Co., Inc.

- C. EMC Flagpoles.
- D. Morgan-Francis AABEC Pole.
- E. Or approved equal.

## 2.2 COMPONENTS

- A. Aluminum: 6063 alloy, T6 temper.
- B. Outside butt diameter: 6" (150 mm).
- C. Outside tip diameter: 3½" (88 mm).
- D. Nominal wall thickness: 0.188 (5 mm).
- E. Nominal height: 35' (11 m); measured from top of base.
- F. Flagpole: Ground-mounted type.
- G. Flagpole design: Cone tapered.
- H. Halyard: Interior type.

## 2.3 ACCESSORIES

- A. Finial ball: Bronze anodized, 6" (150 mm) diameter.
- B. Truck assembly: Cast bronze, nonrevolving, non-fouling.
- C. Hand crank operator: Removable type.
- D. Pole base attachment: Tube; aluminum base with base cover.

## 2.4 FACTORY FINISHING

- A. Metal surfaces in contact with concrete: Asphaltic paint.
- B. Aluminum: Anodized to medium bronze color.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify concrete foundation is ready to receive work and dimensions are as indicated on Shop Drawings.

### 3.2 PREPARATION

- A. Coat metal sleeve surfaces below grade, in contact with cementitious surfaces, and in contact with dissimilar metals with asphaltic paint.

### 3.3 INSTALLATION

- A. Electrically ground flagpole installation.
- B. Fill foundation tube sleeve with concrete specified in Section 033000 and compact.
- C. Install welded base assembly for flagpoles base set on concrete base and fasten.

### 3.4 ADJUSTING

- A. Adjust operating devices so halyard and flag function smoothly.

END OF SECTION 107500

## SECTION 122100 – WINDOW BLINDS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Horizontal aluminum blinds and accessories.

#### 1.2 RELATED REQUIREMENTS

- A. 061000 – Rough Carpentry
- B. 062000 – Finish Carpentry
- C. 085413 – Fiberglass Casement Windows

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Product Data: Data indicating physical and dimensional characteristics, operating features, and material list.
- B. Shop Drawings: Indicate opening sizes, tolerances required, method of attachment, clearances, and operation.
- C. Samples: Two samples, six-inch-long illustrating slat materials and finish, color, cord type and color for each accessory.
- D. Quality assurance data: Manufacturer's Installation Instructions including special procedures, and perimeter conditions requiring special attention.

#### 1.4 MAINTENANCE MATERIALS

- A. Supply ten additional slats.
- B. Supply two additional complete blind assemblies of each size.
- C. Supply extra lift cords.

#### 1.5 QUALITY ASSURANCE

- A. Manufacturer qualifications: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer qualifications: Installer shall be qualified to install product specified as demonstrated by prior experience.

1.6 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.7 COORDINATION

- A. Coordinate Work with window installation and placement of concealed blocking to support blinds.

1.8 WARRANTY

- A. Provide manufacturer's standard written warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Hunter Douglas.
- B. Levolor.
- C. Springs Window Fashions Division, Inc.
- D. Materials referenced in this Section are manufactured by Levolor, unless noted otherwise. Equivalent products from other manufacturers are acceptable.

2.2 HORIZONTAL BLINDS

- A. Type: Model No. RIV1, "Riviera Classic 1" Blind."
- B. Slat material: 5000 series, magnesium aluminum alloy with "DustGuard" coating.
- C. Slat design:
- D. Unperforated.
  - 1. "Sheerview" perforations: Staggered pattern of 0.020" diameter holes; nominally 177 per inch of slat length.
  - 2. Slat width: Nominal 1".
- E. Slat thickness: Nominal 0.008."
- F. Head material: 0.025" thick painted steel with baked-on finish.
- G. Head size: 1" high x 1-9/16" wide. "U" shaped.
- H. Bottom rail: 0.23" thick, painted steel with molded plastic ladder and clear end caps.

- I. Guardian tilter, cord lock, drum and cradle, and end braces: Tomized steel Installation brackets shall be of minimum 0.048" thick painted steel with baked-on finish to match headrail. Provide intermediate brackets as recommended by manufacturer.
- J. Ladder (slat support): Braided polyester yarn. Distance between slats shall not exceed 0.875".
- K. Distance between ladders shall not exceed 23" for blinds up to 80" long.
- L. Each ladder shall have its own drum and cradle.
- M. Ladder length: Sufficient for blind to cover openings.
- N. Lift cord:
  - 1. Braided, 0.05" diameter polyester fiber with a high-tenacity polyester core.
  - 2. Length: In accordance with manufacturer's recommendation.
- O. Total unit shall be braced and reinforced to prevent racking or malfunction.
- P. Provide unit with necessary hardware as per manufacturer's recommendation for complete installation.
- Q. Color: Selected by Owner from manufacturer's standard colors.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Verify openings are ready to receive work.
- B. Verify structural blocking and supports are correctly placed.

#### 3.2 EXISTING WORK

- A. Remove abandoned window treatments and patch surfaces.
- B. Clean and repair existing window treatments indicated to remain or to be reinstalled.

#### 3.3 INSTALLATION

- A. Installation shall comply with manufacturer's specifications, standards, and procedures.
- B. Secure in place with concealed fasteners.
- C. Place intermediate head supports at 36 inch oc.
- D. Install blinds plumb, level, and true with connecting hardware.

3.4 ADJUSTING

- A. Adjust blinds for smooth operation.
- B. Blinds shall be in proper operating order prior to Owner's acceptance.

3.5 CLEANING

- A. Clean blind surfaces just prior to occupancy.

END OF SECTION 122100

## SECTION 123200 – MANUFACTURED WOOD CASEWORK

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Manufactured solid wood cabinetry, including base cabinets and wall cabinets.
- B. Countertops.
- C. Fasteners, anchorage, and hardware.

#### 1.2 INFORMATIONAL SUBMITTALS

- A. Shop Drawings and Product Data with material samples, showing cabinet layouts, model numbers, hardware, trim, and accessories.
- B. Color samples shall be submitted after award of Contract.

#### 1.3 QUALITY ASSURANCE

- A. Cabinet manufacturer: Company specializing in manufacture and installation of cabinetry with minimum of 5 years of experience.
- B. Manufacturer's product test data, performed and certified by independent testing agency, showing that product meets specified manufacturer's product.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Materials referenced in this Section are manufactured by Bertch Cabinet Mfg. Inc., unless noted otherwise.
- B. Equivalent products from other manufacturers are acceptable.

#### 2.2 MATERIALS

- A. Style: Quincy - Elan.
- B. Construction:
  - 1. White oak plywood with white oak hardwood face frames, drawers, and door panels.
  - 2. Drawers shall have dovetail construction.
- C. Exterior cabinet surfaces: Manufacturer's standard oven-dried sealers and catalyzed conversion varnish top coats.
- D. Stain color: Tinted Clear Coat.

- E. Hardware:
  - 1. Pulls: As identified per the Finish Legend in the drawings, or approved equal.
  - 2. Hinges: Manufacturer's standard soft-close hinges and glides.
  - 3. Remaining hardware: Manufacturer's standard.
- F. Unit sizes: Base units 24" (600 mm) deep; wall units 12" (300 mm) deep.
- G. Arrangement and location: As indicated on Drawings.
- H. Provide additional trim and fillers as required.
- I. Provide cutouts as required by other trades.

## 2.3 COUNTERTOPS

- A. Caesarstone Classico, sizes and depths per drawing details, or approved equal.
  - 1. Color: Selected by Owner from manufacturer's standard colors.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install units only after painting has been completed.
- B. Stationary cabinet units shall be installed as recommended by cabinetry manufacturer.
- C. Damaged material shall be replaced.
- D. Finishes shall be protected until project completion and acceptance by Owner.

END OF SECTION 123200

## SECTION 220516 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Packless expansion joints.
  - 2. Alignment guides and anchors.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Delegated-Design Submittal: For each anchor and alignment guide, including analysis data, signed and sealed by the qualified professional engineer responsible for their preparation.
  - 1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
  - 2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
  - 3. Alignment Guide Details: Detail field assembly and attachment to building structure.
  - 4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Maintenance data.

#### 1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.
- B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

### 2.2 PACKLESS EXPANSION JOINTS

#### A. Rubber Union Connector Expansion Joints RUEJ-01:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Amber/Booth Company, Inc.; a VMC Group Company.
  - b. Flex-Hose Co., Inc.
  - c. Flexicraft Industries.
  - d. General Rubber Corporation.
  - e. Kadant Unaflex, LLC.
  - f. Mason Industries, Inc.
  - g. Metraflex Company (The).
  - h. Proco Products, Inc.
  - i. Unisource Manufacturing, Inc.
- 2. Material: Twin reinforced-rubber spheres with external restraining cables.
- 3. Minimum Pressure Rating: 150 psig at 170 deg F, unless otherwise indicated.
- 4. End Connections for NPS 2 and Smaller: Threaded.

#### B. Flexible-Hose Packless Expansion Joints FHEJ-01:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Flex-Hose Co., Inc.
  - b. Flexicraft Industries.
  - c. Flex-Pression.
  - d. Mason Industries, Inc.
  - e. Metraflex Company (The).
  - f. Unisource Manufacturing, Inc.
- 2. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
- 3. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
- 4. Expansion Joints for Copper Tubing NPS 2 and Smaller: Copper-alloy fittings with solder-joint end connections.

- a. Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F and 340 psig at 450 deg F ratings.
  - 5. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4: Copper-alloy fittings with threaded end connections.
    - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F and 225 psig at 450 deg F ratings.
  - 6. Expansion Joints for Steel Piping NPS 2 and Smaller: Carbon-steel fittings with threaded end connections.
    - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F and 325 psig at 600 deg F ratings.
  - 7. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6: Carbon-steel fittings with flanged end connections.
    - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F and 145 psig at 600 deg F ratings.
- C. Externally Pressurized Metal-Bellows Packless Expansion Joints EPEJ-01:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Adesco Manufacturing LLC.
    - b. Flex-Hose Co., Inc.
    - c. Hyspan Precision Products, Inc.
    - d. Mason Industries, Inc.
    - e. U.S. Bellows, Inc.
  - 2. Minimum Pressure Rating: 150 psig, unless otherwise indicated.
  - 3. Description:
    - a. Totally enclosed, externally pressurized, multi-ply, stainless-steel bellows isolated from fluid flow by an internal pipe sleeve.
    - b. Carbon-steel housing.
    - c. Drain plugs and lifting lug for NPS 3 and larger.
    - d. Bellows shall have operating clearance between the internal pipe sleeves and the external shrouds.
    - e. Joints shall be supplied with a built-in scale to confirm the starting position and operating movement.
    - f. Joint Axial Movement: 6 inches of compression and 1 inch of extension.
  - 4. Permanent Locking Bolts: Set locking bolts to maintain joint lengths during installation. Temporary welding tabs that are removed after installation in lieu of locking bolts are not acceptable.
  - 5. End Connection Configuration: Flanged; one raised, fixed and one floating flange.

## 2.3 ALIGNMENT GUIDES AND ANCHORS

### A. Alignment Guides AG-01:

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. Advanced Thermal Systems, Inc.
  - b. Flex-Hose Co., Inc.
  - c. Flexicraft Industries.
  - d. Flex-Weld; a division of Kelco.
  - e. Hyspan Precision Products, Inc.
  - f. Mason Industries, Inc.
  - g. Metraflex Company (The).
2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe.

### B. Anchor Materials:

1. Steel Shapes and Plates: ASTM A36/A36M.
2. Bolts and Nuts: ASME B18.10 or ASTM A183, steel hex head.
3. Washers: ASTM F844, steel, plain, flat washers.
4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
  - a. Stud: Threaded, zinc-coated carbon steel.
  - b. Expansion Plug: Zinc-coated steel.
  - c. Washer and Nut: Zinc-coated steel.
5. Chemical Fasteners: Insert-type stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
  - a. Bonding Material: ASTM C881/C881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
  - b. Stud: ASTM A307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
  - c. Washer and Nut: Zinc-coated steel.

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF EXPANSION JOINTS

- A. Install expansion joints of sizes matching sizes of piping in which they are installed.

- B. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

### 3.2 INSTALLATION OF PIPE LOOPS AND SWING CONNECTIONS

- A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
- B. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.
- C. Connect risers and branch connections to terminal units with at least four pipe fittings, including tee in riser.
- D. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

### 3.3 INSTALLATION OF ALIGNMENT-GUIDES AND ANCHORS

- A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
- B. Install one guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.
- C. Attach guides to pipe, and secure guides to building structure.
- D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- E. Anchor Attachments:
  - 1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - 2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24; U bolts bolted to anchor.
- F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
  - 1. Anchor Attachment to Steel Structural Members: Attach by welding.
  - 2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
- G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 220516

## SECTION 220517 - 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 waterstop 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. Sleeve-seal systems in this article are used for piping penetrations in slabs-on-grade and below grade in exterior walls. These systems are available for NPS 1/2 to NPS 48 (DN 15 to DN 1200) piping.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Advance Products & Systems, Inc.
  - 2. CALPICO, Inc.

3. Metraflex Company (The).
  4. Pipeline Seal and Insulator, Inc.
  5. Proco Products, Inc.
- C. 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: Stainless steel.
  3. Connecting Bolts and Nuts: Stainless steel 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: Nonshrink; 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: Galvanized-steel 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: PVC-pipe sleeves.
    - b. Piping NPS 6 and Larger: PVC-pipe sleeves.

END OF SECTION 220517

## SECTION 220518 - ESCUTCHEONS FOR PLUMBING PIPING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Escutcheons.
  - 2. Floor plates.

#### 1.2 ACTION SUBMITTALS

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

### PART 2 - PRODUCTS

#### 2.1 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

#### 2.2 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
  - 1. Escutcheons for 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.
  - 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.
  - 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.
  - j. Bare Piping in Equipment Rooms: One-piece, cast-brass type with polished, chrome-plated finish.
  - k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
- 1. New Piping: One-piece, floor-plate type.

### 3.2 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 220518

## SECTION 220519 - METERS AND GAGES FOR PLUMBING PIPING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Bimetallic-actuated thermometers.
  - 2. Liquid-in-glass thermometers.
  - 3. Thermowells.
  - 4. Dial-type pressure gages.
  - 5. Gage attachments.

#### 1.2 ACTION SUBMITTALS

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

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Product certificates.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

### PART 2 - PRODUCTS

#### 2.1 BIMETALLIC-ACTUATED THERMOMETERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Ashcroft Inc.
  - 2. Ernst Flow Industries.
  - 3. Marsh Bellofram.
  - 4. Miljoco Corporation.
  - 5. Nanmac Corporation.
  - 6. Noshok.
  - 7. Palmer Wahl Instrumentation Group.
  - 8. REOTEMP Instrument Corporation.
  - 9. Tel-Tru Manufacturing Company.
  - 10. Terice, H. O. Co.
  - 11. Watts; a Watts Water Technologies company.

12. Weiss Instruments, Inc.
13. Weksler Glass Thermometer Corp.
14. WIKA Instrument Corporation.
15. Winters Instruments - U.S.

- B. Standard: ASME B40.200.
- C. Case: Liquid-filled and sealed type(s); stainless steel with 3-inch nominal diameter.
- D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F.
- E. Connector Type(s): Union joint, rigid, back and rigid, bottom, with unified-inch screw threads.
- F. Connector Size: 1/2 inch, with ASME B1.1 screw threads.
- G. Stem: 0.25 or 0.375 inch in diameter; stainless steel.
- H. Window: Plain glass.
- I. Ring: Stainless steel.
- J. Element: Bimetal coil.
- K. Pointer: Dark-colored metal.
- L. Accuracy: Plus or minus 1 percent of scale range.

## 2.2 LIQUID-IN-GLASS THERMOMETERS

- A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Flo Fab inc.
    - b. Miljoco Corporation.
    - c. Palmer Wahl Instrumentation Group.
    - d. Tel-Tru Manufacturing Company.
    - e. Trerice, H. O. Co.
    - f. Weiss Instruments, Inc.
    - g. Weksler Glass Thermometer Corp.
    - h. Winters Instruments - U.S.
  2. Standard: ASME B40.200.
  3. Case: Cast aluminum; 7-inch nominal size unless otherwise indicated.
  4. Case Form: Adjustable angle unless otherwise indicated.
  5. Tube: Glass with magnifying lens and blue or red organic liquid.
  6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
  7. Window: Glass.
  8. Stem: Aluminum and of length to suit installation.

- a. Design for Thermowell Installation: Bare stem.
- 9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
- 10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

## 2.3 THERMOWELLS

### A. Thermowells:

- 1. Standard: ASME B40.200.
- 2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
- 3. Material for Use with Copper Tubing: CNR or CUNI.
- 4. Material for Use with Steel Piping: CRES.
- 5. Type: Stepped shank unless straight or tapered shank is indicated.
- 6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
- 7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
- 8. Bore: Diameter required to match thermometer bulb or stem.
- 9. Insertion Length: Length required to match thermometer bulb or stem.
- 10. Lagging Extension: Include on thermowells for insulated piping and tubing.
- 11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

### B. Heat-Transfer Medium: Mixture of graphite and glycerin.

## 2.4 PRESSURE GAGES

### A. Direct-Mounted and remote mounted, Metal-Case, Dial-Type Pressure Gages:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. AMETEK, Inc.
  - b. Ashcroft Inc.
  - c. Ernst Flow Industries.
  - d. Flo Fab inc.
  - e. Marsh Bellofram.
  - f. Miljoco Corporation.
  - g. Noshok.
  - h. Palmer Wahl Instrumentation Group.
  - i. REOTEMP Instrument Corporation.
  - j. Tel-Tru Manufacturing Company.
  - k. Terice, H. O. Co.
  - l. Watts; a Watts Water Technologies company.
  - m. Weiss Instruments, Inc.
  - n. Weksler Glass Thermometer Corp.
  - o. WIKA Instrument Corporation.
  - p. Winters Instruments - U.S.

2. Standard: ASME B40.100.
3. Case: Liquid-filled type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Metal.
11. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.

## 2.5 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.
- B. Valves: Brass ball, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.
- G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- H. Install remote-mounted pressure gages on panel.
- I. Install valve and snubber in piping for each pressure gage for fluids.
- J. Install thermometers in the following locations:
  1. Inlet and outlet of each water heater.
  2. Inlets and outlets of each domestic water heat exchanger.

3. Inlet and outlet of each domestic hot-water storage tank.
4. Inlet and outlet of each remote domestic water chiller.

K. Install pressure gages in the following locations:

1. Building water service entrance into building.
2. Inlet and outlet of each pressure-reducing valve.
3. Suction and discharge of each domestic water pump.

L. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

M. Adjust faces of meters and gages to proper angle for best visibility.

### 3.2 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each domestic water heater shall be the following:

1. Industrial-style, liquid-in-glass type.

B. Thermometers at inlets and outlets of each domestic water heat exchanger shall be the following:

1. Industrial-style, liquid-in-glass type.

C. Thermometers at inlet and outlet of each domestic hot-water storage tank shall be the following:

1. Industrial-style, liquid-in-glass type.

D. Thermometers at inlet and outlet of each remote domestic water chiller shall be the following:

1. Industrial-style, liquid-in-glass type.

E. Thermometer stems shall be of length to match thermowell insertion length.

### 3.3 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F.

B. Scale Range for Domestic Hot-Water Piping: 20 to 240 deg F.

C. Scale Range for Domestic Cooled-Water Piping: 0 to 100 deg F.

### 3.4 PRESSURE-GAGE SCHEDULE

A. Pressure gages at discharge of each water service into building shall be the following:

1. Liquid-filled, direct-mounted, metal case.

- B. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be the following:
  - 1. Liquid-filled, direct-mounted, metal case.
- C. Pressure gages at suction and discharge of each domestic water pump shall be the following:
  - 1. Liquid-filled, direct-mounted, metal case.

### 3.5 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for Water Service Piping: 0 to 100 psi.
- B. Scale Range for Domestic Water Piping: 0 to 100 psi.

END OF SECTION 220519

## SECTION 220523.12 - BALL VALVES FOR PLUMBING PIPING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Brass ball valves.
  - 2. Bronze ball valves.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of valve.
  - 1. Certification that products comply with NSF 61.

### PART 2 - PRODUCTS

#### 2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. All piping, valves, and equipment for domestic water use shall comply with the reduction of lead in Drinking Water Act of 2011 which will be enforced January 4, 2014.
- C. ASME Compliance:
  - 1. ASME B1.20.1 for threads for threaded end valves.
  - 2. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
  - 3. ASME B16.18 for solder-joint connections.
  - 4. ASME B31.9 for building services piping valves.
- D. NSF Compliance: NSF 61 for valve materials for potable-water service.
- E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- F. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- G. Valve Sizes: Same as upstream piping unless otherwise indicated.
- H. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 4 and larger.
2. Handlever: For quarter-turn valves smaller than NPS 4.

I. Valves in Insulated Piping:

1. Include 2-inch stem extensions.
2. Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
3. Memory stops that are fully adjustable after insulation is applied.

## 2.2 BRASS BALL VALVES

A. One-Piece, Brass Ball Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. KITZ Corporation.
2. Description:
  - a. Standard: MSS SP-110.
  - b. CWP Rating: 400 psig.
  - c. Body Design: One piece.
  - d. Body Material: Forged brass or bronze.
  - e. Ends: Threaded and soldered.
  - f. Seats: PTFE.
  - g. Stem: Brass or stainless steel.
  - h. Ball: Chrome-plated brass or stainless steel.
  - i. Port: Reduced.

B. Two-Piece, Brass Ball Valves with Full Port and Brass Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. American Valve, Inc.
  - b. Conbraco Industries, Inc.
  - c. Crane; Crane Energy Flow Solutions.
  - d. DynaQuip Controls.
  - e. Hammond Valve.
  - f. Jomar Valve.
  - g. KITZ Corporation.
  - h. Legend Valve.
  - i. Marwin Valve; Richards Industries.
  - j. Milwaukee Valve Company.
  - k. NIBCO INC.
  - l. Red-White Valve Corporation.
  - m. Stockham; Crane Energy Flow Solutions.
  - n. Watts; a Watts Water Technologies company.

2. Description:
  - a. Standard: MSS SP-110.
  - b. CWP Rating: 600 psig.
  - c. Body Design: Two piece.
  - d. Body Material: Forged brass.
  - e. Ends: Threaded and soldered.
  - f. Seats: PTFE.
  - g. Stem: Brass.
  - h. Ball: Chrome-plated brass.
  - i. Port: Full.

C. Two-Piece, Brass Ball Valves with Regular Port and Brass Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Hammond Valve.
  - b. Legend Valve.
  - c. Milwaukee Valve Company.
  - d. NIBCO INC.
  - e. Watts; a Watts Water Technologies company.
2. Description:
  - a. Standard: MSS SP-110.
  - b. CWP Rating: 600 psig.
  - c. Body Design: Two piece.
  - d. Body Material: Forged brass.
  - e. Ends: Threaded and soldered.
  - f. Seats: PTFE.
  - g. Stem: Brass.
  - h. Ball: Chrome-plated brass.
  - i. Port: Regular.

2.3 BRONZE BALL VALVES

A. One-Piece, Bronze Ball Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Conbraco Industries, Inc.
  - b. NIBCO INC.
  - c. Watts; a Watts Water Technologies company.
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.
- g. Stem: Bronze.
- h. Ball: Chrome-plated brass.
- i. Port: Reduced.

B. Two-Piece, Bronze Ball Valves with Full Port, and Bronze or Brass Trim:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Conbraco Industries, Inc.
  - b. Crane; Crane Energy Flow Solutions.
  - c. Hammond Valve.
  - d. Lance Valves.
  - e. Milwaukee Valve Company.
  - f. NIBCO INC.
  - g. Watts; a Watts Water Technologies company.
- 2. Description:
  - a. Standard: MSS SP-110.
  - b. CWP Rating: 600 psig.
  - c. Body Design: Two piece.
  - d. Body Material: Bronze.
  - e. Ends: Threaded and soldered.
  - f. Seats: PTFE.
  - g. Stem: Bronze or brass.
  - h. Ball: Chrome-plated brass.
  - i. Port: Full.

C. Two-Piece, Bronze Ball Valves with Regular Port and Bronze or Brass Trim:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Conbraco Industries, Inc.
  - b. DynaQuip Controls.
  - c. Hammond Valve.
  - d. Milwaukee Valve Company.
  - e. NIBCO INC.
  - f. Watts; a Watts Water Technologies company.
- 2. Description:
  - a. Standard: MSS SP-110.
  - b. CWP Rating: 600 psig.
  - c. Body Design: Two piece.
  - d. Body Material: Bronze.

- e. Ends: Threaded.
- f. Seats: PTFE.
- g. Stem: Bronze or brass.
- h. Ball: Chrome-plated brass.
- i. Port: Regular.

## PART 3 - EXECUTION

### 3.1 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. Locate valves above accessible ceilings. If this is not possible, provide

### 3.2 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- B. Select valves 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 Steel Piping, NPS 2 and Smaller: Threaded ends.

### 3.3 DOMESTIC HOT- AND COLD-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. One piece, brass ball valve.
  - 3. One piece, bronze ball valve with bronze trim.
  - 4. Two-piece, brass ball valves with full port and brass trim.
  - 5. Two-piece, bronze ball valves with full port and bronze or brass trim.

END OF SECTION 220523.12

## SECTION 220523.14 - CHECK VALVES FOR PLUMBING PIPING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
1. Bronze swing check valves.
  2. Iron swing check valves.
  3. Iron swing check valves with closure control.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of valve.
1. Certification that products comply with NSF 61.

### PART 2 - PRODUCTS

#### 2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
1. ASME B1.20.1 for threads for threaded end valves.
  2. ASME B16.1 for flanges on iron valves.
  3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
  4. ASME B16.18 for solder joint.
  5. ASME B31.9 for building services piping valves.
- C. NSF Compliance: NSF 61 for valve materials for potable-water service.
- D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- F. Valve Sizes: Same as upstream piping unless otherwise indicated.
- G. Valve Bypass and Drain Connections: MSS SP-45.

## 2.2 BRONZE SWING CHECK VALVES

### A. Class 125, Bronze Swing Check Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. American Valve, Inc.
  - b. Crane; Crane Energy Flow Solutions.
  - c. Hammond Valve.
  - d. NIBCO INC.
  - e. Red-White Valve Corporation.
  - f. Watts; a Watts Water Technologies company.
2. Description:
  - a. Standard: MSS SP-80, Type 3.
  - b. CWP Rating: 200 psig.
  - c. Body Design: Horizontal flow.
  - d. Body Material: ASTM B 62, bronze.
  - e. Ends: Threaded or soldered. See valve schedule articles.
  - f. Disc: Bronze.

### B. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Crane; Crane Energy Flow Solutions.
  - b. Hammond Valve.
  - c. NIBCO INC.
  - d. Red-White Valve Corporation.
  - e. Watts; a Watts Water Technologies company.
2. Description:
  - a. Standard: MSS SP-80, Type 4.
  - b. CWP Rating: 200 psig.
  - c. Body Design: Horizontal flow.
  - d. Body Material: ASTM B 62, bronze.
  - e. Ends: Threaded or soldered. See valve schedule articles.
  - f. Disc: PTFE.

## 2.3 IRON SWING CHECK VALVES

### A. Class 125, Iron Swing Check Valves with Metal Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Crane; Crane Energy Flow Solutions.
- b. Hammond Valve.
- c. NIBCO INC.
- d. Red-White Valve Corporation.
- e. Watts; a Watts Water Technologies company.

2. Description:

- a. Standard: MSS SP-71, Type I.
- b. CWP Rating: 200 psig.
- c. Body Design: Clear or full waterway.
- d. Body Material: ASTM A 126, gray iron with bolted bonnet.
- e. Ends: Flanged or threaded. See valve schedule articles.
- f. Trim: Bronze.
- g. Gasket: Asbestos free.

B. Class 125, Iron Swing Check Valves with Nonmetallic-to-Metal Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Crane; Crane Energy Flow Solutions.
- b. Stockham; Crane Energy Flow Solutions.

2. Description:

- a. Standard: MSS SP-71, Type I.
- b. CWP Rating: 200 psig.
- c. Body Design: Clear or full waterway.
- d. Body Material: ASTM A 126, gray iron with bolted bonnet.
- e. Ends: Flanged or threaded. See valve schedule articles.
- f. Trim: Composition.
- g. Seat Ring: Bronze.
- h. Disc Holder: Bronze.
- i. Disc: PTFE.
- j. Gasket: Asbestos free.

## 2.4 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

A. Class 125, Iron Swing Check Valves with Lever- and Spring-Closure Control:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

- a. NIBCO INC.

2. Description:

- a. Standard: MSS SP-71, Type I.
- b. CWP Rating: 200 psig.

- c. Body Design: Clear or full waterway.
- d. Body Material: ASTM A 126, gray iron with bolted bonnet.
- e. Ends: Flanged or threaded. See valve schedule articles.
- f. Trim: Bronze.
- g. Gasket: Asbestos free.
- h. Closure Control: Factory-installed exterior lever and spring.

B. Class 125, Iron Swing Check Valves with Lever and Weight-Closure Control:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Crane; Crane Energy Flow Solutions.
  - b. Hammond Valve.
  - c. NIBCO INC.
  - d. Watts; a Watts Water Technologies company.
2. Description:
  - a. Standard: MSS SP-71, Type I.
  - b. CWP Rating: 200 psig.
  - c. Body Design: Clear or full waterway.
  - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
  - e. Ends: Flanged or threaded. See valve schedule articles.
  - f. Trim: Bronze.
  - g. Gasket: Asbestos free.
  - h. Closure Control: Factory-installed exterior lever and weight.

## PART 3 - EXECUTION

### 3.1 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 swing check valves for proper direction of flow in horizontal position with hinge pin level.
- F. Provide check valves at the discharge of each pump.

### 3.2 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.

### 3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
  - 1. Pump-Discharge Check Valves:
    - a. NPS 2 and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
    - b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or spring; metal-seat or resilient-seat check valves.
    - c. 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 CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- C. End Connections:
  - 1. For Copper Tubing, NPS 2 and Smaller: Threaded or soldered.
  - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged or threaded.
  - 3. For Copper Tubing, NPS 5 and Larger: Flanged.
  - 4. For Steel Piping, NPS 2 and Smaller: Threaded.
  - 5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged or threaded.
  - 6. For Steel Piping, NPS 5 and Larger: Flanged.

### 3.4 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller: Bronze swing check valves, Class 125, bronze disc with soldered or threaded end connections.
- B. Pipe NPS 2-1/2 and Larger:
  - 1. Iron swing check valves, Class 125, metal seats with threaded or flanged end connections.
  - 2. Iron swing check valves with closure control, Class 125, lever and spring with threaded or flanged end connections.

END OF SECTION 220523.14

## SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Metal pipe hangers and supports.
  - 2. Trapeze pipe hangers.
  - 3. Thermal-hanger shield inserts.
  - 4. Fastener systems.
  - 5. Pipe positioning systems.
  - 6. Equipment supports.

#### 1.2 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
  - 1. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
  - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
  - 3. Design seismic-restraint hangers and supports for piping and equipment.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:
  - 1. Trapeze pipe hangers.
  - 2. Equipment supports.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

#### 1.5 QUALITY ASSURANCE

- A. Structural Steel 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.

## PART 2 - PRODUCTS

### 2.1 METAL PIPE HANGERS AND SUPPORTS

#### A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

#### B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

#### C. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

### 2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

### 2.3 THERMAL-HANGER SHIELD INSERTS

- A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- B. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig minimum compressive strength.
- C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

- E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

## 2.4 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, stainless- steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

## 2.5 PIPE POSITIONING SYSTEMS

- A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

## 2.6 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

## 2.7 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
  - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
  - 2. Design Mix: 5000-psi, 28-day compressive strength.

# PART 3 - EXECUTION

## 3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal 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 the building structure.
- B. Metal 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 for individual pipe hangers.
  2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- D. Fastener System Installation:
1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
  2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- E. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.
- F. Install hangers and supports complete with necessary attachments, 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 and seismic 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 that 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 to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- M. Insulated Piping:
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 allowed by ASME B31.9 for building services piping.
- 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
  - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
- 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
  - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
- 4. 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.
  - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
- 5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
- 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

### 3.2 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 bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

### 3.3 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/D1.1M 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 so contours of welded surfaces match adjacent contours.

### 3.4 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.

### 3.5 PAINTING

- A. Touchup: 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 a minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

### 3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are 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 carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.

- J. 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 up to 1050 deg F, pipes NPS 4 to NPS 24, 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 36, requiring clamp flexibility and up to 4 inches of insulation.
  4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
  5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
  6. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
  7. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
  8. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
  9. 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.
- K. 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 24.
  2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- L. 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.
- M. 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-joint 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. 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.
  8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
  9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
  2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
  3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
  2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
  3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
- P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- R. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 220529

## SECTION 220548.13 - VIBRATION 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 support.
9. Resilient pipe guides.
10. Elastomeric hangers.
11. Spring hangers.
12. Snubbers.
13. Restraints - rigid type.
14. Restraints - cable type.
15. Restraint accessories.
16. Post-installed concrete anchors.
17. Concrete inserts.

##### B. Related Requirements:

1. Section 210548.13 "Vibration Controls for Fire-Suppression Piping and Equipment" for devices for fire-suppression equipment and systems.
2. Section 230548.13 "Vibration Controls for HVAC" for devices for HVAC equipment and systems.

#### 1.2 ACTION SUBMITTALS

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

##### B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

##### C. Delegated-Design Submittal:

1. Design Calculations for Vibration Isolation Devices: Calculate static and dynamic loading due to equipment weight and operating forces required to select proper vibration isolators, and to design vibration isolation bases.
2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and spring deflection changes. Include certification that riser system was examined for excessive stress and that none exists.

### 1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of vibration isolation device installation for plumbing piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
- B. Welding certificates.
- C. Field quality-control reports.

### 1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct testing indicated, be an NRTL as defined by OSHA in 29 CFR 1910.7 and be acceptable to authorities having jurisdiction.
- B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design system.
- B. Fire/Smoke Resistance: All components that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.
- C. Component Supports:
  1. Load ratings, features, and applications of all reinforcement components must be based on testing standards of a nationally recognized testing agency.
  2. All component support attachments must comply with force and displacement resistance requirements of ASCE/SEI 7-05 Section 13.6.

## 2.2 ELASTOMERIC ISOLATION PADS

### A. Elastomeric Isolation Pads:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ace Mountings Co., Inc.
  - b. CADDY; brand of nVent Electrical plc.
  - c. California Dynamics Corporation.
  - d. Isolation Technology, Inc.
  - e. Kinetics Noise Control, Inc.
  - f. Korfund.
  - g. Mason Industries, Inc.
  - h. Novia; A Division of C&P.
  - i. Vibration Eliminator Co., Inc.
  - j. Vibration Isolation.
  - k. Vibration Management Corp.
  - l. 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. Minimum deflection as indicated on Drawings.
5. Pad Material: Oil- and water-resistant rubber.
6. Infused nonwoven cotton or synthetic fibers.
7. Load-bearing metal plates adhered to pads.
8. Sandwich-Core Material: Resilient and elastomeric.
  - a. Infused nonwoven cotton or synthetic fibers.

## 2.3 ELASTOMERIC ISOLATION MOUNTS

### A. Elastomeric Isolation Mounts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ace Mountings Co., Inc.
  - b. CADDY; brand of nVent Electrical plc.
  - c. California Dynamics Corporation.
  - d. Isolation Technology, Inc.
  - e. Kinetics Noise Control, Inc.
  - f. Korfund.
  - g. Mason Industries, Inc.
  - h. Novia; A Division of C&P.
  - i. Vibration Eliminator Co., Inc.
  - j. Vibration Isolation.
  - k. Vibration Management Corp.
  - l. 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. Minimum deflection as indicated on Drawings.
4. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

## 2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

### A. Restrained Elastomeric Isolation Mounts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ace Mountings Co., Inc.
  - b. CADDY; brand of nVent Electrical plc.
  - c. California Dynamics Corporation.
  - d. Isolation Technology, Inc.
  - e. Kinetics Noise Control, Inc.
  - f. Korfund.
  - g. Mason Industries, Inc.
  - h. Novia; A Division of C&P.
  - i. Vibration Eliminator Co., Inc.
  - j. Vibration Isolation.
  - k. Vibration Management Corp.
  - l. Vibration Mountings & Controls, Inc.
2. Description: All-directional isolator with 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.
3. Minimum deflection as indicated on Drawings.

## 2.5 OPEN-SPRING ISOLATORS

### A. Freestanding, Laterally Stable, Open-Spring Isolators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ace Mountings Co., Inc.

- b. CADDY; brand of nVent Electrical plc.
  - c. California Dynamics Corporation.
  - d. Isolation Technology, Inc.
  - e. Kinetics Noise Control, Inc.
  - f. Korfund.
  - g. Mason Industries, Inc.
  - h. Novia; A Division of C&P.
  - i. Vibration Eliminator Co., Inc.
  - j. Vibration Isolation.
  - k. Vibration Management Corp.
  - l. 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 psi.
  7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
  8. Minimum deflection as indicated on Drawings.

## 2.6 HOUSED-SPRING ISOLATORS

### A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ace Mountings Co., Inc.
  - b. CADDY; brand of nVent Electrical plc.
  - c. California Dynamics Corporation.
  - d. Isolation Technology, Inc.
  - e. Kinetics Noise Control, Inc.
  - f. Korfund.
  - g. Mason Industries, Inc.
  - h. Vibration Eliminator Co., Inc.
  - i. Vibration Isolation.
  - j. Vibration Management Corp.
  - k. 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. Minimum deflection as indicated on Drawings.

7. 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 psi.
  - b. Top housing with elastomeric pad.

## 2.7 RESTRAINED-SPRING ISOLATORS

### A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ace Mountings Co., Inc.
  - b. CADDY; brand of nVent Electrical plc.
  - c. California Dynamics Corporation.
  - d. Isolation Technology, Inc.
  - e. Kinetics Noise Control, Inc.
  - f. Korfund.
  - g. Mason Industries, Inc.
  - h. Novia; A Division of C&P.
  - i. Vibration Eliminator Co., Inc.
  - j. Vibration Isolation.
  - k. Vibration Management Corp.
  - l. 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 psi.
  - b. Top plate with elastomeric pad.
  - 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.
8. Minimum deflection as indicated on Drawings.

## 2.8 HOUSED-RESTRAINED-SPRING ISOLATORS

### A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ace Mountings Co., Inc.
  - b. CADDY; brand of nVent Electrical plc.
  - c. California Dynamics Corporation.
  - d. Isolation Technology, Inc.
  - e. Kinetics Noise Control, Inc.
  - f. Korfund.
  - g. Mason Industries, Inc.
  - h. Vibration Eliminator Co., Inc.
  - i. Vibration Isolation.
  - j. Vibration Management Corp.
  - k. 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 psi.
  - 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.
7. Minimum deflection as indicated on Drawings.

## 2.9 PIPE-RISER RESILIENT SUPPORT

- A. All-Directional, Acoustical Pipe Anchor Consisting of Two Steel Tubes Separated by a Minimum 1/2-inch-Thick Neoprene.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. California Dynamics Corporation.
    - b. Kinetics Noise Control, Inc.
    - c. Mason Industries, Inc.
    - d. Vibration Eliminator Co., Inc.
    - e. Vibration Management Corp.
  
  2. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
  3. Maximum Load Per Support: 500 psi on isolation material providing equal isolation in all directions.

4. Minimum deflection as indicated on Drawings.

## 2.10 RESILIENT PIPE GUIDES

- A. Telescopic Arrangement of Two Steel Tubes or Post and Sleeve Arrangement Separated by a Minimum 1/2-inch-Thick Neoprene:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. California Dynamics Corporation.
    - b. Kinetics Noise Control, Inc.
    - c. Mason Industries, Inc.
    - d. Vibration Eliminator Co., Inc.
    - e. Vibration Management Corp.
    - f. Vibration Mountings & Controls, Inc.
  2. 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Ace Mountings Co., Inc.
    - b. CADDY; brand of nVent Electrical plc.
    - c. California Dynamics Corporation.
    - d. Kinetics Noise Control, Inc.
    - e. Mason Industries, Inc.
    - f. Novia; A Division of C&P.
    - g. Vibration Eliminator Co., Inc.
    - h. Vibration Isolation.
    - i. Vibration Management Corp.
    - j. 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. Damping Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel-to-steel contact.
  4. Minimum deflection as indicated on Drawings.

## 2.12 SPRING HANGERS

- A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Ace Mountings Co., Inc.
    - b. CADDY; brand of nVent Electrical plc.
    - c. California Dynamics Corporation.
    - d. Kinetics Noise Control, Inc.
    - e. Mason Industries, Inc.
    - f. Novia; A Division of C&P.
    - g. Vibration Eliminator Co., Inc.
    - h. Vibration Isolation.
    - i. Vibration Management Corp.
    - j. 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. Minimum deflection as indicated on Drawings.
  7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  8. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
  9. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
  10. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

## 2.13 SNUBBERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. CADDY; brand of nVent Electrical plc.
  2. Kinetics Noise Control, Inc.
  3. Mason Industries, Inc.
  4. Vibration Management Corp.
  5. 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. Post-Installed Concrete Anchor Bolts: Secure to concrete surface with post-installed concrete anchors. Anchors to be prequalified in accordance with ACI 355.2 testing and designated in accordance with ACI 318-08 Appendix D for 2009 IBC
2. Preset Concrete Inserts: Prequalified in accordance with ICC-ES AC446 testing.
3. Anchors in Masonry: Design in accordance with TMS 402.
4. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
5. Resilient Cushion: Maximum 1/4-inch air gap, and minimum 1/4 inch thick.

#### 2.14 RESTRAINTS - RIGID TYPE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. CADDY; brand of nVent Electrical plc.
  2. California Dynamics Corporation.
  3. Cooper B-line; brand of Eaton, Electrical Sector.
  4. Hilti, Inc.
  5. Isolation Technology, Inc.
  6. TOLCO.
  7. Unistrut; Atkore International.
  8. Vibration Mountings & Controls, Inc.
- B. Description: Shop- or field-fabricated bracing assembly made of AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes 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 RESTRAINTS - CABLE TYPE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. CADDY; brand of nVent Electrical plc.
  2. Cooper B-line; brand of Eaton, Electrical Sector.
  3. Gripple Inc.
  4. Loos & Co.
  5. Vibration Mountings & Controls, Inc.
- B. Restraint Cables: ASTM A492 stainless steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with fittings attached by means of poured socket, swaged socket, or mechanical (Flemish eye) loop.
- C. Restraint cable assembly and cable fittings must comply with ASCE/SEI 19-10. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

## 2.16 RESTRAINT ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. CADDY; brand of nVent Electrical plc.
  - 2. Cooper B-line; brand of Eaton, Electrical Sector.
  - 3. Hilti, Inc.
  - 4. Loos & Co.
  - 5. Mason Industries, Inc.
  - 6. TOLCO.
  - 7. Unistrut; Atkore International.
- 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.

## 2.17 POST-INSTALLED CONCRETE ANCHORS

- A. Mechanical Anchor Bolts:
  - 1. 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 E488/E488M.
- B. Adhesive Anchor Bolts:
  - 1. 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 E488/E488M.
  - 2. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
  - 3. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

- C. Expansion-type anchor bolts are not permitted for equipment in excess of 10 hp that is not vibration isolated.
  - 1. Undercut expansion anchors are permitted.

## 2.18 CONCRETE INSERTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Cooper B-line; brand of Eaton, Electrical Sector.
  - 2. Hilti, Inc.
  - 3. Mason Industries, Inc.
  - 4. Powers Fasteners.
  - 5. Simpson Strong-Tie Co., Inc.
  - 6. Unistrut; Atkore International.
- B. Provide preset concrete inserts that are prequalified in accordance with ICC-ES AC466 testing.
- C. Comply with ANSI/MSS SP-58.

## PART 3 - EXECUTION

### 3.1 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength is adequate to carry static forces within specified loading limits.

### 3.2 INSTALLATION OF VIBRATION-CONTROL DEVICES

- A. Provide vibration-control devices for systems and equipment where indicated in Equipment Schedules or Vibration-Control Device Schedules, where indicated on Drawings, or where the Specifications indicate they are to be installed on specific equipment and systems.
- B. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."
- C. Installation of vibration isolators must not cause any stresses, misalignment or change of position of equipment or piping.
- D. Equipment Restraints:

1. Install 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.

E. 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.

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. Post-Installed Concrete 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 Project 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. Mechanical-Type Anchor Bolts: 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 MOTION

- A. Provide flexible connections in piping systems where they cross structural joints and other point where differential movement may occur. Provide adequate flexibility to accommodate differential movement as determined in accordance with ASCE/SEI 7. Comply with requirements in Section 221116 "Domestic Water Piping" and Section 221119 "Domestic Water Piping Specialties" for piping flexible connections.

### 3.4 ADJUSTING

- A. Adjust isolators after 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.

### 3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
  - 1. Perform tests and inspections with the assistance of a factory-authorized service representative.
  - 2. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
  - 3. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
  - 4. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
  - 5. Test no fewer than four of each type and size of installed anchors and fasteners selected by Architect.
  - 6. Test to 90 percent of rated proof load of device.
  - 7. Measure isolator restraint clearance.
  - 8. Measure isolator deflection.
  - 9. Verify snubber minimum clearances.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Units will be considered defective if they do not pass tests and inspections
- E. Prepare test and inspection reports.

END OF SECTION 220548.13

## SECTION 220553 - 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.

#### 1.2 ACTION SUBMITTALS

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

### PART 2 - PRODUCTS

#### 2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Brady Corporation.
    - b. Brimar Industries, Inc.
    - c. Carlton Industries, LP.
    - d. Champion America.
    - e. Craftmark Pipe Markers.
    - f. emedco.
    - g. Kolbi Pipe Marker Co.
    - h. LEM Products Inc.
    - i. Marking Services, Inc.
    - j. Seton Identification Products.
  2. Material and Thickness: aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
  3. Letter Color: White.
  4. Background Color: Black.
  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-quarters 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.

B. Plastic Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Brady Corporation.
  - b. Brimar Industries, Inc.
  - c. Carlton Industries, LP.
  - d. Champion America.
  - e. Craftmark Pipe Markers.
  - f. emedco.
  - g. Kolbi Pipe Marker Co.
  - h. LEM Products Inc.
  - i. Marking Services, Inc.
  - j. Seton Identification Products.
2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
3. Letter Color: White.
4. Background Color: Black.
5. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
7. 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-quarters the size of principal lettering.
8. Fasteners: Stainless-steel rivets or self-tapping screws.
9. 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), and 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) and 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
  2. Brimar Industries, Inc.

3. Carlton Industries, LP.
  4. Champion America.
  5. Craftmark Pipe Markers.
  6. emedco.
  7. LEM Products Inc.
  8. Marking Sevices Inc.
  9. National Marker Company.
  10. Seton Identification Products.
  11. Stranco, Inc.
- B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- C. Letter Color: Yellow.
- D. Background Color: Black.
- E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- G. 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-quarters the size of principal lettering.
- H. Fasteners: Stainless-steel rivets or self-tapping screws.
- I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- J. Label Content: Include caution and warning information plus emergency notification instructions.

### 2.3 PIPE LABELS

- A. Retain this article if these devices will identify some or all piping. Identification of piping by color-coded painting is covered in "Pipe Label Installation" Article.
- B. Do not use pipe labels or plastic tapes for bare pipes conveying fluids at temperatures of 125 deg F (52 deg C) or higher.
- C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
  2. Brady Corporation.
  3. Brimar Industries, Inc.
  4. Carlton Industries, LP.
  5. Champion America.

6. Craftmark Pipe Markers.
  7. emedco.
  8. Kolbi Pipe Marker Co.
  9. LEM Products Inc.
  10. Marking Sevices Inc.
  11. Seton Identification Products.
- D. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- E. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- F. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- G. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include 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 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.

## PART 3 - EXECUTION

### 3.1 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

### 3.2 PIPE LABEL INSTALLATION

- A. Pipe Label Locations: 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 and on both sides of 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 25 feet along each run. Reduce intervals to 15 feet in areas of congested piping and equipment.

7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

B. Pipe Label Color Schedule:

1. Domestic Water Piping

- a. Background: Safety green.
- b. Letter Colors: White.

2. Sanitary Waste and Storm Drainage Piping:

- a. Background Color: Safety black.
- b. Letter Color: White.

END OF SECTION 220553

## SECTION 220593 - TESTING, ADJUSTING, AND BALANCING FOR PLUMBING

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. TAB of domestic water system.
2. TAB of plumbing equipment:
  - a. Domestic water booster pumps.
  - b. Domestic hot-water in-line circulation pumps.
  - c. General-duty air compressors.
  - d. Sanitary sewage pumps.
  - e. Drainage pumps.
  - f. Laboratory air compressors.
  - g. Laboratory vacuum pumps.
3. Pipe-leakage test verification.
4. Testing, adjusting, and balancing of existing plumbing systems and equipment.

#### 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 independent entity meeting qualifications to perform TAB work.
- F. TDH: Total dynamic head.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report, as specified in Part 3.
- C. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures, as specified in "Preparation" Article.

- D. System Readiness Checklists: Within 30 days of Contractor's Notice to Proceed, submit system readiness checklists, as specified in "Preparation" Article.
- E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
- F. Certified TAB reports.
- G. Sample report forms.
- H. 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 Specialists Qualifications, Certified by AABC:
  - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
  - 2. TAB Technician: Employee of the TAB specialist and certified by AABC.
- B. TAB Specialists Qualifications, Certified by NEBB or TABB:
  - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB or TABB.
  - 2. TAB Technician: Employee of the TAB specialist and certified by NEBB or TABB.
- C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
- D. ASHRAE 111 Compliance: Requirements in ASHRAE 111 applicable to analogous domestic water system and plumbing equipment balancing.
- E. ASHRAE 188 Compliance: Comply with balancing and report requirements, Section 8.3 "Balancing."
- F. Code and Authorities Having Jurisdiction Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

#### 1.5 FIELD CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

- B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

## 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 installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, and balancing valves and fittings. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine approved submittals for plumbing systems and equipment.
- D. Examine design data, including plumbing system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about plumbing system and equipment controls.
- E. Examine equipment performance data, including pump curves.
  - 1. Relate performance data to Project conditions and requirements, including pump system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
  - 2. Calculate pump system-effect factors to reduce performance ratings of plumbing equipment when installed under conditions different from the conditions used to rate equipment performance. Compare results with the design data and installed conditions.
- 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 plumbing equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- I. Examine temporary and permanent strainers. Verify that temporary strainer screens used during system cleaning and flushing have been removed and permanent strainers are installed and clean.
- J. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.
- K. Examine system pumps to ensure absence of entrained air in the suction piping.

- L. Examine operating safety interlocks and controls on plumbing equipment.
- M. 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 the following:
  - 1. Equipment and systems to be tested.
  - 2. Strategies and step-by-step procedures for balancing the systems.
  - 3. Instrumentation to be used.
  - 4. Sample forms with specific identification for all equipment.
- B. Perform system-readiness checks of plumbing systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
  - 1. Domestic Water System:
    - a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed in accordance with applicable code and authority having jurisdiction.
    - b. Water heaters are installed and functioning.
    - c. Piping is complete and all points of outlet are installed.
    - d. Water treatment is complete.
    - e. Systems are flushed, filled, and air purged.
    - f. Strainers are clean.
    - g. Control valves are functioning in accordance with the sequence of operation.
    - h. Shutoff and balance valves are 100 percent open.
    - i. hot-water circulating pumps are operational and proper rotation is verified.
    - j. Pump gauge connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
    - k. Variable-frequency controllers' startup is complete and safeties are verified.
    - l. Suitable access to balancing devices and equipment is provided.
  - 2. Sanitary Sewage/Drainage System:
    - a. Leakage and pressure tests on sanitary sewage/drainage systems have been completed in accordance with applicable code and authority having jurisdiction requirements.
    - b. Piping is complete.
    - c. Sanitary sewage pumps/drainage pumps are operational.
    - d. Control valves are functioning in accordance with the sequence of operation.
    - e. Shutoff valves are 100 percent open.
    - f. Suitable access to equipment is provided.
  - 3. Compressed-Air System:

- a. Leakage and pressure tests on compressed air distribution system have been satisfactorily completed in accordance with Division 22 requirements.
- b. Piping is complete and all points of outlet are installed.
- c. Systems are flushed, filled, and air purged.
- d. Strainers are clean.
- e. Control valves are functioning in accordance with the sequence of operation.
- f. Shutoff and balance valves are 100 percent open.
- g. Compressors are operational and of proper rotation.
- h. Gauge connections are installed directly at compressor inlet and outlet flanges prior to valves or strainers.
- i. Variable-frequency controllers' startup is complete and safeties are verified.
- j. Suitable access to balancing devices and equipment is provided,

4. Vacuum System:

- a. Leakage and pressure tests on vacuum system have been satisfactorily completed in accordance with Division 22 requirements.
- b. Piping is complete and all points of inlet are installed.
- c. Systems are flushed, filled, and purged.
- d. Strainers are clean.
- e. Control valves are functioning in accordance with the sequence of operation.
- f. Shutoff and balance valves are 100 percent open.
- g. Vacuum pumps are operational and of proper rotation.
- h. Gauge connections are installed directly at vacuum pump inlet and outlet flanges prior to valves or strainers.
- i. Variable-frequency controllers' startup is complete and safeties are verified.
- j. Suitable access to balancing devices and equipment is provided.

### 3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system in accordance with the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.
- B. Cut insulation, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.
  - 1. Where holes for probes are required in piping or equipment, install pressure and temperature test plugs to seal systems.
  - 2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 220716 "Plumbing Equipment Insulation" and Section 220719 "Plumbing Piping Insulation."
- C. Mark equipment and balancing devices, including valve position indicators 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 PLUMBING EQUIPMENT

- A. Test, adjust, and balance plumbing equipment indicated on Drawings, including, but not limited to, the following:
  - 1. Motors.
  - 2. Domestic water in-line pumps.
  - 3. Domestic water heaters.

### 3.5 PROCEDURES FOR DOMESTIC WATER SYSTEMS

- A. Prepare test reports for pumps and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required equipment flow rates with system design flow rates.
- B. Prepare schematic diagrams of systems' Record drawings piping layouts.
- C. In addition to requirements in "Preparation" Article, prepare domestic water systems for testing and balancing as follows:
  - 1. Check expansion tank for proper setting.
  - 2. Check water heater for proper discharge temperature setting.
  - 3. Check remotest point of outlet for adequate pressure.
  - 4. Check flow-control valves for proper position.
  - 5. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
  - 6. Verify that motor controllers are equipped with properly sized thermal protection.
  - 7. Check that air has been purged from the system.
- D. Measure and record upstream and downstream pressure of each piece of equipment.
- E. Measure and record upstream and downstream pressure of pressure-reducing valves.
- F. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.
- G. Check settings and operation of each safety valve. Record settings.

### 3.6 PROCEDURES FOR COMPRESSED-AIR SYSTEMS

- A. Prepare test reports for air compressors, and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required equipment flow rates with system design flow rates.
- B. Prepare schematic diagrams of systems' Record drawings piping layouts.
- C. In addition to requirements in "Preparation" Article, prepare compressed-air systems for testing and balancing as follows:
  - 1. Check remotest point of outlet for adequate pressure.
  - 2. Check pressure-control valves for proper position.

3. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
  4. Verify that motor controllers are equipped with properly sized thermal protection.
- D. Measure and record upstream and downstream pressure of pressure-reducing valves.
  - E. Check settings and operation of pressure-reducing valves. Record final settings.
  - F. Check settings and operation of each safety valve. Record settings.

### 3.7 PROCEDURES FOR VACUUM SYSTEMS

- A. Prepare test reports for vacuum pumps and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required equipment flow rates with system design flow rates.
- B. Prepare schematic diagrams of systems' Record drawings piping layouts.
- C. In addition to requirements in "Preparation" Article, prepare domestic water systems for testing and balancing as follows:
  1. Check remotest point of inlet for adequate vacuum.
  2. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
  3. Verify that motor controllers are equipped with properly sized thermal protection.

### 3.8 PROCEDURES FOR DOMESTIC WATER SYSTEM BOOSTER PUMPS

- A. Adjust pumps to deliver total design flow.
  1. Measure total water flow.
    - a. Position valves for full flow through coils.
    - b. Measure flow by main flow meter, if installed.
    - c. If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.
  2. Measure pump TDH as follows:
    - a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
    - b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
    - c. Convert pressure to head and correct for differences in gauge heights.
    - d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
    - e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.

3. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.
- B. Adjust flow-measuring devices installed in mains and branches to design water flows.
1. Measure flow in main and branch pipes.
  2. Adjust main and branch balance valves for design flow.
  3. Re-measure each main and branch after all have been adjusted.
- C. Verify final system conditions as follows:
1. Re-measure and confirm that total water flow is within design.
  2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
  3. Mark final settings.
- D. Verify that memory stops have been set.

### 3.9 PROCEDURES FOR DOMESTIC HOT-WATER CIRCULATING INLINE PUMP

- A. Balance system with manual or automatic balancing valves by setting at design flow.
1. Measure flow in main and branch pipes.
  2. Adjust main and branch balance valves for design flow.
  3. Re-measure each main and branch after all have been adjusted.
- B. Adjust pump to deliver total design flow.
1. Measure pump TDH as follows:
    - a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
    - b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
    - c. Convert pressure to head and correct for differences in gauge heights.
    - d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
  2. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.
  3. Mark final settings and verify that all memory stops have been set.
  4. Verify final system conditions as follows:
    - a. Re-measure and confirm that total flow is within design.
    - b. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
    - c. Mark final settings.

### 3.10 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. Phase and hertz.
  - 5. Nameplate and measured voltage, each phase.
  - 6. Nameplate and measured amperage, each phase.
  - 7. Starter size and thermal-protection-element rating.
  - 8. Service factor and frame size.
- B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

### 3.11 PROCEDURES FOR WATER HEATERS

- A. Gas- and Oil-Fired Water Heaters:
  - 1. Measure and record entering- and leaving-water temperatures.
  - 2. Measure and record water flow.
  - 3. Measure and record pressure drop.
  - 4. Measure and Record relief valve(s) pressure setting.
  - 5. Capacity: Calculate in Btu/h of heating output.
  - 6. Fuel Consumption: If fuel supply is equipped with flow meter, measure and record consumption.
  - 7. Efficiency: Calculate operating efficiency for comparison to submitted equipment.
  - 8. Fan, motor, and motor controller operating data.

### 3.12 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

- A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
  - 1. Measure and record flows, temperatures, and pressures of each piece of equipment. Compare the values to design or nameplate information, where information is available.
  - 2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
  - 3. Check the condition of filters.
  - 4. Check bearings and other lubricated parts for proper lubrication.
  - 5. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.
- B. TAB After Construction: Before performing testing and balancing of renovated existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished in accordance with renovation scope indicated by Contract Documents. Verify the following:
  - 1. New filters are installed.

2. Bearings and other parts are properly lubricated.
  3. Deficiencies noted in the preconstruction report are corrected.
- C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
1. Compare the indicated system flows of the renovated work to the measured flows, and determine the new pump speed.
  2. Verify that the indicated system flows of the renovated work result in velocities and pump speeds that are within the acceptable limits defined by equipment manufacturer.
  3. If calculations increase or decrease the system flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.

### 3.13 TOLERANCES

- A. Set plumbing system's flow rates within the following tolerances:
1. Domestic Water Flow Rate: Plus or minus 10 percent. If design value is less than 10 gpm, within 10 percent.
  2. Compressed-Air Flow Rate: Plus or minus 10 percent. If design value is less than 10 gpm, within 10 percent.
  3. Vacuum Flow Rate: Plus or minus 10 percent.

### 3.14 PROGRESS 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 system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to plumbing systems and general construction to allow access for performance-measuring and -balancing devices.
- B. Status Reports: Prepare weekly 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.

### 3.15 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.
  3. Certify validity and accuracy of field data.

- B. Final Report Contents: In addition to certified field-report data, include the following:
1. Pump curves.
  2. Manufacturers' test data.
  3. Field test reports prepared by system and equipment installers.
  4. 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 specialist.
  3. Project name.
  4. Project location.
  5. Architect'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. Notes to explain why certain final data in the body of reports vary from indicated values.
  14. Test conditions for pump performance forms, including the following:
    - a. Variable-frequency controller settings for variable-flow hydronic systems.
    - b. Settings for pressure controller(s).
    - c. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of distribution systems. Present each system with single-line diagram and include the following:
1. Flow rates.
  2. Pipe and valve sizes and locations.
  3. Balancing stations.
  4. Position of balancing devices.
- E. Gas- and Oil-Fired Water Heaters Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
1. Unit Data:
    - a. System identification.
    - b. Location.

- c. Make and type.
- d. Model number and unit size.
- e. Manufacturer's serial number.
- f. Fuel type in input data.
- g. Output capacity in Btu/h.
- h. Ignition type.
- i. Burner-control types.
- j. Motor horsepower and speed.
- k. Motor volts, phase, and hertz.
- l. Motor full-load amperage and service factor.
- m. Sheave make, size in inches, and bore.
- n. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):

- a. Total airflow rate in cfm.
- b. Entering-water temperature in deg F.
- c. Leaving-water temperature in deg F.
- d. Low-fire fuel input in Btu/h.
- e. High-fire fuel input in Btu/h.
- f. High-temperature-limit setting in deg F.
- g. Operating set point in Btu/h.
- h. Heating value of fuel in Btu/h.

F. Electric Water Heater Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

- a. System identification.
- b. Location.
- c. Model number and unit size.
- d. Manufacturer's serial number.
- e. Output capacity in Btu/h.
- f. Number of stages.
- g. Connected volts, phase, and hertz.
- h. Rated amperage.

2. Test Data (Indicated and Actual Values):

- a. Heat output in Btu/h.
- b. Entering-water temperature in deg F.
- c. Leaving-water temperature in deg F.
- d. High-temperature-limit setting in deg F.
- e. Operating set point in deg F.
- f. Voltage at each connection.
- g. Amperage for each phase.

G. 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 speed.
  - 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.

#### H. Instrument Calibration Reports:

1. Report Data:
  - a. Instrument type and make.
  - b. Serial number.
  - c. Application.
  - d. Dates of use.
  - e. Dates of calibration.

### 3.16 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.

END OF SECTION 220593

## SECTION 220719 - PLUMBING PIPING INSULATION

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes insulating the following plumbing piping services:
  - 1. Domestic hot-water piping.
  - 2. Domestic recirculating hot-water piping.
  - 3. Sanitary waste piping exposed to freezing conditions.
  - 4. Storm-water piping exposed to freezing conditions.
  - 5. Roof drains and rainwater leaders.
  - 6. Supplies and drains for handicap-accessible lavatories and sinks.

#### 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 removable insulation at piping specialties, equipment connections, and access panels.

#### 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. 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. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Pittsburgh Corning Corporation.
  - 2. Special-Shaped Insulation: ASTM C 552, Type III.
  - 3. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
  - 4. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
  - 5. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
- H. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Aeroflex USA, Inc.
  - 2. Armacell LLC.
  - 3. K-Flex USA.
- I. Mineral-Fiber, Preformed Pipe Insulation:
- J. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Johns Manville; a Berkshire Hathaway company.
  - 2. Knauf Insulation.

3. Manson Insulation Inc.
  4. Owens Corning.
  5. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- K. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials.
- L. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Armacell LLC.
  2. Nomaco Insulation.

## 2.2 INSULATING CEMENTS

- A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
- B. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Ramco Insulation, Inc.

## 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: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.
- C. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Foster Brand; H. B. Fuller Construction Products.
- D. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
- E. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Aeroflex USA, Inc.
  2. Armacell LLC.
  3. Foster Brand; H. B. Fuller Construction Products.
  4. K-Flex USA.
- F. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
- G. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Childers Brand; H. B. Fuller Construction Products.

2. Eagle Bridges - Marathon Industries.
  3. Foster Brand; H. B. Fuller Construction Products.
  4. Mon-Eco Industries, Inc.
- H. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
- I. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Childers Brand; H. B. Fuller Construction Products.
  2. Eagle Bridges - Marathon Industries.
  3. Foster Brand; H. B. Fuller Construction Products.
  4. Mon-Eco Industries, Inc.
- J. PVC Jacket Adhesive: Compatible with PVC jacket.
- K. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Dow Corning Corporation.
  2. Johns Manville; a Berkshire Hathaway company.
  3. P.I.C. Plastics, Inc.
  4. Speedline Corporation.

## 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Foster Brand; H. B. Fuller Construction Products.
    - b. Vimasco Corporation.
  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.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Childers Brand; H. B. Fuller Construction Products.
  - b. Eagle Bridges - Marathon Industries.
  - c. Foster Brand; H. B. Fuller Construction Products.
  - d. Mon-Eco Industries, Inc.
  - e. Vimasco Corporation.
- 2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
  - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
  - 4. Solids Content: 60 percent by volume and 66 percent by weight.
  - 5. Color: White.

## 2.5 SEALANTS

### A. Joint Sealants:

### B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1. Childers Brand; H. B. Fuller Construction Products.
- 2. Eagle Bridges - Marathon Industries.
- 3. Foster Brand; H. B. Fuller Construction Products.
- 4. Mon-Eco Industries, Inc.
- 5. Pittsburgh Corning Corporation.

### C. FSK and Metal Jacket Flashing Sealants:

#### 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Childers Brand; H. B. Fuller Construction Products.
- b. Eagle Bridges - Marathon Industries.
- c. Foster Brand; H. B. Fuller Construction Products.
- d. Mon-Eco Industries, Inc.

- 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.

### D. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

#### 1. Manufacturers: Subject to compliance with requirements, provide products by the following:

- a. Childers Brand; H. B. Fuller Construction Products.

- 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.

## 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. 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.

## 2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Foster Brand; H. B. Fuller Construction Products.
  2. Vimasco Corporation.

## 2.8 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Johns Manville; a Berkshire Hathaway company.
    - b. P.I.C. Plastics, Inc.
    - c. Proto Corporation.
    - d. Speedline Corporation.
  2. Adhesive: As recommended by jacket material manufacturer.
  3. Color: White.
  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.
- C. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. ITW Insulation Systems; Illinois Tool Works, Inc.
    - c. RPR Products, Inc.
  2. Factory cut and rolled to size.
  3. Finish and thickness are indicated in field-applied jacket schedules.
  4. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
  5. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
  6. Factory-Fabricated Fitting Covers:
    - a. Same material, finish, and thickness as jacket.
    - b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
    - c. Tee covers.
    - d. Flange and union covers.
    - e. End caps.
    - f. Beveled collars.
    - g. Valve covers.
    - h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- D. Underground Direct-Buried Jacket: 125-mil-thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.
- E. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Pittsburgh Corning Corporation.
  2. Polyguard Products, Inc.

## 2.9 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Avery Dennison Corporation, Specialty Tapes Division.
    - b. Compac Corporation.
    - c. Ideal Tape Co., Inc.,; an American Biltrite company.
    - d. Venture Tape.
  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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Avery Dennison Corporation, Specialty Tapes Division.
    - b. Compac Corporation.
    - c. Ideal Tape Co., Inc.; an American Biltrite company.
    - d. Venture Tape.
  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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Compac Corporation.
    - b. Ideal Tape Co., Inc.; an American Biltrite company.
    - c. Venture Tape.
  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.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Avery Dennison Corporation, Specialty Tapes Division.
    - b. Compac Corporation.
    - c. Ideal Tape Co., Inc.; an American Biltrite company.
    - d. Venture Tape.
  2. Width: 2 inches.
  3. Thickness: 3.7 mils.

4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

## 2.10 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 or closed seal.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. ITW Insulation Systems; Illinois Tool Works, Inc.
  2. RPR Products, 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.
- E. Manufacturers: Subject to compliance with requirements, provide products by the following:
  1. C & F Wire.

## 2.11 PROTECTIVE SHIELDING GUARDS

- A. Protective Shielding Pipe Covers:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Engineered Brass Company.
    - b. Insul-Tect Products Co.
    - c. McGuire Manufacturing.
    - d. Plumberex Specialty Products, Inc.
    - e. Truebro.
    - f. Zurn Industries, LLC.
  2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

## 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 4 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 078413 "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 078413 "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. 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. 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 CELLULAR-GLASS INSULATION

- 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. 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 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.

### 3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

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.

### 3.7 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.

3.8 INSTALLATION OF POLYOLEFIN INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Seal split-tube 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 polyolefin 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 polyolefin 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 cut sections of polyolefin pipe and sheet 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.
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 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.

### 3.10 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "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.

### 3.11 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 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.

### 3.12 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. Drainage piping located in crawl spaces.
  2. Underground piping.
  3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

### 3.13 INDOOR PIPING INSULATION SCHEDULE

A.

System	Pipe Size and Location	Insulation Type and Thickness
Domestic Hot Water	Piping in Building 1-1/2-inches and smaller	1-inch fiberglass insulation with ASJ Vapor barrier jacket
Domestic Cold Water	Piping in Building 2-inches and smaller	1-inch fiberglass insulation with ASJ Vapor barrier jacket
Domestic Hot Water Recirculation Piping	Piping in Building	1-inch Fiberglass insulation with ASJ Vapor barrier jacket

### 3.14 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. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
  1. None.
- D. Piping, Exposed:
  1. None.

### 3.15 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. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. Aluminum, Smooth: 0.024 inch thick.

D. Piping, Exposed:

1. Aluminum, Smooth: 0.024 inch thick.

3.16 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

- A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 220719

## SECTION 221113 - FACILITY WATER DISTRIBUTION PIPING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes water-distribution piping and related components outside the building for water service mains.
- B. Utility-furnished products include water meters that will be furnished to the site, ready for installation.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

#### 1.5 QUALITY ASSURANCE

- A. Regulatory Requirements:
  - 1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
  - 2. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.
  - 3. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.
- B. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- C. Comply with ASTM F 645 for selection, design, and installation of thermoplastic water piping.
- D. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.

- E. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.
- F. NSF Compliance:
  - 1. Comply with NSF 14 for plastic potable-water-service piping.
  - 2. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

## 1.6 COORDINATION

- A. Coordinate connection to water main with utility company.

## PART 2 - PRODUCTS

### 2.1 PIPE AND FITTINGS

- A. Soft Copper Tube: ASTM B 88, Type K, water tube, annealed temper.
  - 1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
- B. Hard Copper Tube: ASTM B 88, Type K, water tube, drawn temper.
  - 1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
- C. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
  - 1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
  - 2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- D. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
  - 1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
  - 2. Gaskets: AWWA C111, rubber.
- E. Grooved-Joint, Ductile-Iron Pipe: AWWA C151, with cut, rounded-grooved ends.
  - 1. Grooved-End, Ductile-Iron Pipe Appurtenances:

- F. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Anvil International; a subsidiary of Mueller Water Products, Inc.
  - 2. Smith-Cooper International.
  - 3. Victaulic Company.
  
- G. PVC, AWWA Pipe: AWWA C900, Class 150 and Class 200, with bell end with gasket, and with spigot end.
  - 1. Comply with UL 1285 for fire-service mains if indicated.
  - 2. PVC Fabricated Fittings: AWWA C900, Class 150 and Class 200, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
  - 3. PVC Molded Fittings: AWWA C907, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
  - 4. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
    - a. Gaskets: AWWA C111, rubber.
  - 5. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
    - a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

## 2.2 JOINING MATERIALS

- A. Refer to Section 330500 "Common Work Results for Utilities" for commonly used joining materials.
- B. Brazing Filler Metals: AWS A5.8, BCuP Series.
- C. Bonding Adhesive for Fiberglass Piping: As recommended by fiberglass piping manufacturer.
- D. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

## 2.3 PIPING SPECIALTIES

- A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
- B. Tubular-Sleeve Pipe Couplings:
  - 1. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners and with ends of same sizes as piping to be joined.
    - a. Standard: AWWA C219.

## 2.4 GATE VALVES

A. AWWA, Cast-Iron Gate Valves:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American AVK Co.
2. American Cast Iron Pipe Company.
3. Crane; Crane Energy Flow Solutions.
4. East Jordan Iron Works, Inc.
5. McWane, Inc.
6. Mueller Co.
7. NIBCO INC.
8. U.S. Pipe and Foundry Company.
9. Zurn Industries, LLC.

10. Nonrising-Stem, Metal-Seated Gate Valves:

a. Description: Gray- or ductile-iron body and bonnet; with cast-iron or bronze double-disc gate, bronze gate rings, bronze stem, and stem nut.

- 1) Standard: AWWA C500.
- 2) Minimum Pressure Rating: 200 psig.
- 3) End Connections: Mechanical joint.
- 4) Interior Coating: Complying with AWWA C550.

11. Nonrising-Stem, Resilient-Seated Gate Valves:

a. Description: Gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.

- 1) Standard: AWWA C509.
- 2) Minimum Pressure Rating: 200 psig.
- 3) End Connections: Mechanical joint.
- 4) Interior Coating: Complying with AWWA C550.

12. Nonrising-Stem, High-Pressure, Resilient-Seated Gate Valves:

a. Description: Ductile-iron body and bonnet; with bronze or ductile-iron gate, resilient seats, bronze stem, and stem nut.

- 1) Standard: AWWA C509.
- 2) Minimum Pressure Rating: 250 psig.
- 3) End Connections: Push on or mechanical joint.
- 4) Interior Coating: Complying with AWWA C550.

13. OS&Y, Rising-Stem, Metal-Seated Gate Valves:

a. Description: Cast- or ductile-iron body and bonnet, with cast-iron double disc, bronze disc and seat rings, and bronze stem.

- 1) Standard: AWWA C500.
- 2) Minimum Pressure Rating: 200 psig.
- 3) End Connections: Flanged.

14. OS&Y, Rising-Stem, Resilient-Seated Gate Valves:

- a. Description: Cast- or ductile-iron body and bonnet, with bronze or gray- or ductile-iron gate, resilient seats, and bronze stem.

- 1) Standard: AWWA C509.
- 2) Minimum Pressure Rating: 200 psig.
- 3) End Connections: Flanged.

C. UL/FMG, Cast-Iron Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. American Cast Iron Pipe Company.
- b. Crane; Crane Energy Flow Solutions.
- c. McWane, Inc.
- d. Mueller Co.
- e. NIBCO INC.
- f. U.S. Pipe and Foundry Company.
- g. Zurn Industries, LLC.

2. UL/FMG, Nonrising-Stem Gate Valves:

- a. Description: Iron body and bonnet with flange for indicator post, bronze seating material, and inside screw.

- 1) Standards: UL 262 and FMG approved.
- 2) Minimum Pressure Rating: 175 psig.
- 3) End Connections: Flanged.

3. OS&Y, Rising-Stem Gate Valves:

- a. Description: Iron body and bonnet and bronze seating material.

- 1) Standards: UL 262 and FMG approved.
- 2) Minimum Pressure Rating: 175 psig.
- 3) End Connections: Flanged.

D. Bronze Gate Valves:

- E. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Crane; Crane Energy Flow Solutions.
2. Hammond Valve.
3. Milwaukee Valve Company.

4. NIBCO INC.
5. Red-White Valve Corporation.
6. Zurn Industries, LLC.
7. OS&Y, Rising-Stem Gate Valves:
  - a. Description: Bronze body and bonnet and bronze stem.
    - 1) Standards: UL 262 and FMG approved.
    - 2) Minimum Pressure Rating: 175 psig.
    - 3) End Connections: Threaded.
8. Nonrising-Stem Gate Valves:
  - a. Description: Class 125, Type 1, bronze with solid wedge, threaded ends, and malleable-iron handwheel.
    - 1) Standard: MSS SP-80.

## 2.5 GATE VALVE ACCESSORIES AND SPECIALTIES

### A. Tapping-Sleeve Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. American Cast Iron Pipe Company.
  - b. East Jordan Iron Works, Inc.
  - c. Flowserve Corporation.
  - d. McWane, Inc.
  - e. Mueller Co.
  - f. U.S. Pipe and Foundry Company.
2. Description: Sleeve and valve compatible with drilling machine.
  - a. Standard: MSS SP-60.
  - b. Tapping Sleeve: Cast- or ductile-iron or stainless-steel, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.
  - c. Valve: AWWA, cast-iron, nonrising-stem, metal-seated gate valve with one raised face flange mating tapping-sleeve flange.

### B. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5 inches in diameter.

1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

- C. Indicator Posts: UL 789, FMG-approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.

## PART 3 - EXECUTION

### 3.1 PIPING APPLICATIONS

- A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.
- B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.
- C. Do not use flanges or unions for underground piping.
- D. Flanges, unions, and special fittings may be used, instead of joints indicated, on aboveground piping.
- E. Underground Water-Service Piping NPS 3/4 to NPS 3 shall be soft copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.

### 3.2 VALVE APPLICATIONS

- A. General Application: Use mechanical-joint-end valves for NPS 3 and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FMG, nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 and smaller installation.
- B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
  - 1. Use the following for valves in vaults and aboveground:
    - a. Gate Valves, NPS 2 and Smaller: Bronze, nonrising stem.
    - b. Gate Valves, NPS 3 and Larger: AWWA, cast iron, OS&Y rising stem, resilient seated.

### 3.3 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. See Section 330500 "Common Work Results for Utilities" for piping-system common requirements.

### 3.4 PIPING INSTALLATION

- A. Water-Main Connection: Arrange with utility company for tap of size and in location indicated in water main.

- B. Water-Main Connection: Tap water main according to requirements of water utility company and of size and in location indicated.
- C. Make connections larger than NPS 2 with tapping machine according to the following:
  - 1. Install tapping sleeve and tapping valve according to MSS SP-60.
  - 2. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.
  - 3. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.
  - 4. Install gate valve onto tapping sleeve. Comply with MSS SP-60. Install valve with stem pointing up and with valve box.
- D. Make connections NPS 2 and smaller with drilling machine according to the following:
  - 1. Install service-saddle assemblies and corporation valves in size, quantity, and arrangement required by utility company standards.
  - 2. Install service-saddle assemblies on water-service pipe to be tapped. Position outlets for corporation valves.
  - 3. Use drilling machine compatible with service-saddle assemblies and corporation valves. Drill hole in main. Remove drilling machine and connect water-service piping.
  - 4. Install corporation valves into service-saddle assemblies.
  - 5. Install manifold for multiple taps in water main.
  - 6. Install curb valve in water-service piping with head pointing up and with service box.
- E. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.
- F. Install PE pipe according to ASTM D 2774 and ASTM F 645.
- G. Install PVC, AWWA pipe according to ASTM F 645 and AWWA M23.
- H. Extend water-service piping and connect to water-supply source and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.
- I. Sleeves are specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- J. Mechanical sleeve seals are specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

### 3.5 JOINT CONSTRUCTION

- A. See Section 330500 "Common Work Results for Utilities" for basic piping joint construction.
- B. Make pipe joints according to the following:
  - 1. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
  - 2. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.
  - 3. Ductile-Iron Piping, Grooved Joints: Cut-groove pipe. Assemble joints with grooved-end, ductile-iron-piping couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions.

4. PE Piping Insert-Fitting Joints: Use plastic insert fittings and fasteners according to fitting manufacturer's written instructions.
5. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139 and pipe manufacturer's written instructions.
6. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure.

### 3.6 ANCHORAGE INSTALLATION

- A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
  1. Concrete thrust blocks.
  2. Locking mechanical joints.
  3. Set-screw mechanical retainer glands.
  4. Bolted flanged joints.
  5. Heat-fused joints.
  6. Pipe clamps and tie rods.
- B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
  1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.
  2. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.
  3. Fire-Service-Main Piping: According to NFPA 24.
- C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

### 3.7 VALVE INSTALLATION

- A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.
- B. UL/FMG, Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.
- C. MSS Valves: Install as component of connected piping system.

### 3.8 BACKFLOW PREVENTER INSTALLATION

- A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.
- B. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.

- C. Do not install bypass piping around backflow preventers.
- D. Support NPS 2-1/2 and larger backflow preventers, valves, and piping near floor and on brick or concrete piers.

### 3.9 CONNECTIONS

- A. See Section 330500 "Common Work Results for Utilities" for piping connections to valves and equipment.
- B. Connect water-distribution piping to existing water main. Use tapping sleeve and tapping valve.
- C. Connect water-distribution piping to interior domestic water piping.

### 3.10 FIELD QUALITY CONTROL

- A. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.
- B. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.
  - 1. Increase pressure in 50-psig increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig. Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.
- C. Prepare reports of testing activities.

### 3.11 IDENTIFICATION

- A. Permanently attach equipment nameplate or marker indicating plastic water-service piping, on main electrical meter panel. See Section 330500 "Common Work Results for Utilities" for identifying devices.

### 3.12 CLEANING

- A. Clean and disinfect water-distribution piping as follows:
  - 1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
  - 2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.

3. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:
  - a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
  - b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.
  - c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
  - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.
- B. Prepare reports of purging and disinfecting activities.

END OF SECTION 221113

## SECTION 221116 - DOMESTIC WATER PIPING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For transition fittings and dielectric fittings.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. System purging and disinfecting activities report.
- B. Field quality-control reports.

### 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.
- B. Potable-water piping and components shall comply with NSF 14 and NSF 61. Plastic piping components shall be marked with "NSF-pw."

#### 2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
- B. Soft Copper Tube: ASTM B 88, Type K water tube, annealed temper.
- C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- F. Copper Unions:
  - 1. MSS SP-123.

2. Cast-copper-alloy, hexagonal-stock body.
3. Ball-and-socket, metal-to-metal seating surfaces.
4. Solder-joint or threaded ends.

G. Copper Pressure-Seal-Joint Fittings:

1. Fittings for NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
2. Fittings for NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

H. Copper Push-on-Joint Fittings:

1. Cast-copper fitting complying with ASME B16.18 or wrought-copper fitting complying with ASME B 16.22.
2. Stainless-steel teeth and EPDM-rubber, O-ring seal in each end instead of solder-joint ends.

## 2.3 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe:

1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Standard-Pattern, Mechanical-Joint Fittings:

1. AWWA C110/A21.10, ductile or gray iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

C. Compact-Pattern, Mechanical-Joint Fittings:

1. AWWA C153/A21.53, ductile iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

## 2.4 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe:

1. ASTM A 53/A 53M, Type E, Grade B, Standard Weight.
2. Include ends matching joining method.

B. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Standard Weight, seamless steel pipe with threaded ends.

C. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

- D. Malleable-Iron Unions:
  - 1. ASME B16.39, Class 150.
  - 2. Hexagonal-stock body.
  - 3. Ball-and-socket, metal-to-metal, bronze seating surface.
  - 4. Threaded ends.
- E. Flanges: ASME B16.1, Class 125, cast iron.

## 2.5 CPVC PIPING

- A. CPVC Pipe: ASTM F 441/F 441M, Schedule 40.
  - 1. CPVC Socket Fittings: ASTM F 438 for Schedule 40.
  - 2. CPVC Threaded Fittings: ASTM F 437, Schedule 80.
- B. CPVC Piping System: ASTM D 2846/D 2846M, SDR 11, pipe and socket fittings.
- C. CPVC Tubing System: ASTM D 2846/D 2846M, SDR 11, tube and socket fittings.

## 2.6 PEX TUBE AND FITTINGS

- A. PEX Distribution System: ASTM F 877, SDR 9 tubing.
- B. Fittings for PEX Tube: ASTM F 1807, metal-insert type with copper or stainless-steel crimp rings and matching PEX tube dimensions.
- C. Manifold: Multiple-outlet, plastic or corrosion-resistant-metal assembly complying with ASTM F 877; with plastic or corrosion-resistant-metal valve for each outlet.

## 2.7 PVC PIPE AND FITTINGS

- A. PVC Pipe: ASTM D 1785, Schedule 40.
- B. PVC Socket Fittings: ASTM D 2466 for Schedule 40.
- C. PVC Schedule 80 Threaded Fittings: ASTM D 2464.

## 2.8 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials:
  - 1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
  - 2. 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.
- D. Flux: ASTM B 813, water flushable.
- E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- F. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.
  - 1. CPVC solvent cement shall have a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 2. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 3. Solvent cement and adhesive primer 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."
- G. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
  - 1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 2. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 3. Solvent cement and adhesive primer 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."
- H. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

## 2.9 TRANSITION FITTINGS

- A. General Requirements:
  - 1. Same size as pipes to be joined.
  - 2. Pressure rating at least equal to pipes to be joined.
  - 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Plastic-to-Metal Transition Fittings:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Charlotte Pipe and Foundry Company.

- b. Harvel Plastics, Inc.
  - c. Spears Manufacturing Company.
2. Description:
- a. CPVC or PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
  - b. One end with threaded brass insert and one solvent-cement-socket or threaded end.
- D. Plastic-to-Metal Transition Unions:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- a. Colonial Engineering, Inc.
  - b. NIBCO INC.
  - c. Spears Manufacturing Company.
2. Description:
- a. CPVC or PVC four-part union.
  - b. Brass or stainless-steel threaded end.
  - c. Solvent-cement-joint or threaded plastic end.
  - d. Rubber O-ring.
  - e. Union nut.

## 2.10 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- a. A.Y. McDonald Mfg. Co.
  - b. Capitol Manufacturing Company.
  - c. Central Plastics Company.
  - d. Hart Industries International, Inc.
  - e. Jomar Valve.
  - f. Matco-Norca.
  - g. Watts; a Watts Water Technologies company.
  - h. Wilkins.
  - i. Zurn Industries, LLC.
2. Standard: ASSE 1079.
3. Pressure Rating: 150 psig.
4. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Capitol Manufacturing Company.
  - b. Central Plastics Company.
  - c. Matco-Norca.
  - d. Watts; a Watts Water Technologies company.
  - e. Wilkins.
  - f. Zurn Industries, LLC.
2. Standard: ASSE 1079.
3. Factory-fabricated, bolted, companion-flange assembly.
4. Pressure Rating: 150 psig.
5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Advance Products & Systems, Inc.
  - b. Calpico, Inc.
  - c. Central Plastics Company.
  - d. Pipeline Seal and Insulator, Inc.
2. Nonconducting materials for field assembly of companion flanges.
3. Pressure Rating: 150 psig.
4. Gasket: Neoprene or phenolic.
5. Bolt Sleeves: Phenolic or polyethylene.
6. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples: NOT PERMITTED

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 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 copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
- D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 221119 "Domestic Water Piping Specialties."
- E. Install shutoff valve immediately upstream of each dielectric fitting.
- F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."
- G. Install domestic water piping level without pitch and plumb.
- H. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- I. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- J. 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.
- K. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- L. Install piping to permit valve servicing.
- M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- N. Install piping free of sags and bends.
- O. Install fittings for changes in direction and branch connections.
- P. Install PEX piping with loop at each change of direction of more than 90 degrees.
- Q. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- R. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping."
- S. Install thermostats in hot-water circulation piping.

- T. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 220519 "Meters and Gages for Plumbing Piping."
- U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

### 3.3 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 for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Braze Joints" chapter.
- E. Soldered Joints for Copper Tubing: 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. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.
- G. 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.
- H. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
  - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
  - 3. PVC Piping: Join according to ASTM D 2855.
- I. Joints for PEX Piping: Join according to ASTM F 1807.

- J. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

### 3.4 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
  - 1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
  - 2. Fittings for NPS 2 and Larger: Sleeve-type coupling.
- C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

### 3.5 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 no nipples allowed. Provide isolation valves on each side of dielectric unions.
- 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.

### 3.6 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
  - 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.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

- E. 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.
  - 6. NPS 6: 10 feet with 5/8-inch rod.
  - 7. NPS 8: 10 feet with 3/4-inch rod.
  
- F. Install supports for vertical copper tubing every 10 feet.
  
- G. 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.
  - 7. NPS 6: 12 feet with 3/4-inch rod.
  - 8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.
  
- H. Install supports for vertical steel piping every 15 feet.
  
- I. Install vinyl-coated hangers for CPVC piping with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 1 and Smaller: 36 inches with 3/8-inch rod.
  - 2. NPS 1-1/4 to NPS 2: 48 inches with 3/8-inch rod.
  - 3. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
  - 4. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
  - 5. NPS 6: 48 inches with 3/4-inch rod.
  - 6. NPS 8: 48 inches with 7/8-inch rod.
  
- J. Install supports for vertical CPVC piping every 60 inches for NPS 1 and smaller, and every 72 inches for NPS 1-1/4 and larger.
  
- K. Install vinyl-coated hangers for PEX piping with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 1 and Smaller: 32 inches with 3/8-inch rod.
  
- L. Install hangers for vertical PEX piping every 48 inches.
  
- M. Install vinyl-coated hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 2 and Smaller: 48 inches with 3/8-inch rod.

2. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
4. NPS 6: 48 inches with 3/4-inch rod.
5. NPS 8: 48 inches with 7/8-inch rod.

N. Install supports for vertical PVC piping every 48 inches.

O. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

### 3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
4. 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.

### 3.8 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

B. Label pressure piping with system operating pressure.

### 3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:

- a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.

- b. 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:
  - 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 authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
- c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
- d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

- a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
- b. 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.
- c. 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.
- d. 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 it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
- e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
- f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. 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 hot-water flow 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. Repeat procedures if biological examination shows contamination.
  - e. Submit water samples in sterile bottles to authorities having jurisdiction.

#### B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

#### C. 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. Under-building-slab, domestic water, building-service piping, NPS 3 and smaller, shall be one of the following:

1. Soft copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.
- E. Aboveground domestic water 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.
  2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
  3. PEX tube and fittings may be used on domestic water piping less than 1”.

### 3.13 TRAINING

- A. Training will be performed for each system installed. Training is to be two separate identical sessions, held on separate weeks. A training Agenda will be developed by the Commissioning Authority. Contractor is responsible to have a competent party perform training, preferably the site foreman in conjunction with manufacturer’s representatives.

END OF SECTION 221116

## SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Vacuum breakers.
2. Backflow preventers.
3. Strainers.
4. Hose bibbs.
5. Wall hydrants.
6. Drain valves.
7. Water-hammer arresters.
8. Trap-seal primer valves.

##### B. Related Requirements:

1. Section 220519 "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
2. Section 221116 "Domestic Water Piping" for water meters.

#### 1.2 ACTION SUBMITTALS

- ##### A. Product Data: For each type of product.

#### 1.3 INFORMATIONAL SUBMITTALS

- ##### A. Field quality-control reports.

#### 1.4 CLOSEOUT SUBMITTALS

- ##### A. Operation and maintenance data.

### PART 2 - PRODUCTS

#### 2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- ##### A. Potable-water piping and components shall comply with NSF 61 and NSF 14. Mark "NSF-pw" on plastic piping components.

## 2.2 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

## 2.3 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Standard: ASSE 1001.
2. Size: NPS 1/4 to NPS 3, as required to match connected piping.
3. Body: Bronze.
4. Inlet and Outlet Connections: Threaded.
5. Finish: Chrome plated.

- B. Hose-Connection Vacuum Breakers:

1. Standard: ASSE 1011.
2. Body: Bronze, nonremovable, with manual drain.
3. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
4. Finish: Chrome or nickel plated.

## 2.4 BACKFLOW PREVENTERS

- A. Intermediate Atmospheric-Vent Backflow Preventers:

1. Standard: ASSE 1012.
2. Operation: Continuous-pressure applications.
3. Size: NPS 1/2 and NPS 3/4.
4. Body: Bronze.
5. End Connections: Union, solder joint.
6. Finish: Rough bronze.

- B. Reduced-Pressure-Principle Backflow Preventers:

1. Standard: ASSE 1013.
2. Operation: Continuous-pressure applications.
3. Pressure Loss: 12 psig maximum, through middle third of flow range.
4. Size: See plans.
5. Design Flow Rate: 150 gpm.
6. Selected Unit Flow Range Limits: 150 gpm.
7. Pressure Loss at Design Flow Rate: 12 psig for sizes NPS 2 and smaller; 12 psig for NPS 2-1/2 and larger.
8. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
9. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
10. Configuration: Designed for horizontal, straight-through flow.
11. Accessories:

- a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
  - b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
  - c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
- C. Double-Check, Backflow-Prevention Assemblies Insert drawing designation if any:
- 1. Standard: ASSE 1015.
  - 2. Operation: Continuous-pressure applications unless otherwise indicated.
  - 3. Pressure Loss: 5 psig maximum, through middle third of flow range.
  - 4. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
  - 5. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
  - 6. Configuration: Designed for horizontal, straight-through flow.
  - 7. Accessories:
    - a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
    - b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.

## 2.5 TEMPERATURE-ACTUATED, WATER MIXING VALVES

### A. Water-Temperature Limiting Devices:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Armstrong International, Inc.
  - b. Cash Acme.
  - c. Conbraco Industries, Inc.
  - d. Honeywell Water Controls.
  - e. Legend Valve.
  - f. Leonard Valve Company.
  - g. Powers.
  - h. Symmons Industries, Inc.
  - i. TACO Incorporated.
  - j. Watts; a Watts Water Technologies company.
  - k. Zurn Industries, LLC.
- 2. Standard: ASSE 1017.
- 3. Pressure Rating: 125 psig.
- 4. Type: Thermostatically controlled, water mixing valve.
- 5. Material: Bronze body with corrosion-resistant interior components.
- 6. Connections: Threaded union inlets and outlet.
- 7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
- 8. Tempered-Water Setting: 110 deg F.
- 9. Tempered-Water Design Flow Rate: See schedule..
- 10. Valve Finish: Rough bronze.

B. Primary, Thermostatic, Water Mixing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Armstrong International, Inc.
  - b. Lawler Manufacturing Company, Inc.
  - c. Leonard Valve Company.
  - d. Powers.
  - e. Symmons Industries, Inc.
  - f. Zurn Industries, LLC.
2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig minimum unless otherwise indicated.
4. Type: Exposed-mounted and Cabinet-type, thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded union inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Tempered-Water Setting: 110 deg F.
9. Tempered-Water Design Flow Rate: .
10. Selected Valve Flow Rate at 45-psig Pressure Drop: .
11. Pressure Drop at Design Flow Rate: See schedule.
12. Valve Finish: Rough bronze.
13. Piping Finish: Copper.
14. Cabinet: Factory fabricated, stainless steel, for recessed mounting and with hinged, stainless-steel door.

## 2.6 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 with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and 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.

## 2.7 HOSE BIBBS

A. Hose Bibbs :

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Chrome or nickel plated.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Wheel handle.
13. Operation for Finished Rooms: Operating key.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

## 2.8 WALL HYDRANTS

### A. Nonfreeze Wall Hydrants:

1. Standard: ASME A112.21.3M for exposed-outlet, self-draining wall hydrants.
2. Pressure Rating: 125 psig.
3. Operation: Loose key.
4. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
5. Inlet: NPS 3/4 or NPS 1.
6. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
7. Box: Deep, flush mounted with cover.
8. Box and Cover Finish: Polished nickel bronze.
9. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
10. Nozzle and Wall-Plate Finish: Polished nickel bronze.
11. Operating Keys(s): One with each wall hydrant.

## 2.9 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.

## 2.10 WATER-HAMMER ARRESTERS

### A. Water-Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. AMTROL, Inc.
  - b. Josam Company.
  - c. MIFAB, Inc.
  - d. Precision Plumbing Products, Inc.
  - e. Sioux Chief Manufacturing Company, Inc.
  - f. Smith, Jay R. Mfg. Co.
  - g. Tyler Pipe; a subsidiary of McWane Inc.
  - h. Watts; a Watts Water Technologies company.
  - i. Zurn Industries, LLC.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

## 2.11 TRAP-SEAL PRIMER DEVICE

### A. Supply-Type, Trap-Seal Primer Device:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. MIFAB, Inc.
  - b. Precision Plumbing Products, Inc.
  - c. Sioux Chief Manufacturing Company, Inc.
  - d. Smith, Jay R. Mfg. Co.
  - e. Watts; a Watts Water Technologies company.
  - f. Zurn Industries, LLC.
2. Standard: ASSE 1018.
3. Pressure Rating: 125 psig minimum.
4. Body: Bronze.
5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

### B. Drainage-Type, Trap-Seal Primer Device:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Smith, Jay R. Mfg. Co.
2. Standard: ASSE 1044, lavatory P-trap with NPS 3/8 minimum, trap makeup connection.
3. Size: NPS 1-1/4 minimum.
4. Material: Chrome-plated, cast brass.

## 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 unacceptable for this application.
  3. Do not install bypass piping around backflow preventers.
- B. Install water regulators with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.
- C. Install balancing valves in locations where they can easily be adjusted.
- D. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
  1. Install cabinet-type units recessed in wall as specified.
- E. Install Y-pattern strainers for water on supply side of each control valve water pressure-reducing valve solenoid valve and pump.
- F. Set nonfreeze, nondraining-type post hydrants in concrete or pavement.
- G. Install water-hammer arresters in water piping according to PDI-WH 201.
- H. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
- I. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

### 3.2 CONNECTIONS

- A. Comply with requirements for ground equipment in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Fire-retardant-treated-wood blocking is specified in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical connections.

### 3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. Test each pressure vacuum breaker double-check, backflow-prevention assembly according to authorities having jurisdiction and the device's reference standard.
- B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.4 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION 221119

## SECTION 221316 - SANITARY WASTE AND VENT PIPING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Pipe, tube, and fittings.
  - 2. Specialty pipe fittings.

#### 1.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

#### 1.3 ACTION SUBMITTALS

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

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For waste and vent piping, 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. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.
- B. Field quality-control reports.

#### 1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

## 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 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. CISPI, Hubless-Piping Couplings:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. ANACO-Husky.
    - b. Dallas Specialty & Mfg. Co.
    - c. Fernco Inc.
    - d. Matco-Norca.
    - e. MIFAB, Inc.
    - f. Mission Rubber Company, LLC; a division of MCP Industries.
    - g. Stant.
    - h. Tyler Pipe; a subsidiary of McWane Inc.
  - 2. Standards: ASTM C 1277 and CISPI 310.
  - 3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
- C. Heavy-Duty, Hubless-Piping Couplings:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. ANACO-Husky.
    - b. Clamp-All Corp.
    - c. Dallas Specialty & Mfg. Co.
    - d. MIFAB, Inc.
    - e. Mission Rubber Company, LLC; a division of MCP Industries.
    - f. Stant.
    - g. Tyler Pipe; a subsidiary of McWane Inc.
  - 2. Standards: ASTM C 1277 and ASTM C 1540.
  - 3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

### 2.3 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

- B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- C. Adhesive Primer: ASTM F 656.
  - 1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 2. Adhesive primer 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. Solvent Cement: ASTM D 2564.
  - 1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 2. Solvent cement 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 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
  - 1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
  - 2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
  - 3. Unshielded, Nonpressure Transition Couplings:
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Dallas Specialty & Mfg. Co.
      - 2) Fernco Inc.
      - 3) Froet Industries LLC.
      - 4) Mission Rubber Company, LLC; a division of MCP Industries.
      - 5) Plastic Oddities.
    - b. Standard: ASTM C 1173.
    - c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
    - d. Sleeve Materials:
      - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
      - 2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
      - 3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

4. Shielded, Nonpressure Transition Couplings:
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) Cascade Waterworks Mfg. Co.
    - 2) Mission Rubber Company, LLC; a division of MCP Industries.
  - b. Standard: ASTM C 1460.
  - c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

## PART 3 - EXECUTION

### 3.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

### 3.2 PIPING INSTALLATION

- A. 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.
- 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 at indicated slopes.
- F. Install piping free of sags and bends.
- G. Install fittings for changes in direction and branch connections.
- H. 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 two 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.

- I. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
  - J. 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. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
  - K. 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."
  - L. Install aboveground PVC piping according to ASTM D 2665.
  - M. Install underground PVC piping according to ASTM D 2321.
  - N. Plumbing Specialties:
    - 1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."
    - 2. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."
  - O. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
  - P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
  - Q. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
  - R. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."
- ### 3.3 JOINT CONSTRUCTION
- A. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

- B. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.
- C. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
  2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
  3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

### 3.4 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
  1. Install transition couplings at joints of piping with small differences in OD's.
  2. In Drainage Piping: Shielded, nonpressure transition couplings.

### 3.5 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
  1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
  2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
  3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
  4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
  5. Vertical Piping: MSS Type 8 or Type 42, clamps.
  6. Install 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.
  7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
  8. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support horizontal piping and tubing within 12 inches of each fitting and coupling.
- D. Support vertical piping and tubing at base and at each floor.
- E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- F. 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 and NPS 8: 60 inches with 3/4-inch rod.
  5. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- G. Install supports for vertical cast-iron soil piping every 15 feet.
- H. 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 and NPS 5: 10 feet with 1/2-inch rod.
  5. NPS 6: 10 feet with 5/8-inch rod.
  6. NPS 8: 10 feet with 3/4-inch rod.
- I. Install supports for vertical copper tubing every 10 feet.
- J. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
  2. NPS 3: 48 inches with 1/2-inch rod.
  3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
  4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.
- K. Install supports for vertical PVC piping every 48 inches.
- L. 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. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
  5. Install horizontal backwater valves in pit with pit cover flush with floor.
  6. Comply with requirements for backwater valves cleanouts and drains specified in Section 221319 "Sanitary Waste Piping Specialties."
  7. 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.
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- E. 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.

### 3.7 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

### 3.8 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 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 authorities having jurisdiction 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.

### 3.9 CLEANING AND PROTECTION

- 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.
- D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

### 3.10 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste piping NPS 8 and smaller shall be any of the following (if piping is located in a ceiling plenum, utilize cast iron piping only):
  1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
  2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
  3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- C. Aboveground, vent piping NPS 6 and smaller shall be any of the following (If piping is located in a ceiling plenum, utilize cast iron piping only):
  1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
  2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
  3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- D. Underground, soil, waste, and vent piping NPS 8 and smaller shall be any of the following:

1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

END OF SECTION 221316

## SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Cleanouts.
2. Floor drains.
3. Roof flashing assemblies.
4. Miscellaneous sanitary drainage piping specialties.
5. Flashing materials.

#### 1.2 ACTION SUBMITTALS

- ##### A. Product Data:
- For each type of product indicated. Include rated capacities, operating characteristics, and accessories for grease interceptors.

#### 1.3 QUALITY ASSURANCE

- ##### A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

### PART 2 - PRODUCTS

#### 2.1 CLEANOUTS

##### A. Exposed Cast-Iron Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Josam Company.
  - b. MIFAB, Inc.
  - c. Smith, Jay R. Mfg. Co.
  - d. Tyler Pipe; a subsidiary of McWane Inc.
  - e. Watts; a Watts Water Technologies company.
  - f. Zurn Industries, LLC.
2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
3. Size: Same as connected drainage piping
4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, brass plug.

6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Cast-Iron Floor Cleanouts (F.C.O.):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Josam Company.
  - b. Oatey.
  - c. Sioux Chief Manufacturing Company, Inc.
  - d. Smith, Jay R. Mfg. Co.
  - e. Sioux Chief
  - f. Watts; a Watts Water Technologies company.
  - g. Zurn Industries, LLC.
2. Standard: ASME A112.36.2M for adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Adjustable housing.
5. Body or Ferrule: Cast iron.
6. Clamping Device: Required.
7. Outlet Connection: Threaded.
8. Closure: Brass plug with tapered threads.
9. Adjustable Housing Material: Cast iron with threads.
10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
11. Frame and Cover Shape: Round.
12. Top Loading Classification: Heavy Duty.
13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
14. Floor drain shall allow adjustment of 1" before concrete pour and 1" after the concrete pour.

C. Cast-Iron Wall Cleanouts (W.C.O.):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Josam Company.
  - b. MIFAB, Inc.
  - c. Smith, Jay R. Mfg. Co.
  - d. Tyler Pipe; a subsidiary of McWane Inc.
  - e. Watts; a Watts Water Technologies company.
  - f. Zurn Industries, LLC.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Raised-head, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
8. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

## 2.2 FLOOR DRAINS

### A. Cast-Iron Floor Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Smith, Jay R. Mfg. Co.
  - b. Sioux Chief
2. Standard: ASME A112.6.3.
3. Pattern: Floor drain.
4. Body Material: Gray iron.
5. Seepage Flange: Required.
6. Coating on Interior and Exposed Exterior Surfaces: Not required.
7. Top or Strainer Material: Nickel bronze.
8. Top of Body and Strainer Finish: Nickel bronze.
9. Top Shape: Round.
10. Top Loading Classification: Heavy Duty.
11. Trap Material: Cast iron.
12. Trap Pattern: Deep-seal P-trap.
13. Trap Features: Trap-seal primer valve drain connection.

## 2.3 ROOF FLASHING ASSEMBLIES

### A. Roof Flashing Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Acorn Engineering Company.
  - b. Thaler Metal Industries Ltd.
  - c. Zurn Industries, LLC.
2. Description: Manufactured assembly made of 6.0-lb/sq. ft., 0.0938-inch-thick, lead flashing collar and skirt extending at least 8 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.
  - a. Open-Top Vent Cap: Without cap.
  - b. Low-Silhouette Vent Cap: With vandal-proof vent cap.
  - c. Extended Vent Cap: With field-installed, vandal-proof vent cap.

## 2.4 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

### A. Open Drains:

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.

2. Size: Same as connected waste piping with increaser fitting of size indicated.

B. 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.

C. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

D. 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.

E. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

F. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

G. Vent Caps:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

## 2.5 FLASHING MATERIALS

- A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
  2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
  3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.
- B. Fasteners: Metal compatible with material and substrate being fastened.
- C. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- D. Solder: ASTM B 32, lead-free alloy.
- E. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. 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.
- B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- 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 floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
1. Position floor drains for easy access and maintenance.
  2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
    - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
    - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
    - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
  3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
  4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

- E. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- F. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
- G. Assemble open drain fittings and install with top of hub 1 inch above floor.
- H. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- I. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
  - 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
  - 2. Size: Same as floor drain inlet.
- J. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- K. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- L. Install vent caps on each vent pipe passing through roof.
- M. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

### 3.2 CONNECTIONS

- A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

### 3.3 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
  - 1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
  - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
  - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
  - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Section 076200 "Sheet Metal Flashing and Trim."
- F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

### 3.4 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each grease interceptor.
- 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 220553 "Identification for Plumbing Piping and Equipment."

### 3.5 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 221319

## SECTION 223400 - FUEL-FIRED, DOMESTIC-WATER HEATERS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Commercial, LPG-fired, domestic-water heaters.
  - 2. Domestic-water heater accessories.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type and size of domestic-water heater indicated.
- B. Shop Drawings:
  - 1. Wiring Diagrams: For power, signal, and control wiring.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For fuel-fired, domestic-water heaters, accessories, and components, from manufacturer.
- B. Product certificates.
- 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.

#### 1.4 CLOSEOUT SUBMITTALS

- A. 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. 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."

## 1.6 WARRANTY

- A. Special Warranty: 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. Warranty Periods: From date of Substantial Completion.

- a. Commercial, LPG-Fired, Storage, Domestic-Water Heaters:

- 1) Heat Exchanger: Twelve years.
- 2) Controls and Other Components: Five year(s).

## PART 2 - PRODUCTS

### 2.1 COMMERCIAL, LPG-FIRED, DOMESTIC-WATER HEATERS

- A. Commercial, On-Demand, LPG-Fired, Domestic-Water Heaters:

- 1. Manufacturers: Subject to compliance with requirements, provide products by the following:

- a. Rinnai Corporation.
- b. Navien
- c. AO Smith
- d. Bosh
- e. Prior Approved equal.

- 2. Standard: ANSI Z21.10.3/CSA 4.3.

- 3. Factory-Installed Appurtenances:

- a. Anode Rod: Replaceable magnesium.
- b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
- c. Burner: For use gas-fired, domestic-water heaters and liquefied petroleum-gas fuel.
- d. Automatic Ignition: ANSI Z21.20/CSA C22.2 No. 199, electric, automatic, gas-ignition system.
- e. Temperature Control: Adjustable thermostat.
- f. 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.

## 2.2 DOMESTIC-WATER HEATER ACCESSORIES

### A. Domestic-Water Compression Tanks:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. WATTS.
  - b. Taco
  - c. Bell and Gorsett
  - d. Wessels
  - e. Prior Approved Equal
2. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
3. Construction:
  - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
  - 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. Air-Charging Valve: Factory installed.
4. Capacity and Characteristics:
  - a. Working-Pressure Rating: 150 psig max.
  - b. Capacity Acceptable: 1 gal. minimum.
  - c. Air Precharge Pressure: 40 psig.

B. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M, manually operated. Furnish for installation in piping.

C. 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.

D. Condensate Neutralizer: Provide a refillable condensate neutralizer with neutralizer fill.

## PART 3 - EXECUTION

### 3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Install domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523.12 "Ball Valves for Plumbing Piping."
- B. Install water-heater 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 221119 "Domestic Water Piping Specialties."

### 3.2 CONNECTIONS

- A. Comply with requirements for domestic-water piping specified in Section 221116 "Domestic Water Piping."
- B. Comply with requirements for gas piping specified in Section 231126 "Facility Liquefied Petroleum-Gas Piping."
- C. Drawings indicate general arrangement of piping, fittings, and specialties.

### 3.3 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 220553 "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 in Section 014000 "Quality Requirements" for retesting and reinspecting requirements.
- C. Prepare test and inspection reports.

END OF SECTION 223400

## SECTION 224213.13 - COMMERCIAL WATER CLOSETS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Water closets.
  - 2. Toilet seats.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Include diagrams for power, signal, and control wiring.

#### 1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

### PART 2 - PRODUCTS

#### 2.1 FLOOR-MOUNTED WATER CLOSETS

- A. Water Closets: Floor mounted, top spud.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Moen Commercial.
  - 2. Bowl:
    - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
    - b. Material: Vitreous china.
    - c. Type: Siphon jet.
    - d. Style: Flush Tank.
    - e. Height: ADA Standard.
    - f. Rim Contour: Elongated.
    - g. Water Consumption: As noted on plumbing fixture schedule.
    - h. Spud Size and Location: NPS 1-1/2; top.
  - 3. Toilet Seat: Provide to match fixture.

## 2.2 FLUSHOMETER VALVES

### A. Sensor Operated Flushometer Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. American Standard.
2. Standard: ASSE 1037.
3. Minimum Pressure Rating: 125 psig.
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Panel Finish: Chrome plated or stainless steel.
8. Style: Exposed.
9. Consumption: Per plumbing fixture schedule.
10. Minimum Inlet: NPS 1.
11. Minimum Outlet: NPS 1-1/4.
12. Battery Powered

## 2.3 TOILET SEATS

### A. Toilet Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Church Seats; Bemis Manufacturing Company.
2. Standard: IAPMO/ANSI Z124.5.
3. Material: Plastic.
4. Type: Commercial (Heavy duty).
5. Shape: Elongated rim, open front.
6. Hinge: Check.
7. Hinge Material: Noncorroding metal.
8. Seat Cover: Not required.
9. Color: White.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

#### A. Water-Closet Installation:

1. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate. Indicate on Drawings those water closets that are required to be accessible.

- B. Install toilet seats on water closets.
- C. Wall Flange and Escutcheon Installation:
  - 1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
  - 2. Install deep-pattern escutcheons if required to conceal protruding fittings.
  - 3. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
- D. Joint Sealing:
  - 1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
  - 2. Match sealant color to water-closet color.
  - 3. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

### 3.2 CONNECTIONS

- A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."
- D. Where installing piping adjacent to water closets, allow space for service and maintenance.

### 3.3 ADJUSTING

- A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.
- B. Adjust water pressure at flushometer valves to produce proper flow.

### 3.4 CLEANING AND PROTECTION

- A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed water closets and fittings.
- C. Do not allow use of water closets for temporary facilities unless approved in writing by Owner.

### 3.5 TRAINING

- A. Training will be performed for each system installed. Training is to be two separate identical sessions, held on separate weeks. A training Agenda will be developed by the Commissioning Authority. Contractor is responsible to have a competent party perform training, preferably the site foreman in conjunction with manufacturer's representatives.

END OF SECTION 224213.13

## SECTION 224216.13 - COMMERCIAL LAVATORIES

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Lavatories.
2. Faucets.

#### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include diagrams for power, signal, and control wiring of automatic faucets.

#### 1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.

#### 1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lavatories and faucets to include in operation and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
  - a. Servicing and adjustments of automatic faucets.

### PART 2 - PRODUCTS

#### 2.1 VITREOUS-CHINA, WALL-MOUNTED LAVATORIES

A. Lavatory: vitreous china, wall mounted.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. American Standard America.
  - b. DXV
2. Fixture:

- a. Standard: ASME A112.19.2/CSA B45.1.
  - b. Type: Slab or wheelchair.
  - c. Nominal Size: Rectangular, 20 by 18 inches and Trough II 47 by 17 inches.
  - d. Faucet-Hole Punching: One hole and Two Holes.
  - e. Faucet-Hole Location: Top.
  - f. Color: White.
  - g. Mounting: For concealed-arm carrier.
3. Faucet: See Schedule.
  4. Support: ASME A112.6.1M, Type II, concealed-arm lavatory carrier with rectangular, steel uprights.

## 2.2 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.
- B. Standard: ASME A112.18.1/CSA B125.1.
- C. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless-steel wall flange.
- D. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
- E. Operation: Wheel handle.
- F. Risers:
  1. NPS 1/2.
  2. ASME A112.18.6, braided- or corrugated-stainless-steel, flexible hose riser.

## 2.3 WASTE FITTINGS

- A. Standard: ASME A112.18.2/CSA B125.2.
- B. Drain: Grid type with NPS 1-1/4 offset and straight tailpiece.
- C. Trap:
  1. Size: NPS 1-1/2 by NPS 1-1/4.
  2. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch-thick brass tube to wall; and chrome-plated, brass or steel wall flange.
  3. Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch-thick stainless-steel tube to wall; and stainless-steel wall flange.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before lavatory installation.
- B. Examine counters and walls for suitable conditions where lavatories will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install lavatories level and plumb according to roughing-in drawings.
- B. Install supports, affixed to building substrate, for wall-mounted lavatories.
- C. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1.
- D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
- E. Seal joints between lavatories and counters and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
- F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

### 3.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

### 3.4 ADJUSTING

- A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.

- C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

### 3.5 CLEANING AND PROTECTION

- A. After completing installation of lavatories, inspect and repair damaged finishes.
- B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed lavatories and fittings.
- D. Do not allow use of lavatories for temporary facilities unless approved in writing by Owner.

### 3.6 TRAINING

- A. Training will be performed for each system installed. Training is to be two separate identical sessions, held on separate weeks. A training Agenda will be developed by the Commissioning Authority. Contractor is responsible to have a competent party perform training, preferably the site foreman in conjunction with manufacturer's representatives.

END OF SECTION 224216.13

## SECTION 224216.16 - COMMERCIAL SINKS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Service basins.
  - 2. Handwash sinks.
  - 3. Sink faucets.
  - 4. Laminar-flow, faucet-spout outlets.
  - 5. Supply fittings.
  - 6. Waste fittings.

#### 1.2 ACTION SUBMITTALS

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

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Maintenance data.

### PART 2 - PRODUCTS

#### 2.1 SERVICE BASINS

- A. Service Basins: Plastic, floor mounted.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Fiat.
    - b. Prior Approved Equal
  - 2. Fixture:
    - a. Standard: IAPMO/ANSI Z124.6.
    - b. Material: Cast polymer.
    - c. Nominal Size: See Schedule

- d. Tiling Flange: Not required.
  - e. Rim Guard: See Schedule.
  - f. Color: Not applicable.
  - g. Drain: Grid with NPS 3 outlet.
- 3. Mounting: On floor and flush to wall.
  - 4. Faucet: See Schedule.

## 2.2 HANDWASH SINKS

### A. Handwash Sinks: Stainless steel, wall mounted.

- 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Just Manufacturing Co.
  - b. Elkay
  - c. Prior Approved Equal
- 2. Fixture:
  - a. Standards: ASME A112.19.3/CSA B45.4 and NSF/ANSI 2.
  - b. Type: Basin with radius corners, back for faucet.
  - c. Nominal Size: See Schedule.
- 3. Faucet: See Schedule.
- 4. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
- 5. Waste Fittings: Comply with requirements in "Waste Fittings" Article.

## 2.3 SINK FAUCETS

### A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for faucet-spout materials that will be in contact with potable water.

### B. Sink Faucets: See Schedule.

- 1. Commercial, Solid-Brass Faucets:
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) Chicago Faucet.
    - 2) Moen Incorporated.
    - 3) American Standard
- 2. Standard: ASME A112.18.1/CSA B125.1.
- 3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
- 4. Body Type: .
- 5. Body Material: .

6. Finish: Chrome plated.
7. Maximum Flow Rate: See Schedule.
8. Handle(s): See Schedule.
9. Mounting Type: See Schedule.
10. Spout Type: See Schedule.

## 2.4 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.
- B. Standard: ASME A112.18.1/CSA B125.1.
- C. Supply Piping: Chrome-plated brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass or stainless-steel wall flange.
- D. Supply Stops: Chrome-plated brass, one-quarter-turn, valve with inlet connection matching supply piping.
- E. Operation: Wheel handle.
- F. Risers:
  1. NPS 1/2
  2. ASME A112.18.6, braided or corrugated stainless-steel flexible hose.

## 2.5 WASTE FITTINGS

- A. Standard: ASME A112.18.2/CSA B125.2.
- B. Drain: Grid type with NPS 1-1/2 offset and straight tailpiece.
- C. Trap:
  1. Size: NPS 1-1/2.
  2. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch-thick brass tube to wall; and chrome-plated brass or steel wall flange.
  3. Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch-thick stainless-steel tube to wall; and stainless-steel wall flange.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before sink installation.
- B. Examine walls, floors, and counters for suitable conditions where sinks will be installed.

- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install sinks level and plumb according to roughing-in drawings.
- B. Install supports, affixed to building substrate, for wall-hung sinks.
- C. Install accessible wall-mounted sinks at handicapped/elderly mounting height according to ICC/ANSI A117.1.
- D. Set floor-mounted sinks in leveling bed of cement grout.
- E. Install water-supply piping with stop on each supply to each sink faucet.
  - 1. Exception: Use ball or gate valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping."
  - 2. Install stops in locations where they can be easily reached for operation.
- F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
- G. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
- H. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

### 3.3 CONNECTIONS

- A. Connect sinks with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

### 3.4 ADJUSTING

- A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.

### 3.5 CLEANING AND PROTECTION

- A. After completing installation of sinks, inspect and repair damaged finishes.
- B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed sinks and fittings.
- D. Do not allow use of sinks for temporary facilities unless approved in writing by Owner.

### 3.6 TRAINING

- A. Training will be performed for each system installed. Training is to be two separate identical sessions, held on separate weeks. A training Agenda will be developed by the Commissioning Authority. Contractor is responsible to have a competent party perform training, preferably the site foreman in conjunction with manufacturer's representatives.

END OF SECTION 224216.16

## SECTION 230513 - 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 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: 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. Rotor: Random-wound, squirrel cage.
- F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- G. Temperature Rise: Match insulation rating.
- H. Insulation: Class F.
- I. 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.
- J. 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. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
  - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
  - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

#### 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 230513

## SECTION 230516 - EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Packed expansion joints.
  - 2. Packless expansion joints.
  - 3. Alignment guides and anchors.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Delegated-Design Submittal: For each anchor and alignment guide, including analysis data, signed and sealed by the qualified professional engineer responsible for their preparation.
  - 1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
  - 2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
  - 3. Alignment Guide Details: Detail field assembly and attachment to building structure.
  - 4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Maintenance data.

#### 1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.
- B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

### 2.2 PACKED EXPANSION JOINTS

#### A. Slip-Joint Packed Expansion Joints SJ-01:

- 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. Adscos Manufacturing LLC.
  - b. Advanced Thermal Systems, Inc.
  - c. Hyspan Precision Products, Inc.
  - d. Mason Industries, Inc.
  - e. Metraflex Company (The).
- 2. Standard: ASTM F1007.
- 3. Material: Carbon steel with asbestos-free PTFE packing.
- 4. Design: With internal guide and injection ports for repacking under full system pressure. Housing shall be furnished with drain ports and lifting ring. Include drip connection if used for steam piping.
- 5. Configuration: Single joint class(es), unless otherwise indicated.
- 6. Slip Tube for sizes NPS 1-1/2 through NPS 16: Schedule 80.
- 7. Sliding Surface: 2 mil thick chrome finish.
- 8. End Connections: Flanged or welded ends to match piping system.

### 2.3 PACKLESS EXPANSION JOINTS

#### A. Metal, Compensator Packless Expansion Joints MCEJ-01:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Flex-Hose Co., Inc.
  - b. Flexicraft Industries.
  - c. Flex-Weld, Inc.
  - d. Hyspan Precision Products, Inc.
  - e. Mason Industries, Inc.
  - f. Metraflex Company (The).
- 2. Minimum Pressure Rating: 150 psig, unless otherwise indicated.

3. Description: Totally enclosed, externally pressurized, multi-ply bellows isolated from fluid flow by an internal pipe sleeve and external housing.
4. Joint Axial Movement: 2 inches of compression and 1/2 inch of extension.
5. Configuration for Copper Tubing: Multi-ply, phosphor-bronze bellows with copper pipe ends.
  - a. End Connections for Copper Tubing NPS 2 and Smaller: Solder joint or threaded.
  - b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Threaded.
6. Configuration for Steel Piping: Multi-ply, stainless-steel bellows; steel-pipe end connections; and carbon-steel shroud.
  - a. End Connections for Steel Pipe NPS 2 and Smaller: Threaded.
  - b. End Connections for Steel Pipe NPS 2-1/2 to NPS 4: Flanged.

B. Rubber Union Connector Expansion Joints RUEJ-01:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Amber/Booth Company, Inc.; a VMC Group Company.
  - b. Flex-Hose Co., Inc.
  - c. Flexicraft Industries.
  - d. General Rubber Corporation.
  - e. Mason Industries, Inc.
  - f. Metraflex Company (The).
  - g. Proco Products, Inc.
  - h. Unaflex.
  - i. Unisource Manufacturing, Inc.
2. Material: Twin reinforced-rubber spheres with external restraining cables.
3. Minimum Pressure Rating: 150 psig at 170 deg F, unless otherwise indicated.
4. End Connections for NPS 2 and Smaller: Threaded.

C. Flexible-Hose Packless Expansion Joints FHEJ-01:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Flex-Hose Co., Inc.
  - b. Flexicraft Industries.
  - c. Flex-Pression.
  - d. Mason Industries, Inc.
  - e. Metraflex Company (The).
  - f. Unisource Manufacturing, Inc.
2. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
3. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.

4. Expansion Joints for Copper Tubing NPS 2 and Smaller: Copper-alloy fittings with solder-joint end connections.
  - a. Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F and 340 psig at 450 deg F ratings.
5. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4: Copper-alloy fittings with threaded end connections.
  - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F and 225 psig at 450 deg F ratings.
6. Expansion Joints for Steel Piping NPS 2 and Smaller: Carbon-steel fittings with threaded end connections.
  - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F and 325 psig at 600 deg F ratings.
7. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6: Carbon-steel fittings with flanged end connections.
  - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F and 145 psig at 600 deg F ratings.

D. Externally Pressurized Metal-Bellows Packless Expansion Joints EPEJ-01:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. AdSCO Manufacturing LLC.
  - b. Flex-Hose Co., Inc.
  - c. Hyspan Precision Products, Inc.
  - d. Mason Industries, Inc.
  - e. Metraflex Company (The).
  - f. U.S. Bellows, Inc.
2. Minimum Pressure Rating: 150 psig, unless otherwise indicated.
3. Description:
  - a. Totally enclosed, externally pressurized, multi-ply, stainless-steel bellows isolated from fluid flow by an internal pipe sleeve.
  - b. Carbon-steel housing.
  - c. Drain plugs and lifting lug for the NPS 3 and larger.
  - d. Bellows shall have operating clearance between the internal pipe sleeves and the external shrouds.
  - e. Joints shall be supplied with a built-in scale to confirm the starting position and operating movement.
  - f. Joint Axial Movement: 6 inches of compression and of extension.

4. Permanent Locking Bolts: Set locking bolts to maintain joint lengths during installation. Temporary welding tabs that are removed after installation in lieu of locking bolts are not acceptable.
5. End Connection Configuration: Flanged; one raised, fixed and one floating flange.

## 2.4 ALIGNMENT GUIDES AND ANCHORS

### A. Alignment Guides AG-01:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Adscos Manufacturing LLC.
  - b. Advanced Thermal Systems, Inc.
  - c. Flex-Hose Co., Inc.
  - d. Flexicraft Industries.
  - e. Flex-Weld, Inc.
  - f. Hyspan Precision Products, Inc.
  - g. Mason Industries, Inc.
  - h. Metraflex Company (The).
  - i. Senior Flexonics Pathway.
  - j. U.S. Bellows, Inc.
  - k. Unisource Manufacturing, Inc.
2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe.

### B. Anchor Materials:

1. Steel Shapes and Plates: ASTM A36/A36M.
2. Bolts and Nuts: ASME B18.10 or ASTM A183, steel hex head.
3. Washers: ASTM F844, steel, plain, flat washers.
4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
  - a. Stud: Threaded, zinc-coated carbon steel.
  - b. Expansion Plug: Zinc-coated steel.
  - c. Washer and Nut: Zinc-coated steel.
5. Chemical Fasteners: Insert-type stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
  - a. Bonding Material: ASTM C881/C881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
  - b. Stud: ASTM A307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
  - c. Washer and Nut: Zinc-coated steel.

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF EXPANSION JOINTS

- A. Install expansion joints of sizes matching sizes of piping in which they are installed.
- B. Install packed-type expansion joints with packing suitable for fluid service.
- C. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

### 3.2 INSTALLATION OF PIPE LOOPS AND SWING CONNECTIONS

- A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
- B. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.
- C. Connect risers and branch connections to terminal units with at least four pipe fittings, including tee in riser.
- D. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

### 3.3 INSTALLATION OF ALIGNMENT GUIDES AND ANCHORS

- A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
- B. Install two guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.
- C. Attach guides to pipe, and secure guides to building structure.
- D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- E. Anchor Attachments:
  - 1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - 2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24; U bolts bolted to anchor.
- F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
  - 1. Anchor Attachment to Steel Structural Members: Attach by welding.

2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
- G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 230516

## SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC 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 waterstop 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Advance Products & Systems
  - 2. CALPICO, Inc.
  - 3. Metraflex Company
  - 4. Pipeline Seal and Insulation
  - 5. Proco Products, Inc.

- B. 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: Stainless steel.
  - 3. Connecting Bolts and Nuts: Stainless steel 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: Nonshrink; 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.

### 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: PVC-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 230517

## SECTION 230518 - ESCUTCHEONS FOR HVAC PIPING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Escutcheons.
  - 2. Floor plates.

#### 1.2 ACTION SUBMITTALS

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

### PART 2 - PRODUCTS

#### 2.1 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

#### 2.2 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
  - 1. Escutcheons for 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.
  - 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.
  - 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.
  - j. Bare Piping in Equipment Rooms: One-piece, cast-brass type with polished, chrome-plated finish.
  - k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
- 1. New Piping: One-piece, floor-plate type.

### 3.2 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 230518

## SECTION 230519 - METERS AND GAUGES FOR HVAC PIPING

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Bimetallic-actuated thermometers.
2. Liquid-in-glass thermometers.
3. Duct-thermometer mounting brackets.
4. Thermowells.
5. Dial-type pressure gages.
6. Gage attachments.
7. Flowmeters.
8. Thermal-energy meters.

##### B. Related Requirements:

1. SECTION 231126 - FACILITY LIQUEFIED-PETROLEUM GAS PIPING

#### 1.2 ACTION SUBMITTALS

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

##### B. Shop Drawings:

1. Include diagrams for power, signal, and control wiring.

#### 1.3 INFORMATIONAL SUBMITTALS

##### A. Product Certificates: For each type of meter and gage.

#### 1.4 CLOSEOUT SUBMITTALS

##### A. Operation and maintenance data.

### PART 2 - PRODUCTS

#### 2.1 BIMETALLIC-ACTUATED THERMOMETERS

##### A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ashcroft Inc.
2. Blue Ribbon Corp.
3. Ernst Flow Industries.
4. Marsh Bellofram.
5. Miljoco Corporation.
6. Nanmac Corporation.
7. Noshok.
8. Palmer Wahl Instrumentation Group.
9. REOTEMP Instrument Corporation.
10. Tel-Tru Manufacturing Company.
11. Terrice, H. O. Co.
12. WATTS.
13. Weiss Instruments, Inc.
14. Weksler Glass Thermometer Corp.
15. WIKA Instrument Corporation.
16. Winters Instruments - U.S.

B. Standard: ASME B40.200.

C. Case: Liquid-filled and sealed type(s); stainless steel with 5-inch nominal diameter.

D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F.

E. Connector Type(s): Union joint, adjustable angle rigid, back and rigid, bottom, with unified-inch screw threads.

F. Connector Size: 1/2 inch, with ASME B1.1 screw threads.

G. Stem: 0.25 or 0.375 inch in diameter; stainless steel.

H. Window: Plain glass.

I. Ring: Stainless steel.

J. Element: Bimetal coil.

K. Pointer: Dark-colored metal.

L. Accuracy: Plus or minus 1 percent of scale range.

## 2.2 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Blue Ribbon Corp.
  - b. Flo Fab Inc.
  - c. Miljoco Corporation.
  - d. Palmer Wahl Instrumentation Group.

- e. Tel-Tru Manufacturing Company.
  - f. Trerice, H. O. Co.
  - g. Weiss Instruments, Inc.
  - h. Weksler Glass Thermometer Corp.
  - i. Winters Instruments - U.S.
2. Standard: ASME B40.200.
  3. Case: Cast aluminum; 7-inch nominal size unless otherwise indicated.
  4. Case Form: Adjustable angle unless otherwise indicated.
  5. Tube: Glass with magnifying lens and blue or red organic liquid.
  6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
  7. Window: Glass.
  8. Stem: Aluminum and of length to suit installation.
    - a. Design for Air-Duct Installation: With ventilated shroud.
    - b. Design for Thermowell Installation: Bare stem.
  9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
  10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

B. Plastic-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ernst Flow Industries.
  - b. Marsh Bellofram.
  - c. Miljoco Corporation.
  - d. Palmer Wahl Instrumentation Group.
  - e. REOTEMP Instrument Corporation.
  - f. WATTS.
  - g. Weiss Instruments, Inc.
  - h. Weksler Glass Thermometer Corp.
  - i. WIKA Instrument Corporation.
2. Standard: ASME B40.200.
3. Case: Plastic; 9-inch nominal size unless otherwise indicated.
4. Case Form: Adjustable angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue or red organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
7. Window: Glass.
8. Stem: Aluminum and of length to suit installation.
  - a. Design for Air-Duct Installation: With ventilated shroud.
  - b. Design for Thermowell Installation: Bare stem.
9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.

10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

### 2.3 DUCT-THERMOMETER MOUNTING BRACKETS

- A. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

### 2.4 THERMOWELLS

- A. Thermowells:
  1. Standard: ASME B40.200.
  2. Description: Pressure-tight, socket-type fitting made for insertion in piping tee fitting.
  3. Material for Use with Copper Tubing: CNR or CUNI.
  4. Material for Use with Steel Piping: CRES.
  5. Type: Stepped shank unless straight or tapered shank is indicated.
  6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
  7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
  8. Bore: Diameter required to match thermometer bulb or stem.
  9. Insertion Length: Length required to match thermometer bulb or stem.
  10. Lagging Extension: Include on thermowells for insulated piping and tubing.
  11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
- B. Heat-Transfer Medium: Mixture of graphite and glycerin.

### 2.5 DIAL-TYPE PRESSURE GAGES

- A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Ametek U.S. Gauge.
    - b. Ashcroft Inc.
    - c. Blue Ribbon Corp.
    - d. Ernst Flow Industries.
    - e. Flo Fab Inc.
    - f. Marsh Bellofram.
    - g. Miljoco Corporation.
    - h. Noshok.
    - i. Palmer Wahl Instrumentation Group.
    - j. REOTEMP Instrument Corporation.
    - k. Tel-Tru Manufacturing Company.
    - l. Terice, H. O. Co.
    - m. WATTS.
    - n. Weiss Instruments, Inc.

- o. Weksler Glass Thermometer Corp.
  - p. WIKA Instrument Corporation.
  - q. Winters Instruments - U.S.
2. Standard: ASME B40.100.
  3. Case: Liquid-filled Sealed Open-front, pressure relief type(s); cast aluminum or drawn steel; 6-inch nominal diameter.
  4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
  5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
  6. Movement: Mechanical, with link to pressure element and connection to pointer.
  7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
  8. Pointer: Dark-colored metal.
  9. Window: Glass.
  10. Ring: Metal.
  11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

B. Direct-Mounted, Plastic-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ametek U.S. Gauge.
  - b. Ashcroft Inc.
  - c. Flo Fab Inc.
  - d. Marsh Bellofram.
  - e. Miljoco Corporation.
  - f. Noshok.
  - g. Palmer Wahl Instrumentation Group.
  - h. REOTEMP Instrument Corporation.
  - i. Tel-Tru Manufacturing Company.
  - j. Trerice, H. O. Co.
  - k. Weiss Instruments, Inc.
  - l. Weksler Glass Thermometer Corp.
  - m. WIKA Instrument Corporation.
  - n. Winters Instruments - U.S.
2. Standard: ASME B40.100.
3. Case: Sealed type; plastic; 6-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

C. Remote-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ametek U.S. Gauge.
  - b. Ashcroft Inc.
  - c. Ernst Flow Industries.
  - d. Flo Fab Inc.
  - e. Marsh Bellofram.
  - f. Miljoco Corporation.
  - g. Noshok.
  - h. Palmer Wahl Instrumentation Group.
  - i. REOTEMP Instrument Corporation.
  - j. Tel-Tru Manufacturing Company.
  - k. Trerice, H. O. Co.
  - l. WATTS.
  - m. Weiss Instruments, Inc.
  - n. WIKA Instrument Corporation.
  - o. Winters Instruments - U.S.
2. Standard: ASME B40.100.
3. Case: Liquid-filled type; cast aluminum or drawn steel metal; 6-inch nominal diameter with back flange and holes for panel mounting.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Metal.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

D. Remote-Mounted, Plastic-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ametek U.S. Gauge.
  - b. Ashcroft Inc.
  - c. Miljoco Corporation.
  - d. Noshok.
  - e. Palmer Wahl Instrumentation Group.
  - f. REOTEMP Instrument Corporation.
  - g. Tel-Tru Manufacturing Company.
  - h. Trerice, H. O. Co.
  - i. Weiss Instruments, Inc.
  - j. WIKA Instrument Corporation.
  - k. Winters Instruments - U.S.
2. Standard: ASME B40.100.

3. Case: Sealed type; plastic; 6-inch nominal diameter with back flange and holes for panel mounting.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

## 2.6 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.
- B. Siphons: Loop-shaped section of brass pipe with NPS 1/4 or NPS 1/2 pipe threads.
- C. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

## 2.7 FLOWMETERS

- A. Pitot-Tube Flowmeters:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. ABB, Process Automation Business.
    - b. Meriam Process Technologies.
    - c. Nexus Valve, Inc.
    - d. Preso Meters.
    - e. Rosemount Inc.; Emerson Electric Company.
    - f. Taco Comfort Solutions.
    - g. Veris Inc.
  2. Description: Flowmeter with sensor and indicator.
  3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
  4. Sensor: Insertion type; for inserting probe in piping and measuring flow directly in gallons per minute.
    - a. Design: Differential-pressure-type measurement for oil.
    - b. Construction: Stainless-steel probe of length to span inside of pipe, with integral transmitter and direct-reading scale.
    - c. Minimum Pressure Rating: 150 psig.
    - d. Minimum Temperature Rating: 250 deg F.
  5. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.
  6. Integral Transformer: For low-voltage power connection.

7. Accuracy: Plus or minus 3 percent.
8. Display: Shows rate of flow.
9. Operating Instructions: Include complete instructions with each flowmeter.

B. Turbine Flowmeters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Process Automation Business.
  - b. EMCO Flow Systems.
  - c. ERDCO Engineering Corp.
  - d. Hoffer Flow Controls, Inc.
  - e. Liquid Controls.
  - f. McCrometer, Inc.
  - g. Midwest Instruments & Controls Corp.
  - h. ONICON Incorporated.
  - i. SeaMetrics, Inc.
  - j. Sponsler, Inc.
2. Description: Flowmeter with sensor and indicator.
3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
4. Sensor: Impeller turbine; for inserting in pipe fitting or for installing in piping and measuring flow directly in gallons per minute.
  - a. Design: Device or pipe fitting with inline turbine and integral direct-reading scale for water.
  - b. Construction: Bronze or stainless-steel body, with plastic turbine or impeller.
  - c. Minimum Pressure Rating: 150 psig.
  - d. Minimum Temperature Rating: 180 deg F.
5. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.
6. Accuracy: Plus or minus 1-1/2 percent.
7. Display: Shows rate of flow.
8. Operating Instructions: Include complete instructions with each flowmeter.

C. Venturi Flowmeters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Process Automation Business.
  - b. Gerand Engineering Co.
  - c. Hyspan Precision Products, Inc.
  - d. Nexus Valve, Inc.
  - e. Preso Meters.
  - f. S. A. Armstrong Limited.
  - g. Victaulic Company.

2. Description: Flowmeter with calibrated flow-measuring element, hoses or tubing, fittings, valves, indicator, and conversion chart.
3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
4. Sensor: Venturi-type, calibrated, flow-measuring element; for installation in piping.
  - a. Design: Differential-pressure-type measurement for liquid.
  - b. Construction: Bronze, brass, or factory-primed steel, with brass fittings and attached tag with flow conversion data.
  - c. Minimum Pressure Rating: 250 psig.
  - d. Minimum Temperature Rating: 250 deg F.
  - e. End Connections for NPS 2 and Smaller: Threaded.
  - f. End Connections for NPS 2-1/2 and Larger: Flanged or welded.
  - g. Flow Range: Flow-measuring element and flowmeter shall cover operating range of equipment or system served.
5. Permanent Indicators: Meter suitable for wall or bracket mounting, calibrated for connected flowmeter element, and having 6-inch-diameter, or equivalent, dial with fittings and copper tubing for connecting to flowmeter element.
  - a. Scale: Gallons per minute.
  - b. Accuracy: Plus or minus 1 percent between 20 and 80 percent of scale range.
6. Portable Indicators: Hand-held, differential-pressure type, calibrated for connected flowmeter element and having two 12-foot hoses, with carrying case.
  - a. Scale: Gallons per minute.
  - b. Accuracy: Plus or minus 2 percent between 20 and 80 percent of scale range.
7. Display: Shows rate of flow.
8. Conversion Chart: Flow rate data compatible with sensor.
9. Operating Instructions: Include complete instructions with each flowmeter.

## 2.8 THERMAL-ENERGY METERS

### A. Impeller-Turbine, Thermal-Energy Meters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Hoffer Flow Controls, Inc.
  - b. ISTECH Corporation.
  - c. ONICON Incorporated.
  - d. Veris Industries.
2. Description: System with strainer, flow sensor, temperature sensors, transmitter, indicator, and connecting wiring.
3. Flow Sensor: Impeller turbine with corrosion-resistant-metal body and transmitter; for installing in piping.

- a. Design: Total thermal-energy measurement.
  - b. Minimum Pressure Rating: 150 psig.
  - c. Minimum Temperature Range: 40 to 250 deg F.
- 4. Temperature Sensors: Insertion-type transducer.
  - 5. Indicator: Solid-state, integrating-type meter; for wall mounting.
    - a. Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or British thermal units.
    - b. Battery Pack: Five-year lithium battery.
  - 6. Accuracy: Plus or minus 1 percent.
  - 7. Display: Visually indicates total fluid volume in gallons and thermal-energy flow in kilowatts per hour or British thermal units.
  - 8. Strainer: Full size of main line piping.
  - 9. Operating Instructions: Include complete instructions with each thermal-energy meter system.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.
- G. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.
- H. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- I. Install remote-mounted pressure gages on panel.
- J. Install valve and snubber in piping for each pressure gage for fluids (except steam).
- K. Install valve and syphon fitting in piping for each pressure gage for steam.
- L. Install test plugs in piping tees.

- M. Install flow indicators in piping systems in accessible positions for easy viewing.
- N. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.
- O. Install flowmeter elements in accessible positions in piping systems.
- P. Install wafer-orifice flowmeter elements between pipe flanges.
- Q. Install differential-pressure-type flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.
- R. Install permanent indicators on walls or brackets in accessible and readable positions.
- S. Install connection fittings in accessible locations for attachment to portable indicators.
- T. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.
- U. Install thermometers in the following locations:
  - 1. Inlet and outlet of each hydronic zone.
  - 2. Inlet and outlet of each hydronic boiler.
  - 3. Two inlets and two outlets of each chiller.
  - 4. Inlet and outlet of each hydronic coil in air-handling units.
  - 5. Two inlets and two outlets of each hydronic heat exchanger.
  - 6. Inlet and outlet of each thermal-storage tank.
  - 7. Outside-, return-, supply-, and mixed-air ducts.
- V. Install pressure gages in the following locations:
  - 1. Discharge of each pressure-reducing valve.
  - 2. Inlet and outlet of each chiller chilled-water and condenser-water connection.
  - 3. Suction and discharge of each pump.

### 3.2 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow space for service and maintenance of meters, gages, machines, and equipment.
- B. Connect flowmeter-system elements to meters.
- C. Connect flowmeter transmitters to meters.
- D. Connect thermal-energy meter transmitters to meters.

### 3.3 ADJUSTING

- A. After installation, calibrate meters according to manufacturer's written instructions.
- B. Adjust faces of meters and gages to proper angle for best visibility.

### 3.4 THERMOMETER SCHEDULE

- A. Thermometers at inlet and outlet of each hydronic zone shall be one of the following:
  - 1. Liquid-filled Sealed, bimetallic-actuated type.
  - 2. Direct Remote-mounted, metal plastic-case, vapor-actuated type.
  - 3. Industrial-style, liquid-in-glass type.
- B. Thermometers at inlet and outlet of each hydronic boiler shall be one of the following:
  - 1. Liquid-filled Sealed, bimetallic-actuated type.
  - 2. Direct Remote-mounted, metal plastic-case, vapor-actuated type.
  - 3. Industrial-style, liquid-in-glass type.
- C. Thermometers at inlets and outlets of each chiller shall be one of the following:
  - 1. Liquid-filled Sealed, bimetallic-actuated type.
  - 2. Direct Remote-mounted, metal plastic-case, vapor-actuated type.
  - 3. Industrial-style, liquid-in-glass type.
- D. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems shall be one of the following:
  - 1. Liquid-filled Sealed, bimetallic-actuated type.
  - 2. Direct Remote-mounted, metal plastic-case, vapor-actuated type.
  - 3. Industrial-style, liquid-in-glass type.
- E. Thermometers at inlets and outlets of each hydronic heat exchanger shall be one of the following:
  - 1. Liquid-filled Sealed, bimetallic-actuated type.
  - 2. Direct Remote-mounted, metal plastic-case, vapor-actuated type.
  - 3. Industrial-style, liquid-in-glass type.
- F. Thermometers at inlet and outlet of each hydronic heat-recovery unit shall be one of the following:
  - 1. Liquid-filled Sealed, bimetallic-actuated type.
  - 2. Direct Remote-mounted, metal plastic-case, vapor-actuated type.
  - 3. Industrial-style, liquid-in-glass type.
- G. Thermometers at inlet and outlet of each thermal-storage tank shall be one of the following:
  - 1. Liquid-filled Sealed, bimetallic-actuated type.
  - 2. Direct Remote-mounted, metal plastic-case, vapor-actuated type.
  - 3. Industrial-style, liquid-in-glass type.
- H. Thermometers at outside-, return-, supply-, and mixed-air ducts shall be one of the following:
  - 1. Liquid-filled Sealed, bimetallic-actuated type.
  - 2. Direct Remote-mounted, metal plastic-case, vapor-actuated type.
  - 3. Industrial-style, liquid-in-glass type.

- I. Thermometer stems shall be of length to match thermowell insertion length.

### 3.5 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Chilled-Water Piping: Minus 40 to plus 160 deg F.
- B. Scale Range for Chilled-Water Piping: 0 to 100 deg F.
- C. Scale Range for Chilled-Water Piping: 0 to 150 deg F.
- D. Scale Range for Condenser-Water Piping: 0 to 100 deg F.
- E. Scale Range for Condenser-Water Piping: 0 to 150 deg F.
- F. Scale Range for Condenser-Water Piping: 0 to 250 deg F.
- G. Scale Range for Heating, Hot-Water Piping: 0 to 250 deg F.
- H. Scale Range for Heating, Hot-Water Piping: 20 to 240 deg F.
- I. Scale Range for Heating, Hot-Water Piping: 50 to 400 deg F.
- J. Scale Range for Steam and Steam-Condensate Piping: 0 to 250 deg F.
- K. Scale Range for Steam and Steam-Condensate Piping: 20 to 240 deg F.
- L. Scale Range for Air Ducts: Minus 40 to plus 160 deg F.
- M. Scale Range for Air Ducts: 0 to 100 deg F.
- N. Scale Range for Air Ducts: 0 to 150 deg F.
- O. Scale Range for Air Ducts: 20 to 240 deg F.

### 3.6 PRESSURE-GAGE SCHEDULE

- A. Pressure gages at discharge of each pressure-reducing valve shall be one of the following:
  - 1. Liquid-filled Sealed Open-front, pressure-relief, direct-mounted, metal case.
  - 2. Sealed, direct-mounted, plastic case.
- B. Pressure gages at inlet and outlet of each chiller chilled-water and condenser-water connection shall be one of the following:
  - 1. Liquid-filled Sealed Open-front, pressure-relief, direct-mounted, metal case.
  - 2. Sealed, direct-mounted, plastic case.
- C. Pressure gages at suction and discharge of each pump shall be one of the following:
  - 1. Liquid-filled Sealed Open-front, pressure-relief Insert type, direct-mounted, metal case.

2. Sealed, direct-mounted, plastic case.

### 3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for Chilled-Water Piping: 0 to 100 psi.
- B. Scale Range for Chilled-Water Piping: 0 to 160 psi.
- C. Scale Range for Chilled-Water Piping: 0 to 300 psi.
- D. Scale Range for Condenser-Water Piping: 0 to 100 psi.
- E. Scale Range for Condenser-Water Piping: 0 to 160 psi.
- F. Scale Range for Condenser-Water Piping: 0 to 300 psi.
- G. Scale Range for Heating, Hot-Water Piping: 0 to 100 psi.
- H. Scale Range for Heating, Hot-Water Piping: 0 to 160 psi.
- I. Scale Range for Heating, Hot-Water Piping: 0 to 300 psi.
- J. Scale Range for Steam Piping: 0 to 100 psi.
- K. Scale Range for Steam Piping: 0 to 160 psi.
- L. Scale Range for Steam Piping: 0 to 200 psi.

### 3.8 FLOWMETER SCHEDULE

- A. Flowmeters for Chilled-Water Piping: Pitot-tube type.
- B. Flowmeters for Condenser-Water Piping: Pitot-tube type.
- C. Flowmeters for Heating, Hot-Water Piping: Pitot-tube type.
- D. Flowmeters for Steam and Steam-Condensate Piping: Turbine type.

### 3.9 THERMAL-ENERGY METER SCHEDULE

- A. Thermal-Energy Meters: Impeller-turbine type.

END OF SECTION 230519

## SECTION 230523.12 - BALL VALVES FOR HVAC PIPING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
1. Brass ball valves.
  2. Bronze ball valves.
  3. Stainless steel ball valves.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of valve.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. ASME Compliance:
1. ASME B1.20.1 for threads for threaded-end valves.
  2. ASME B16.1 for flanges on iron valves.
  3. ASME B16.5 for flanges on steel valves.
  4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
  5. ASME B16.18 for cast copper solder-joint connections.
  6. ASME B16.22 for wrought copper and copper alloy solder-joint connections.
  7. ASME B16.34 for flanged and threaded end connections.
  8. ASME B31.1 for power piping valves.
  9. ASME B31.9 for building services piping valves.
- B. Provide bronze valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- C. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- D. Valve Sizes: Same as upstream piping unless otherwise indicated.
- E. Valve Actuator Types:
1. Gear Actuator: For quarter-turn valves NPS 4 and larger.
  2. Hand Lever: For quarter-turn valves smaller than NPS 4.
- F. Valves in Insulated Piping:

1. Provide 2-inch extended neck stems.
2. Extended operating handles with nonthermal-conductive covering material, and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
3. Memory stops that are fully adjustable after insulation is applied.

G. Valve Bypass and Drain Connections: MSS SP-45.

## 2.2 BRASS BALL VALVES

A. Brass Ball Valves, One Piece:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. KITZ Corporation.
  - b. WATTS.
2. Standard: MSS SP-110.
3. CWP Rating: 400 psig.
4. Body Design: One piece.
5. Body Material: Forged brass.
6. Ends: Threaded.
7. Seats: PTFE.
8. Stem: Brass.
9. Ball: Chrome-plated brass.
10. Port: Reduced.

B. Brass Ball Valves, Two Piece with Full Port and Brass Trim, Threaded or Soldered Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. A.Y. McDonald Mfg. Co.
  - b. American Valve, Inc.
  - c. Apollo Valves; a part of Aalberts Integrated Piping Systems.
  - d. Bray International, Inc.
  - e. Center Line; a Crane Co. brand.
  - f. DynaQuip Controls.
  - g. FNW; Ferguson Enterprises, Inc.
  - h. Hammond Valve.
  - i. Jenkins Valves; a Crane Co. brand.
  - j. Jomar Valve.
  - k. KITZ Corporation.
  - l. Lance Valves.
  - m. Legend Valve & Fitting, Inc.
  - n. Marwin Valve; Richards Industries.
  - o. Milwaukee Valve Company.
  - p. Red-White Valve Corp.
  - q. Siemens Industry, Inc., Building Technologies Division.

- r. Stockham; a Crane Co. brand.
  - s. Viega LLC.
  - t. WATTS.
2. Standard: MSS SP-110.
  3. SWP Rating: 150 psig.
  4. CWP Rating: 600 psig.
  5. Body Design: Two piece.
  6. Body Material: Forged brass.
  7. Ends: Threaded or soldered.
  8. Seats: PTFE.
  9. Stem: Brass.
  10. Ball: Chrome-plated brass.
  11. Port: Full.

C. Brass Ball Valves, Two Piece with Full Port and Brass Trim, Press Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. American Valve, Inc.
  - b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
  - c. Crane; a Crane Co. brand.
  - d. FNW; Ferguson Enterprises, Inc.
  - e. Hammond Valve.
  - f. Jenkins Valves; a Crane Co. brand.
  - g. Jomar Valve.
  - h. KITZ Corporation.
  - i. Lance Valves.
  - j. Legend Valve & Fitting, Inc.
  - k. Milwaukee Valve Company.
  - l. Red-White Valve Corp.
  - m. Stockham; a Crane Co. brand.
  - n. WATTS.
2. Standard: MSS SP-110; IAPMO/ANSI Z1157.
3. CWP Rating: 600 psig.
4. Body Design: Two piece.
5. Body Material: Forged brass.
6. Ends: Press.
7. Seats: PTFE or RPTFE.
8. Stem: Brass.
9. Ball: Chrome-plated brass.
10. Port: Full.
11. O-Ring Seal: Buna-N or EPDM.

D. Brass Ball Valves, Two Piece with Full Port and Stainless Steel Trim, Threaded Ends or Soldered Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. A.Y. McDonald Mfg. Co.
  - b. American Valve, Inc.
  - c. Apollo Valves; a part of Aalberts Integrated Piping Systems.
  - d. Crane; a Crane Co. brand.
  - e. DynaQuip Controls.
  - f. Flow-Tek, Inc.
  - g. FNW; Ferguson Enterprises, Inc.
  - h. Hammond Valve.
  - i. Jamesbury; Metso.
  - j. Jenkins Valves; a Crane Co. brand.
  - k. Jomar Valve.
  - l. KITZ Corporation.
  - m. Lance Valves.
  - n. Legend Valve & Fitting, Inc.
  - o. Marwin Valve; Richards Industries.
  - p. Milwaukee Valve Company.
  - q. Red-White Valve Corp.
  - r. RuB Inc.
  - s. Siemens Industry, Inc., Building Technologies Division.
  - t. Stockham; a Crane Co. brand.
  - u. Viega LLC.
  - v. WATTS.
- 2. Standard: MSS SP-110.
  - 3. SWP Rating: 150 psig.
  - 4. CWP Rating: 600 psig.
  - 5. Body Design: Two piece.
  - 6. Body Material: Forged brass.
  - 7. Ends: Threaded or soldered.
  - 8. Seats: PTFE.
  - 9. Stem: Stainless steel.
  - 10. Ball: Stainless steel, vented.
  - 11. Port: Full.

E. Brass Ball Valves, Two Piece with Full Port and Stainless Steel Trim, Press Ends:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. American Valve, Inc.
  - b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
  - c. Crane; a Crane Co. brand.
  - d. FNW; Ferguson Enterprises, Inc.
  - e. Hammond Valve.
  - f. Jomar Valve.
  - g. KITZ Corporation.
  - h. Lance Valves.
  - i. Legend Valve & Fitting, Inc.
  - j. Milwaukee Valve Company.
  - k. NIBCO INC.
  - l. Red-White Valve Corp.

- m. RuB Inc.
  - n. Stockham; a Crane Co. brand.
  - o. Viega LLC.
  - p. WATTS.
2. Standard: MSS SP-110; IAPMO/ANSI Z1157.
  3. CWP Rating: Minimum 200 psig.
  4. Body Design: Two piece.
  5. Body Material: Forged brass.
  6. Ends: Press.
  7. Press-End Connections Rating: Minimum 200 psig.
  8. Seats: PTFE or RPTFE.
  9. Stem: Stainless steel.
  10. Ball: Stainless steel, vented.
  11. Port: Full.
  12. O-Ring Seal: Buna-N or EPDM.

F. Brass Ball Valves, Two Piece with Regular Port and Brass Trim, Threaded or Soldered Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. A.Y. McDonald Mfg. Co.
  - b. American Valve, Inc.
  - c. Apollo Valves; a part of Aalberts Integrated Piping Systems.
  - d. Center Line; a Crane Co. brand.
  - e. FNW; Ferguson Enterprises, Inc.
  - f. Hammond Valve.
  - g. Jamesbury; Metso.
  - h. Jomar Valve.
  - i. KITZ Corporation.
  - j. Lance Valves.
  - k. Legend Valve & Fitting, Inc.
  - l. Marwin Valve; Richards Industries.
  - m. Milwaukee Valve Company.
  - n. NIBCO INC.
  - o. Red-White Valve Corp.
  - p. Siemens Industry, Inc., Building Technologies Division.
  - q. Stockham; a Crane Co. brand.
  - r. Viega LLC.
  - s. WATTS.
2. Standard: MSS SP-110.
3. SWP Rating: 150 psig.
4. CWP Rating: 600 psig.
5. Body Design: Two piece.
6. Body Material: Forged brass.
7. Ends: Threaded or soldered.
8. Seats: PTFE.
9. Stem: Brass.
10. Ball: Chrome-plated brass.

11. Port: Regular.

G. Brass Ball Valves, Two Piece with Regular Port and Stainless Steel Trim, Threaded or Soldered Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. A.Y. McDonald Mfg. Co.
- b. American Valve, Inc.
- c. Apollo Valves; a part of Aalberts Integrated Piping Systems.
- d. Center Line; a Crane Co. brand.
- e. FNW; Ferguson Enterprises, Inc.
- f. Hammond Valve.
- g. Jomar Valve.
- h. KITZ Corporation.
- i. Lance Valves.
- j. Legend Valve & Fitting, Inc.
- k. Marwin Valve; Richards Industries.
- l. Milwaukee Valve Company.
- m. Red-White Valve Corp.
- n. Siemens Industry, Inc., Building Technologies Division.
- o. Stockham; a Crane Co. brand.
- p. Viega LLC.
- q. WATTS.

2. Standard: MSS SP-110.
3. SWP Rating: 150 psig.
4. CWP Rating: 600 psig.
5. Body Design: Two piece.
6. Body Material: Brass or bronze.
7. Ends: Threaded or soldered.
8. Seats: PTFE.
9. Stem: Stainless steel.
10. Ball: Stainless steel, vented.
11. Port: Regular.

### 2.3 BRONZE BALL VALVES

A. Bronze Ball Valves, One Piece with Bronze Trim, Threaded Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. NIBCO INC.
- b. WATTS.

2. Standard: MSS SP-110.
3. CWP Rating: 400 psig.
4. Body Design: One piece.

5. Body Material: Bronze.
6. Ends: Threaded.
7. Seats: PTFE.
8. Stem: Bronze.
9. Ball: Chrome-plated brass.
10. Port: Reduced.

B. Bronze Ball Valves, One Piece with Stainless Steel Trim, Threaded Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. NIBCO INC.
  - b. WATTS.
2. Standard: MSS SP-110.
3. CWP Rating: 600 psig.
4. Body Design: One piece.
5. Body Material: Bronze.
6. Ends: Threaded.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Reduced.

C. Bronze Ball Valves, Two Piece with Full Port and Bronze or Brass Trim, Threaded or Soldered Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
  - b. Crane; a Crane Co. brand.
  - c. DynaQuip Controls.
  - d. Hammond Valve.
  - e. Jenkins Valves; a Crane Co. brand.
  - f. Milwaukee Valve Company.
  - g. NIBCO INC.
  - h. Red-White Valve Corp.
  - i. Stockham; a Crane Co. brand.
  - j. WATTS.
  - k. Zurn Industries, LLC.
2. Standard: MSS SP-110.
3. SWP Rating: 150 psig.
4. CWP Rating: 600 psig.
5. Body Design: Two piece.
6. Body Material: Bronze.
7. Ends: Threaded or soldered.
8. Seats: PTFE.
9. Stem: Bronze.

10. Ball: Chrome-plated brass.
11. Port: Full.

D. Bronze Ball Valves, Two Piece with Full Port, and Bronze or Brass Trim, Press Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
  - b. Center Line; a Crane Co. brand.
  - c. Hammond Valve.
  - d. Milwaukee Valve Company.
  - e. NIBCO INC.
  - f. Red-White Valve Corp.
  - g. Stockham; a Crane Co. brand.
  - h. Viega LLC.
2. Standard: MSS SP-110; IAPMO/ANSI Z1157.
3. CWP Rating: Minimum 200 psig.
4. Body Design: Two piece.
5. Body Material: Bronze.
6. Ends: Press.
7. Press-End Connections Rating: Minimum 200 psig.
8. Seats: PTFE or RTPFE.
9. Stem: Bronze or brass.
10. Ball: Chrome-plated brass.
11. Port: Full.
12. O-Ring Seal: EPDM or Buna-N.

E. Bronze Ball Valves, Two Piece with Full Port and Stainless Steel Trim, Threaded or Soldered Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
  - b. Crane; a Crane Co. brand.
  - c. DynaQuip Controls.
  - d. Hammond Valve.
  - e. Jenkins Valves; a Crane Co. brand.
  - f. Milwaukee Valve Company.
  - g. NIBCO INC.
  - h. Red-White Valve Corp.
  - i. Stockham; a Crane Co. brand.
  - j. Viega LLC.
  - k. WATTS.
2. Standard: MSS SP-110.
3. SWP Rating: 150 psig.
4. CWP Rating: 600 psig.
5. Body Design: Two piece.

6. Body Material: Bronze.
7. Ends: Threaded or soldered.
8. Seats: PTFE.
9. Stem: Stainless steel.
10. Ball: Stainless steel, vented.
11. Port: Full.

F. Bronze Ball Valves, Two Piece with Regular Port and Bronze or Brass Trim, Threaded Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. American Valve, Inc.
  - b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
  - c. Center Line; a Crane Co. brand.
  - d. DynaQuip Controls.
  - e. Hammond Valve.
  - f. Jenkins Valves; a Crane Co. brand.
  - g. Lance Valves.
  - h. Milwaukee Valve Company.
  - i. NIBCO INC.
  - j. Red-White Valve Corp.
  - k. Stockham; a Crane Co. brand.
  - l. Viega LLC.
2. Standard: MSS SP-110.
3. SWP Rating: 150 psig.
4. CWP Rating: 600 psig.
5. Body Design: Two piece.
6. Body Material: Bronze.
7. Ends: Threaded.
8. Seats: PTFE.
9. Stem: Bronze.
10. Ball: Chrome-plated brass.
11. Port: Regular.

G. Bronze Ball Valves, Two Piece with Regular Port and Stainless Steel Trim, Threaded Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
  - b. Center Line; a Crane Co. brand.
  - c. DynaQuip Controls.
  - d. Hammond Valve.
  - e. Jenkins Valves; a Crane Co. brand.
  - f. Milwaukee Valve Company.
  - g. NIBCO INC.
  - h. Red-White Valve Corp.
  - i. Stockham; a Crane Co. brand.
  - j. Viega LLC.

2. Standard: MSS SP-110.
3. SWP Rating: 150 psig.
4. CWP Rating: 600 psig.
5. Body Design: Two piece.
6. Body Material: Bronze.
7. Ends: Threaded.
8. Seats: PTFE.
9. Stem: Stainless steel.
10. Ball: Stainless steel, vented.
11. Port: Regular.

H. Bronze Ball Valves, Three Piece with Regular Port and Bronze or Brass Trim, Threaded or Soldered Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
  - b. NIBCO INC.
2. Standard: MSS SP-110; MSS SP-145.
3. CWP Rating: 600 psig.
4. Body Design: Three piece.
5. Body Material: Bronze.
6. Ends: Threaded.
7. Seats: PTFE.
8. Stem: Bronze.
9. Ball: Chrome-plated brass.
10. Port: Regular.

## 2.4 STAINLESS STEEL BALL VALVES

A. Stainless Steel Ball Valves, Two Piece with Full Port, Threaded or Flanged Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. A.Y. McDonald Mfg. Co.
  - b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
  - c. Bray International, Inc.
  - d. FNW; Ferguson Enterprises, Inc.
  - e. Hammond Valve.
  - f. Jomar Valve.
2. Standard: MSS SP-110.
3. CWP Rating: 200 psig.
4. Body Design: Split body.
5. Body Material: Type 316 stainless steel.
6. Ends: Threaded or flanged.
7. Seats: PTFE.

8. Stem: Type 316 stainless steel.
9. Ball: Type 316 stainless steel.
10. Port: Full.

## 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. Remove defective valves from site.

### 3.2 INSTALLATION OF VALVES

- A. Install valves with unions or flanges at each piece of equipment arranged to allow space for service, maintenance, and equipment removal without system shutdown.
- B. Provide support of piping adjacent to valves such that no force is imposed upon valves.
- C. Locate valves for easy access.
- D. Install valves in horizontal piping with stem at or above center of pipe.
- E. Install valves in position to allow full valve actuation movement.
- F. Valve Tags: Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.
- G. Adhere to manufacturer's written installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve manufacturer's recommended maximum.
- H. Adjust valve packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves exhibiting leakage.

### 3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified SWP classes or CWP ratings are unavailable, provide the same types of valves with higher SWP classes or CWP ratings.
- B. Select valves with the following end connections:
  - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option or press-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.
  - 7. For Stainless Steel Piping, NPS 2 and Smaller: Threaded ends.
  - 8. For Stainless Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends.
- C. Pipe NPS 2-1/2 and Larger:
  - 1. Iron ball valves, Class 125.
    - a. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
  - 2. Steel ball valves, Class 150.

### 3.4 HEATING-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller: Brass or bronze ball valves, two piece with stainless steel trim, full port, and-joint ends.
- B. Pipe NPS 2-1/2 and Larger:
  - 1. Iron ball valves, Class 125.
    - a. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
  - 2. Steel ball valves, Class 150.

END OF SECTION 230523.12

## SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
1. Metal pipe hangers and supports.
  2. Trapeze pipe hangers.
  3. Thermal-hanger shield inserts.
  4. Fastener systems.
  5. Equipment supports.

#### 1.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
1. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
  2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
  3. Design seismic-restraint hangers and supports for piping and equipment.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:
1. Trapeze pipe hangers.
  2. Equipment supports.
- C. Delegated-Design Submittal: For trapeze hangers 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. Welding certificates.

#### 1.5 QUALITY ASSURANCE

- A. Structural Steel 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.

### PART 2 - PRODUCTS

#### 2.1 METAL PIPE HANGERS AND SUPPORTS

##### A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

##### B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

##### C. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

#### 2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

## 2.3 THERMAL-HANGER SHIELD INSERTS

- A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- B. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig minimum compressive strength.
- C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

## 2.4 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, stainless- steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

## 2.5 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

## 2.6 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
  - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
  - 2. Design Mix: 5000-psi, 28-day compressive strength.

## PART 3 - EXECUTION

### 3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal 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 the building structure.
- B. Metal 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 for individual pipe hangers.
  - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- D. Fastener System Installation:
  - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
  - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- G. Install hangers and supports to allow controlled thermal and seismic 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.
- H. Install lateral bracing with pipe hangers and supports to prevent swaying.
- 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 that 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 to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

L. Insulated Piping:

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 allowed by ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
  - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
  - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. 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.
  - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 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 bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 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/D1.1M 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 so contours of welded surfaces match adjacent contours.

### 3.4 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.

### 3.5 PAINTING

- A. Touchup: 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 a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 099123 "Interior Painting"
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

### 3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are 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 carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.
- J. 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 up to 1050 deg F, pipes NPS 4 to NPS 24, 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 36, requiring clamp flexibility and up to 4 inches of insulation.
  - 4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
  - 5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
  - 6. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
  - 7. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
  - 8. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
  - 9. 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.
- K. 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 24.
  - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- L. 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.

- M. 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-joint 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. 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.
  8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
  9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
  2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
  3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
  2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
  3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
- P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

## SECTION 230548.13 - VIBRATION CONTROLS FOR HVAC

### 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 support.
9. Resilient pipe guides.
10. Elastomeric hangers.
11. Spring hangers.
12. Snubbers.
13. Restraints - rigid type.
14. Restraints - cable type.
15. Restraint accessories.
16. Post-installed concrete anchors.
17. Concrete inserts.

##### B. Related Requirements:

1. Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment" for devices for plumbing equipment and systems.

#### 1.2 ACTION SUBMITTALS

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

##### B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

##### C. Delegated-Design Submittal:

1. Vibration Isolator Selection: Select vibration isolators, and vibration isolation bases complying with performance requirements, design criteria, and analysis data.
2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and

spring deflection changes. Include certification by professional engineer that riser system was examined for excessive stress and that none exists.

### 1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of vibration isolation device installation for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints.
- B. Welding certificates.
- C. Field quality-control reports.

### 1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct testing indicated, be an NRTL as defined by OSHA in 29 CFR 1910.7 and be acceptable to authorities having jurisdiction.
- B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design system.
- B. Consequential Damage: Provide additional restraints for suspended HVAC components or anchorage of floor-, roof-, or wall-mounted HVAC components as indicated in ASCE/SEI 7-05 so that failure of a non-essential or essential HVAC component will not cause the failure of any other essential architectural, mechanical, or electrical building component.
- C. Fire/Smoke Resistance: All components that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.
- D. Component Supports:
  - 1. Load ratings, features, and applications of all reinforcement components must be based on testing standards of a nationally recognized testing agency.

### 2.2 ELASTOMERIC ISOLATION PADS

- A. Elastomeric Isolation Pads:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ace Mountings Co., Inc.
  - b. CADDY; brand of nVent Electrical plc.
  - c. California Dynamics Corporation.
  - d. Isolation Technology, Inc.
  - e. Kinetics Noise Control, Inc.
  - f. Korfund.
  - g. Mason Industries, Inc.
  - h. Novia; A Division of C&P.
  - i. Vibration Eliminator Co., Inc.
  - j. Vibration Isolation.
  - k. Vibration Management Corp.
  - l. 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. Minimum deflection as indicated on Drawings.
5. Pad Material: Oil- and water-resistant rubber.
6. Infused nonwoven cotton or synthetic fibers.
7. Load-bearing metal plates adhered to pads.
8. Sandwich-Core Material: Resilient and elastomeric.
  - a. Infused nonwoven cotton or synthetic fibers.

## 2.3 ELASTOMERIC ISOLATION MOUNTS

### A. Elastomeric Isolation Mounts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ace Mountings Co., Inc.
  - b. CADDY; brand of nVent Electrical plc.
  - c. California Dynamics Corporation.
  - d. Isolation Technology, Inc.
  - e. Kinetics Noise Control, Inc.
  - f. Korfund.
  - g. Mason Industries, Inc.
  - h. Novia; A Division of C&P.
  - i. Vibration Eliminator Co., Inc.
  - j. Vibration Isolation.
  - k. Vibration Management Corp.
  - l. Vibration Mountings & Controls, Inc.
2. Mounting Plates:
  - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded.

- b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
- 3. Minimum deflection as indicated on Drawings.
- 4. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

## 2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

### A. Restrained Elastomeric Isolation Mounts:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ace Mountings Co., Inc.
  - b. CADDY; brand of nVent Electrical plc.
  - c. California Dynamics Corporation.
  - d. Isolation Technology, Inc.
  - e. Kinetics Noise Control, Inc.
  - f. Korfund.
  - g. Mason Industries, Inc.
  - h. Novia; A Division of C&P.
  - i. Vibration Eliminator Co., Inc.
  - j. Vibration Isolation.
  - k. Vibration Management Corp.
  - l. Vibration Mountings & Controls, Inc.
- 2. Description: All-directional isolator with 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.
- 3. Minimum deflection as indicated on Drawings.

## 2.5 OPEN-SPRING ISOLATORS

### A. Freestanding, Laterally Stable, Open-Spring Isolators:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ace Mountings Co., Inc.
  - b. CADDY; brand of nVent Electrical plc.
  - c. California Dynamics Corporation.
  - d. Isolation Technology, Inc.
  - e. Kinetics Noise Control, Inc.

- f. Korfund.
  - g. Mason Industries, Inc.
  - h. Novia; A Division of C&P.
  - i. Vibration Eliminator Co., Inc.
  - j. Vibration Isolation.
  - k. Vibration Management Corp.
  - l. 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 psi (3447 kPa).
  7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
  8. Minimum deflection as indicated on Drawings.

## 2.6 HOUSED-SPRING ISOLATORS

### A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ace Mountings Co., Inc.
  - b. CADDY; brand of nVent Electrical plc.
  - c. California Dynamics Corporation.
  - d. Isolation Technology, Inc.
  - e. Kinetics Noise Control, Inc.
  - f. Korfund.
  - g. Mason Industries, Inc.
  - h. Vibration Eliminator Co., Inc.
  - i. Vibration Isolation.
  - j. Vibration Management Corp.
  - k. 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. Minimum deflection as indicated on Drawings.
7. 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 psi (3447 kPa).
- b. Top housing with elastomeric pad.

## 2.7 RESTRAINED-SPRING ISOLATORS

### A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ace Mountings Co., Inc.
  - b. CADDY; brand of nVent Electrical plc.
  - c. California Dynamics Corporation.
  - d. Isolation Technology, Inc.
  - e. Kinetics Noise Control, Inc.
  - f. Korfund.
  - g. Mason Industries, Inc.
  - h. Novia; A Division of C&P.
  - i. Vibration Eliminator Co., Inc.
  - j. Vibration Isolation.
  - k. Vibration Management Corp.
  - l. 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 psi (3447 kPa).
  - b. Top plate with elastomeric pad.
  - 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.
8. Minimum deflection as indicated on Drawings.

## 2.8 HOUSED-RESTRAINED-SPRING ISOLATORS

### A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Ace Mountings Co., Inc.
  - b. CADDY; brand of nVent Electrical plc.
  - c. California Dynamics Corporation.
  - d. Isolation Technology, Inc.
  - e. Kinetics Noise Control, Inc.
  - f. Korfund.
  - g. Mason Industries, Inc.
  - h. Vibration Eliminator Co., Inc.
  - i. Vibration Isolation.
  - j. Vibration Management Corp.
  - k. 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 psi (3447 kPa).
    - 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.
  7. Minimum deflection as indicated on Drawings.

## 2.9 PIPE-RISER RESILIENT SUPPORT

- A. All-Directional, Acoustical Pipe Anchor Consisting of Two Steel Tubes Separated by a Minimum 1/2-inch- (13-mm-) Thick Neoprene:
  1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
  2. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
  3. Maximum Load Per Support: 500 psi (3447 kPa) on isolation material providing equal isolation in all directions.
  4. Minimum deflection as indicated on Drawings.

## 2.10 RESILIENT PIPE GUIDES

- A. Telescopic Arrangement of Two Steel Tubes or Post and Sleeve Arrangement Separated by a Minimum 1/2-inch- (13-mm-) Thick Neoprene:
  1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ace Mountings Co., Inc.
  - b. CADDY; brand of nVent Electrical plc.
  - c. California Dynamics Corporation.
  - d. Kinetics Noise Control, Inc.
  - e. Mason Industries, Inc.
  - f. Novia; A Division of C&P.
  - g. Vibration Eliminator Co., Inc.
  - h. Vibration Isolation.
  - i. Vibration Management Corp.
  - j. 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. Damping Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel-to-steel contact.
4. Minimum deflection as indicated on Drawings.

## 2.12 SPRING HANGERS

### A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ace Mountings Co., Inc.
  - b. CADDY; brand of nVent Electrical plc.
  - c. California Dynamics Corporation.
  - d. Kinetics Noise Control, Inc.
  - e. Mason Industries, Inc.
  - f. Novia; A Division of C&P.
  - g. Vibration Eliminator Co., Inc.
  - h. Vibration Isolation.
  - i. Vibration Management Corp.
  - j. 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. Minimum deflection as indicated on Drawings.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
8. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
9. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
10. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

### 2.13 SNUBBERS

- A. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
1. Post-Installed Concrete Anchor Bolts: Secure to concrete surface with post-installed concrete anchors. Anchors to be prequalified in accordance with ACI 355.2 testing and designated in accordance with ACI 318-08 Appendix D for 2009 IBC
  2. Preset Concrete Inserts: Prequalified in accordance with ICC-ES AC446 testing.
  3. Anchors in Masonry: Design in accordance with TMS 402.
  4. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
  5. Resilient Cushion: Maximum 1/4-inch (6-mm) air gap, and minimum 1/4 inch (6 mm) thick.

### 2.14 RESTRAINTS - RIGID TYPE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. CADDY; brand of nVent Electrical plc.
  2. California Dynamics Corporation.
  3. Cooper B-line; brand of Eaton, Electrical Sector.
  4. Hilti, Inc.
  5. Isolation Technology, Inc.
  6. TOLCO.
  7. Unistrut; Atkore International.
  8. Vibration Mountings & Controls, Inc.
- B. Description: Shop- or field-fabricated bracing assembly made of AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes 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 RESTRAINTS - CABLE TYPE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. CADDY; brand of nVent Electrical plc.
  - 2. Cooper B-line; brand of Eaton, Electrical Sector.
  - 3. Gripple Inc.
  - 4. Loos & Co.
  - 5. Vibration Mountings & Controls, Inc.
- B. Restraint Cables: ASTM A492 stainless steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with fittings attached by means of poured socket, swaged socket, or mechanical (Flemish eye) loop.
- C. Restraint cable assembly and cable fittings must comply with ASCE/SEI 19-10. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

## 2.16 RESTRAINT ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. CADDY; brand of nVent Electrical plc.
  - 2. Cooper B-line; brand of Eaton, Electrical Sector.
  - 3. Hilti, Inc.
  - 4. Loos & Co.
  - 5. Mason Industries, Inc.
  - 6. TOLCO.
  - 7. Unistrut; Atkore International.
- 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.

## 2.17 POST-INSTALLED CONCRETE ANCHORS

- A. Mechanical Anchor Bolts:
  - 1. 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 for anchor and as tested according to ASTM E488/E488M.
- B. Expansion-type anchor bolts are not permitted for equipment in excess of 10 hp (7.46 kW) that is not vibration isolated.
  - 1. Undercut expansion anchors are permitted.

## 2.18 CONCRETE INSERTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Cooper B-line; brand of Eaton, Electrical Sector.
  - 2. Hilti, Inc.
  - 3. Mason Industries, Inc.
  - 4. Powers Fasteners.
  - 5. Simpson Strong-Tie Co., Inc.
  - 6. Unistrut; Atkore International.
- B. Provide preset concrete inserts that are prequalified in accordance with ICC-ES AC466 testing.
- C. Comply with ANSI/MSS SP-58.

## PART 3 - EXECUTION

### 3.1 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

### 3.2 INSTALLATION OF VIBRATIONCONTROL DEVICES

- A. Provide vibration control devices for systems and equipment where indicated in Equipment Schedules or Vibration-Control Device Schedules on Drawings, where Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.

- B. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."
- C. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
- D. Comply with requirements in Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- E. Equipment Restraints:
  - 1. Install snubbers on HVAC 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 (3.2 mm).
- F. Piping Restraints:
  - 1. Comply with requirements in MSS SP-127.
  - 2. Space lateral supports a maximum of 40 feet (12 m) o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c.
  - 3. Brace a change of direction longer than 12 feet (3.7 m).
- G. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- H. 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.
- I. 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.
- J. Post-Installed Concrete 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 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-Type Anchor Bolts: 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 MOTION

- A. Provide flexible connections in piping systems where they cross structural joints and other point where differential movement may occur. Provide adequate flexibility to accommodate differential movement as determined in accordance with ASCE/SEI 7. Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties" for piping flexible connections.

### 3.4 ADJUSTING

- A. Adjust isolators after 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.

### 3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections with the assistance of a factory-authorized service representative.
- C. Tests and Inspections:
  - 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
  - 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
  - 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
  - 4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
  - 5. Test to 90 percent of rated proof load of device.
  - 6. Measure isolator restraint clearance.
  - 7. Measure isolator deflection.
  - 8. Verify snubber minimum clearances.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

END OF SECTION 230548.13

## SECTION 230553 - 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. Valve labels.
  5. Duct labels.

#### 1.2 ACTION SUBMITTALS

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

### PART 2 - PRODUCTS

#### 2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Brady Corporation.
    - b. Brimar Industries, Inc
    - c. Carlton Industries, LP.
    - d. Champion America.
    - e. Craftmark Pipe Markers.
    - f. emedco.
    - g. Kolbi Pipe Marker Co.
    - h. LEM Products Inc.
    - i. Marking Services, Inc.
    - j. Seton Identification Products.
  2. Material and Thickness: aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
  3. Letter Color: White.
  4. Background Color: Black.
  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-quarters 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.

B. Plastic Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Brady Corporation.
  - b. Brimar Industries, Inc
  - c. Carlton Industries, LP.
  - d. Champion America.
  - e. Craftmark Pipe Markers.
  - f. emedco.
  - g. Kolbi Pipe Marker Co.
  - h. LEM Products Inc.
  - i. Marking Services, Inc.
  - j. Seton Identification Products.
2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
3. Letter Color: White.
4. Background Color: Black.
5. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
7. 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-quarters the size of principal lettering.
8. Fasteners: Stainless-steel rivets or self-tapping screws.
9. 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), and 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) and 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Brady Corporation.
  2. Brimar Industries, Inc
  3. Carlton Industries, LP.
  4. Champion America.
  5. Craftmark Pipe Markers.
  6. emedco.
  7. LEM Products Inc.
  8. Marking Services, Inc.
  9. National Marker Company
  10. Seton Identification Products.
  11. Stranco, Inc.
- B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- C. Letter Color: Black.
- D. Background Color: Yellow.
- E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- G. 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-quarters the size of principal lettering.
- H. Fasteners: Stainless-steel rivets or self-tapping screws.
- I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- J. Label Content: Include caution and warning information plus emergency notification instructions.

### 2.3 PIPE LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Actioncraft Products, Inc.
  2. Brady Corporation.
  3. Brimar Industries, Inc
  4. Carlton Industries, LP.
  5. Champion America.
  6. Craftmark Pipe Markers.
  7. emedco.
  8. Kolbi Pipe Marker Co
  9. LEM Products Inc.

- 10. Marking Services, Inc.
  - 11. Seton Identification Products.
- B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.
  - C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
  - D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
  - E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include 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 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.

#### 2.4 DUCT LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Brady Corporation.
  - 2. Brimar Industries, Inc
  - 3. Carlton Industries, LP.
  - 4. Champion America.
  - 5. Craftmark Pipe Markers.
  - 6. emedco.
  - 7. Kolbi Pipe Marker Co
  - 8. LEM Products Inc.
  - 9. Marking Services, Inc.
  - 10. Seton Identification Products.
- B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- C. Letter Color: White.
- D. Background Color: Black.
- E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- G. 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-quarters the size of principal lettering.

- H. Fasteners: Stainless-steel rivets or self-tapping screws.
- I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- J. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings; also include duct size and an arrow indicating flow direction.
  - 1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.

### 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. Pipe Label Locations: 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 and on both sides of 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 25 feet along each run. Reduce intervals to 15 feet in areas of congested piping and equipment.
  - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- B. Pipe Label Color Schedule:

1. Chilled Water Piping: White letters on a safety-green background.
2. Heating Water Piping: Black letters on a safety-orange background.
3. Refrigerant Piping: Black letters on a safety-orange background.

#### 3.4 VALVE TAG INSTALLATION

- A. Install or permanently fasten tags on each hydronic valve.
- B. Locate valve tag where accessible and visible.

#### 3.5 DUCT LABEL INSTALLATION

- A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:
  1. Blue: For cold-air supply ducts.
  2. Yellow: For hot-air supply ducts.
  3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
- B. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

END OF SECTION 230553

## SECTION 230593 - 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 Domestic Piping Systems
    - a. Hot-water recirculation piping systems.

#### 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.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Certified TAB reports.

#### 1.4 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB entity certified by NEBB.
  - 1. TAB Field Supervisor: Employee of the TAB contractor and certified by NEBB.
  - 2. TAB Technician: Employee of the TAB contractor and who is certified by NEBB as a TAB technician.
- B. 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.
- C. TAB Report Forms: Use standard TAB contractor's forms approved by Architect, Owner.
- D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."
- E. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- F. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

## 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 ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Section 233113 "Metal Ducts" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
- F. 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.
  2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in

AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design."  
Compare results with the design data and installed conditions.

- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. 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.
- J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.
- L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N. Examine system pumps to ensure absence of entrained air in the suction piping.
- O. Examine operating safety interlocks and controls on HVAC equipment.
- P. 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 NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.
  - 1. Comply with requirements in ASHRAE 62.1, 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, patch probe holes in ducts with same material and thickness as used to construct ducts.
  - 2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," and Section 230719 "HVAC Piping 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. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. 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.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.

- L. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

### 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 outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
    - b. Measure static pressure directly at the fan outlet or through the flexible connection.
    - c. 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.
    - d. 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. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
  - 5. 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.
  - 6. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
  - 7. 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.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
  - 1. Measure airflow of submain and branch ducts.

- a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
- 2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
- 3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure air outlets and inlets without making adjustments.
  - 1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
  - 1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
  - 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

### 3.6 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.

### 3.7 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

### 3.8 TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
  - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
  - 2. Air Outlets and Inlets: Plus or minus 10 percent.
  - 3. Heating-Water Flow Rate: Plus or minus 10 percent.
  - 4. Cooling-Water Flow Rate: Plus or minus 10 percent.

### 3.9 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 biweekly 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.

### 3.10 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. Architect'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 distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
  2. Duct, outlet, and inlet sizes.
  3. Pipe and valve sizes and locations.
  4. Terminal units.
  5. Balancing stations.
  6. Position of balancing devices.

### 3.11 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 230593

## SECTION 230713 - 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 return located in unconditioned space.
  - 4. Indoor, exposed return located in unconditioned space.
  - 5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
  - 6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
  - 7. Outdoor, concealed supply and return.
  - 8. Outdoor, exposed supply and return.
- B. Related Sections:
  - 1. Section 230719 "HVAC 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.
  - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

## PART 2 - PRODUCTS

### 2.1 INSULATION MATERIALS

- A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor 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. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- 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 I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- 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. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

## 2.2 FIRE-RATED INSULATION SYSTEMS

- A. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction.

## 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. FSK and Metal 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: Aluminum.
  5. 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).
  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."
- B. ASJ Flashing Sealants, and Vinyl 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. 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/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

## 2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for ducts.

## 2.8 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.
- C. 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.
- D. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
  1. Sheet and roll stock ready for shop or field sizing.
  2. Finish and thickness are indicated in field-applied jacket schedules.

3. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
  4. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
- E. Self-Adhesive Outdoor Jacket: 60-mil-thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with white aluminum-foil facing.

## 2.9 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Width: 3 inches.
  2. Thickness: 11.5 mils.
  3. Adhesion: 90 ounces force/inch in width.
  4. Elongation: 2 percent.
  5. Tensile Strength: 40 lbf/inch in width.
  6. 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. Width: 3 inches.
  2. Thickness: 6.5 mils.
  3. Adhesion: 90 ounces force/inch in width.
  4. Elongation: 2 percent.
  5. Tensile Strength: 40 lbf/inch in width.
  6. 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. Width: 2 inches.
  2. Thickness: 6 mils.
  3. Adhesion: 64 ounces force/inch in width.

4. Elongation: 500 percent.
  5. Tensile Strength: 18 lbf/inch in width.
- D. 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.

## 2.10 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 closed seal.
- 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:
    - a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
    - b. Spindle: Aluminum, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
    - c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
  2. 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:
    - a. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
    - b. Spindle: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
    - c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
  3. 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. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
  - b. Spindle: Aluminum, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
  - c. Adhesive-backed base with a peel-off protective cover.
4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, aluminum sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
5. 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.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
- D. Wire: 0.080-inch nickel-copper alloy.

## 2.11 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or 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 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 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 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: 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.
- E. 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.

### 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.

### 3.7 FINISHES

- A. Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system.
  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. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- C. 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 ductwork, 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 one location(s) 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.

### 3.9 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 return located in unconditioned space.
  - 4. Indoor, exposed return located in unconditioned space.
  - 5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
  - 6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
  - 7. Outdoor, concealed supply and return.
  - 8. Outdoor, exposed supply and return.
- 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.

### 3.10 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Concealed, Supply-Air Duct and Plenum Insulation: Mineral-fiber blanket, 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

- B. Concealed, Return-Air Duct 25' from air handler and Plenum Insulation: Mineral-fiber blanket, 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
- C. Concealed, Outdoor-Air Duct and Plenum Insulation: Mineral-fiber blanket, 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
- D. Concealed, Exhaust-Air Duct and Plenum Insulation from backdraft damper to wall/foot line: Mineral-fiber blanket, 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
- E. Exposed, Return-Air Duct and Plenum Insulation: 1-inches thick and 0.75-lb/cu. ft. nominal density. Lined duct 15' from AHU.

### 3.11 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. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Ducts and Plenums, Concealed:
  - 1. None.
- D. Ducts and Plenums, Exposed:
  - 1. None.

### 3.12 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Ducts and Plenums, Concealed/Exposed:
  - 1. Aluminum, Smooth: 0.040 inch thick, where double wall factory insulated duct is not provided.

END OF SECTION 230713

## SECTION 230719 - HVAC PIPING INSULATION

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes insulating the following HVAC piping systems:
  - 1. Refrigerant suction and hot-gas piping, indoors and outdoors.
- B. Related Sections:
  - 1. Section 230713 "Duct Insulation."

#### 1.2 ACCEPTABLE BIDDING CONTRACTORS

- A. Thermax Insulation No Exceptions.

#### 1.3 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 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.
  - 6. Detail application of field-applied jackets.
  - 7. Detail application at linkages of control devices.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

#### 1.5 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 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 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.

## PART 2 - PRODUCTS

### 2.1 INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. 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.
- C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- E. 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Pittsburgh Corning Corp
  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-SSL: Comply with ASTM C 552, Type II, Class 2.
  7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Aeroflex USA, Inc.
    - b. Armacell LLC
    - c. K-Flex USA
- G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 1290, Type I.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. CertainTeed Corp
    - b. Johns Manville
    - c. Knauf Insulation
    - d. Manson Insulation
    - e. Owens Corning
- H. Mineral-Fiber, Preformed Pipe Insulation:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Johns Manville
    - b. Knauf Insulation
    - c. Manson Insulation
    - d. Owens Corning
  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-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  3. Type II, 1200 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- I. Mineral-Fiber, Pipe Insulation Wicking System: Preformed pipe insulation complying with ASTM C 547, Type I, Grade A, with absorbent cloth factory-applied to the entire inside surface of preformed pipe insulation and extended through the longitudinal joint to outside surface of insulation under insulation jacket. Factory apply a white, polymer, vapor-retarder jacket with self-sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Owens Corning
- J. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Armacell LLC
    - b. Nomaco Insulation
- K. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Ramco Insulation, Inc.

## 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. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Foster Brand
  - 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."
- C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Aeroflex USA, Inc.
    - b. Armacell LLC
    - c. Foster Brand
    - d. K-Flex
  - 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."
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Childers Brand
    - b. Eagle Bridges
    - c. Foster Brand
    - d. Mon-Eco Industries, Inc.
  - 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."
- E. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Childers Brand
    - b. Eagle Bridges
    - c. Foster Brand
    - d. Mon-Eco Industries, Inc.
  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."
- F. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Dow Corning Corp
    - b. Johns Manville
    - c. P.I.C. Plastics, Inc.
    - d. Speedline Corp
  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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Foster Brand
  - b. Vimasco Corp
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.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Childers Brand
    - b. Eagle Bridges
    - c. Foster Brand
    - d. Knauf Insulation
    - e. Mon-Eco Industries, Inc.
    - f. Vimasco Corp
  2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
  3. Service Temperature Range: Minus 20 to plus 180 deg F.
  4. Solids Content: 60 percent by volume and 66 percent by weight.
  5. Color: White.

## 2.4 SEALANTS

### A. Joint Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Childers Brand
  - b. Eagle Bridges
  - c. Foster Brand
  - d. Mon-Eco Industries, Inc.
  - e. Pittsburgh Corning Corp
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.
6. 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).
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."

### B. FSK and Metal Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Childers Brand
  - b. Eagle Bridges
  - c. Foster Brand
  - d. Mon-Eco Industries, Inc.
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, sealants shall 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."

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Childers Brand
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, sealants shall 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. 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. PVDC Jacket for Indoor Applications: 4-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm when tested according to ASTM E 96/E 96M and

with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) ITW Insulation Systems

6. PVDC Jacket for Outdoor Applications: 6-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) ITW Insulation Systems

7. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) ITW Insulation Systems

8. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

## 2.6 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Foster Brand
- b. Vimasco Corp

## 2.7 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.

C. 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Johns Manville
    - b. P.I.C. Plastics, Inc.
    - c. Proto Corporation
    - d. Speedline Corp
  2. Adhesive: As recommended by jacket material manufacturer.
  3. Color: White.
  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.
- D. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Childers Brand
    - b. ITW Insulation Systems
    - c. RPR Products
  2. Factory cut and rolled to size.
  3. Finish and thickness are indicated in field-applied jacket schedules.
  4. Moisture Barrier for Indoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
  5. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
  6. Factory-Fabricated Fitting Covers:
    - a. Same material, finish, and thickness as jacket.
    - b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
    - c. Tee covers.
    - d. Flange and union covers.
    - e. End caps.
    - f. Beveled collars.
    - g. Valve covers.
    - h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- E. Self-Adhesive Outdoor Jacket: 60-mil-thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with white aluminum-foil facing.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Polyguard Products Inc.
- F. PVDC Jacket for Indoor Applications: 4-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. ITW Insulation Systems
- G. PVDC Jacket for Outdoor Applications: 6-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. ITW Insulation Systems
- H. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. ITW Insulation Systems

## 2.8 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Avery Dennison Corp
    - b. Compac Corp
    - c. Ideal Tape Co Inc.
    - d. Knauf Insulation
    - e. Venture Tape
  - 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Avery Dennison Corp
    - b. Compac Corp
    - c. Ideal Tape Co Inc.
    - d. Knauf Insulation
    - e. Venture Tape
  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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Compac Corp
    - b. Ideal Tape Co Inc.
    - c. Venture Tape
  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.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Avery Dennison Corp
    - b. Compac Corp
    - c. Ideal Tape Co Inc.
    - d. Knauf Insulation
    - e. Venture Tape
  2. Width: 2 inches.
  3. Thickness: 3.7 mils.
  4. Adhesion: 100 ounces force/inch in width.
  5. Elongation: 5 percent.
  6. Tensile Strength: 34 lbf/inch in width.
- E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. ITW Insulation systems
  2. Width: 3 inches.
  3. Film Thickness: 4 mils.
  4. Adhesive Thickness: 1.5 mils.
  5. Elongation at Break: 145 percent.
  6. Tensile Strength: 55 lbf/inch in width.
- F. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. ITW Insulation Systems
  2. Width: 3 inches.
  3. Film Thickness: 6 mils.
  4. Adhesive Thickness: 1.5 mils.
  5. Elongation at Break: 145 percent.
  6. Tensile Strength: 55 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 or closed seal.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. ITW Insulation Systems
    - b. RPR Products Inc.
- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
- C. Wire: 0.062-inch soft-annealed, galvanized steel.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. C & F Wire

## 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 4 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. Manholes.
  - 5. Handholes.
  - 6. 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.
- F. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.
  2. Seal penetrations through fire-rated assemblies.

### 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. 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. 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 CELLULAR-GLASS INSULATION

#### 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. 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 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.

### 3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

#### 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.

### 3.7 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.

### 3.8 INSTALLATION OF POLYOLEFIN INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Seal split-tube 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 polyolefin 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 polyolefin 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 cut sections of polyolefin pipe and sheet 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.
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 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. 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-presize jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presize 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.

### 3.10 FINISHES

- A. Pipe Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "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.

### 3.11 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. Underground piping.
  2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

### 3.12 INDOOR PIPING INSULATION SCHEDULE

- A. Refrigerant Suction and Hot-Gas Piping: Flexible elastomeric, 1 inch thick.
- B. Refrigerant Suction and Hot-Gas Flexible Tubing: Flexible elastomeric, 1 inch thick.
- C. Heating-Hot-Water Supply and Return, 200 Deg F and Below: Insulation shall be the following:
  1. Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick.

### 3.13 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Refrigerant Suction and Hot-Gas Piping: Insulation shall be the following:
  1. Flexible Elastomeric: 2 inches thick.
- B. Refrigerant Suction and Hot-Gas Flexible Tubing: Insulation shall be the following:
  1. Flexible Elastomeric: 2 inches thick.

### 3.14 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. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
  - 1. None.

END OF SECTION 230719

## SECTION 230923 - DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. DDC system for monitoring and controlling of HVAC systems.
2. Delivery of selected control devices to equipment and systems manufacturers for factory installation and to HVAC systems installers for field installation.

##### B. Related Requirements:

1. Section 230993 "Sequence of Operations for HVAC Controls" for control sequences in DDC systems.
2. This section specifies a system or part of a system being commissioned as defined in 01 9113 General Commissioning Requirements. Testing of these systems, as well as Operations & Maintenance (O&M) Manuals and Training of the Owner's personnel, is required in cooperation with the Owner, General Contractor, and the Commissioning Professional. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to 01 9113 General Commissioning Requirements for detailed commissioning requirements.

#### 1.2 DEFINITIONS

A. Algorithm: A logical procedure for solving a recurrent mathematical problem. A prescribed set of well-defined rules or processes for solving a problem in a finite number of steps.

B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.

##### C. BACnet Specific Definitions:

1. BACnet: Building Automation Control Network Protocol, ASHRAE 135. A communications protocol allowing devices to communicate data over and services over a network.
2. BACnet Interoperability Building Blocks (BIBBs): BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBs are combined to build the BACnet functional requirements for a device.
3. BACnet/IP: Defines and allows using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number.
4. BACnet Testing Laboratories (BTL): Organization responsible for testing products for compliance with ASHRAE 135, operated under direction of BACnet International.
5. PICS (Protocol Implementation Conformance Statement): Written document that identifies the particular options specified by BACnet that are implemented in a device.

- D. Binary: Two-state signal where a high signal level represents ON" or "OPEN" condition and a low signal level represents "OFF" or "CLOSED" condition. "Digital" is sometimes used interchangeably with "Binary" to indicate a two-state signal.
- E. Controller: Generic term for any standalone, microprocessor-based, digital controller residing on a network, used for local or global control. Three types of controllers are indicated: Network Controller, Programmable Application Controller, and Application-Specific Controller.
- F. Control System Integrator: An entity that assists in expansion of existing enterprise system and support of additional operator interfaces to I/O being added to existing enterprise system.
- G. COV: Changes of value.
- H. DDC System Provider: Authorized representative of, and trained by, DDC system manufacturer and responsible for execution of DDC system Work indicated.
- I. Distributed Control: Processing of system data is decentralized and control decisions are made at subsystem level. System operational programs and information are provided to remote subsystems and status is reported back. On loss of communication, subsystems shall be capable of operating in a standalone mode using the last best available data.
- J. DOCSIS: Data-OverCable Service Interface Specifications.
- K. Gateway: Bidirectional protocol translator that connects control systems that use different communication protocols.
- L. HLC: Heavy load conditions.
- M. I/O: System through which information is received and transmitted. I/O refers to analog input (AI), binary input (BI), analog output (AO) and binary output (BO). Analog signals are continuous and represent control influences such as flow, level, moisture, pressure, and temperature. Binary signals convert electronic signals to digital pulses (values) and generally represent two-position operating and alarm status. "Digital," (DI and (DO), is sometimes used interchangeably with "Binary," (BI) and (BO), respectively.
- N. LAN: Local area network.
- O. LNS: LonWorks Network Services.
- P. LON Specific Definitions:
  1. FTT-10: Echelon Transmitter-Free Topology Transceiver.
  2. LonMark: Association comprising suppliers and installers of LonTalk products. Association provides guidelines for implementing LonTalk protocol to ensure interoperability through a standard or consistent implementation.
  3. LonTalk: An open standard protocol developed by the Echelon Corporation that uses a "Neuron Chip" for communication. LonTalk is a register trademark of Echelon.
  4. LonWorks: Network technology developed by Echelon.
  5. Node: Device that communicates using CEA-709.1-C protocol and that is connected to a CEA-709.1-C network.

6. Node Address: The logical address of a node on the network, consisting of a Domain number, Subnet number, and Node number. "Node number" portion of an address is a number assigned to device during installation, is unique within a subnet, and is not a factory-set unique Node ID.
  7. Node ID: A unique 48-bit identifier assigned at factory to each CEA-709.1-C device. Sometimes called a "Neuron ID."
  8. Program ID: An identifier (number) stored in a device (usually EEPROM) that identifies node manufacturer, functionality of device (application and sequence), transceiver used, and intended device usage.
  9. Standard Configuration Property Type (SCPT): Pronounced "skip-it." A standard format type maintained by LonMark International for configuration properties.
  10. Standard Network Variable Type (SNVT): Pronounced "snivet." A standard format type maintained by LonMark used to define data information transmitted and received by individual nodes. "SNVT" is used in two ways. It is an acronym for "Standard Network Variable Type" and is often used to indicate a network variable itself (i.e., it can mean "a network variable of a standard network variable type").
  11. Subnet: Consists of a logical grouping of up to 127 nodes, where logical grouping is defined by node addressing. Each subnet is assigned a number, which is unique within a Domain. See "Node Address."
  12. TP/FT-10: Free Topology Twisted Pair network defined by CEA-709.3 and is most common media type for a CEA-709.1-C control network.
  13. TP/XF-1250: High-speed, 1.25-Mbps, twisted-pair, doubly terminated bus network defined by "LonMark Interoperability Guidelines" typically used only to connect multiple TP/FT-10 networks.
  14. User-Defined Configuration Property Type (UCPT): Pronounced "U-Keep-It." A Configuration Property format type that is defined by device manufacturer.
  15. User-Defined Network Variable Type (UNVT): Network variable format defined by device manufacturer. UNVTs create non-standard communications that other vendors' devices may not correctly interpret and may negatively impact system operation. UNVTs are not allowed.
- Q. 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.
- R. Modbus TCP/IP: An open protocol for exchange of process data.
- S. MS/TP: Master-slave/token-passing, IEE 8802-3. Datalink protocol LAN option that uses twisted-pair wire for low-speed communication.
- T. Network Controller: Digital controller, which supports a family of programmable application controllers and application-specific controllers, that communicates on peer-to-peer network for transmission of global data.
- U. Network Repeater: Device that receives data packet from one network and rebroadcasts it to another network. No routing information is added to protocol.
- V. PDA: Personal digital assistant.
- W. Peer to Peer: Networking architecture that treats all network stations as equal partners.
- X. POT: Portable operator's terminal.

- Y. RAM: Random access memory.
- Z. RF: Radio frequency.
- AA. Router: Device connecting two or more networks at network layer.
- BB. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.
- CC. UPS: Uninterruptible power supply.
- DD. USB: Universal Serial Bus.
- EE. User Datagram Protocol (UDP): This protocol assumes that the IP is used as the underlying protocol.
- FF. VAV: Variable air volume.
- GG. WLED: White light emitting diode.

### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product include the following:
  1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
  2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
  3. Product description with complete technical data, performance curves, and product specification sheets.
  4. Installation, operation and maintenance instructions including factors effecting performance.
  5. Bill of materials of indicating quantity, manufacturer, and extended model number for each unique product.
    - a. Operator workstations.
    - b. Servers.
    - c. Printers.
    - d. Gateways.
    - e. Routers.
    - f. Protocol analyzers.
    - g. DDC controllers.
    - h. Enclosures.
    - i. Electrical power devices.

- j. UPS units.
    - k. Accessories.
    - l. Instruments.
    - m. Control dampers and actuators.
    - n. Control valves and actuators.
  - 6. When manufacturer's product datasheets apply to a product series rather than a specific product model, clearly indicate and highlight only applicable information.
  - 7. Each submitted piece of product literature shall clearly cross reference specification and drawings that submittal is to cover.
- B. Refer to Section 01 9113 General Commissioning Requirements for commissioning-related submittals and submittal review processes.
- C. Software Submittal:
- 1. Cross-referenced listing of software to be loaded on each operator workstation, server, gateway, and DDC controller.
  - 2. Description and technical data of all software provided, and cross-referenced to products in which software will be installed.
  - 3. Operating system software, operator interface and programming software, color graphic software, DDC controller software, maintenance management software, and third-party software.
  - 4. Include a flow diagram and an outline of each subroutine that indicates each program variable name and units of measure.
  - 5. Listing and description of each engineering equation used with reference source.
  - 6. Listing and description of each constant used in engineering equations and a reference source to prove origin of each constant.
  - 7. Description of operator interface to alphanumeric and graphic programming.
  - 8. Description of each network communication protocol.
  - 9. Description of system database, including all data included in database, database capacity and limitations to expand database.
  - 10. Description of each application program and device drivers to be generated, including specific information on data acquisition and control strategies showing their relationship to system timing, speed, processing burden and system throughout.
  - 11. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.
- D. Shop Drawings:
- 1. Include plans, elevations, sections, and mounting details where applicable.
  - 2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Detail means of vibration isolation and show attachments to rotating equipment.
  - 4. Plan Drawings indicating the following:
    - a. Screened backgrounds of walls, structural grid lines, HVAC equipment, ductwork and piping.

- b. Room names and numbers with coordinated placement to avoid interference with control products indicated.
  - c. Each desktop operator workstation, server, gateway, router, DDC controller, control panel instrument connecting to DDC controller, and damper and valve connecting to DDC controller, if included in Project.
  - d. Exact placement of products in rooms, ducts, and piping to reflect proposed installed condition.
  - e. Network communication cable and raceway routing.
  - f. Proposed routing of wiring, cabling, conduit, and tubing, coordinated with building services for review before installation.
5. Schematic drawings for each controlled HVAC system indicating the following:
- a. I/O points labeled with point names shown. Indicate instrument range, normal operating set points, and alarm set points. Indicate fail position of each damper and valve, if included in Project.
  - b. I/O listed in table format showing point name, type of device, manufacturer, model number, and cross-reference to product data sheet number.
  - c. A graphic showing location of control I/O in proper relationship to HVAC system.
  - d. Wiring diagram with each I/O point having a unique identification and indicating labels for all wiring terminals.
  - e. Unique identification of each I/O that shall be consistently used between different drawings showing same point.
  - f. Elementary wiring diagrams of controls for HVAC equipment motor circuits including interlocks, switches, relays and interface to DDC controllers.
  - g. Narrative sequence of operation.
  - h. Graphic sequence of operation, showing all inputs and output logical blocks.
6. Control panel drawings indicating the following:
- a. Panel dimensions, materials, size, and location of field cable, raceways, and tubing connections.
  - b. Interior subpanel layout, drawn to scale and showing all internal components, cabling and wiring raceways, nameplates and allocated spare space.
  - c. Front, rear, and side elevations and nameplate legend.
  - d. Unique drawing for each panel.
7. DDC system network riser diagram indicating the following:
- a. Each device connected to network with unique identification for each.
  - b. Interconnection of each different network in DDC system.
  - c. For each network, indicate communication protocol, speed and physical means of interconnecting network devices, such as copper cable type, or fiber-optic cable type. Indicate raceway type and size for each.
  - d. Each network port for connection of an operator workstation or other type of operator interface with unique identification for each.
8. DDC system electrical power riser diagram indicating the following:
- a. Each point of connection to field power with requirements (volts/phase/hertz/ampere/connection type) listed for each.

- b. Each control power supply including, as applicable, transformers, power-line conditioners, transient voltage suppression and high filter noise units, DC power supplies, and UPS units with unique identification for each.
  - c. Each product requiring power with requirements (volts/phase/hertz/amperes/connection type) listed for each.
  - d. Power wiring type and size, race type, and size for each.
9. Monitoring and control signal diagrams indicating the following:
- a. Control signal cable and wiring between controllers and I/O.
  - b. Point-to-point schematic wiring diagrams for each product.
  - c. Control signal tubing to sensors, switches and transmitters.
  - d. Process signal tubing to sensors, switches and transmitters.
10. Color graphics indicating the following:
- a. Itemized list of color graphic displays to be provided.
  - b. For each display screen to be provided, a true color copy showing layout of pictures, graphics and data displayed.
  - c. Intended operator access between related hierarchical display screens.

E. System Description:

- 1. Full description of DDC system architecture, network configuration, operator interfaces and peripherals, servers, controller types and applications, gateways, routers and other network devices, and power supplies.
- 2. Complete listing and description of each report, log and trend for format and timing and events which initiate generation.
- 3. System and product operation under each potential failure condition including, but not limited to, the following:
  - a. Loss of power.
  - b. Loss of network communication signal.
  - c. Loss of controller signals to inputs and outpoints.
  - d. Operator workstation failure.
  - e. Gateway failure.
  - f. Network failure
  - g. Controller failure.
  - h. Instrument failure.
  - i. Control damper and valve actuator failure.
- 4. Complete bibliography of documentation and media to be delivered to Owner.
- 5. Description of testing plans and procedures.
- 6. Description of Owner training.

F. Samples:

- 1. For each exposed product, installed in finished space for approval of selection of aesthetic characteristics.

- G. Delegated-Design Submittal: For DDC system products and installation indicated as being delegated.
1. Supporting documentation showing DDC system design complies with performance requirements indicated, including calculations and other documentation necessary to prove compliance.
  2. Schedule and design calculations for control dampers and actuators.
    - a. Flow at Project design and minimum flow conditions.
    - b. Face velocity at Project design and minimum airflow conditions.
    - c. Pressure drop across damper at Project design and minimum airflow conditions.
    - d. AMCA 500-D damper installation arrangement used to calculate and schedule pressure drop, as applicable to installation.
    - e. Maximum close-off pressure.
    - f. Leakage airflow at maximum system pressure differential (fan close-off pressure).
    - g. Torque required at worst case condition for sizing actuator.
    - h. Actuator selection indicating torque provided.
    - i. Actuator signal to control damper (on, close or modulate).
    - j. Actuator position on loss of power.
    - k. Actuator position on loss of control signal.
  3. Schedule and design calculations for control valves and actuators.
    - a. Flow at Project design and minimum flow conditions.
    - b. Pressure-differential drop across valve at Project design flow condition.
    - c. Maximum system pressure-differential drop (pump close-off pressure) across valve at Project minimum flow condition.
    - d. Design and minimum control valve coefficient with corresponding valve position.
    - e. Maximum close-off pressure.
    - f. Leakage flow at maximum system pressure differential.
    - g. Torque required at worst case condition for sizing actuator.
    - h. Actuator selection indicating torque provided.
    - i. Actuator signal to control damper (on, close or modulate).
    - j. Actuator position on loss of power.
    - k. Actuator position on loss of control signal.
  4. Schedule and design calculations for selecting flow instruments.
    - a. Instrument flow range.
    - b. Project design and minimum flow conditions with corresponding accuracy, control signal to transmitter and output signal for remote control.
    - c. Extreme points of extended flow range with corresponding accuracy, control signal to transmitter and output signal for remote control.
    - d. Pressure-differential loss across instrument at Project design flow conditions.
    - e. Where flow sensors are mated with pressure transmitters, provide information for each instrument separately and as an operating pair.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plan drawings, reflected ceiling plan(s), and other details, drawn to scale and coordinated with each other, using input from installers of the items involved.
- B. Qualification Data:
  - 1. Systems Provider Qualification Data:
    - a. Resume of project manager assigned to Project.
    - b. Resumes of application engineering staff assigned to Project.
    - c. Resumes of installation and programming technicians assigned to Project.
    - d. Resumes of service technicians assigned to Project.
    - e. Brief description of past project including physical address, floor area, number of floors, building system cooling and heating capacity and building's primary function.
    - f. Description of past project DDC system, noting similarities to Project scope and complexity indicated.
    - g. Names of staff assigned to past project that will also be assigned to execute work of this Project.
    - h. Owner contact information for past project including name, phone number, and e-mail address.
    - i. Contractor contact information for past project including name, phone number, and e-mail address.
    - j. Architect and Engineer contact information for past project including name, phone number, and e-mail address.
  - 2. Manufacturer's qualification data.
  - 3. Testing agency's qualifications data.
- C. Welding certificates.
- D. Product Certificates:
  - 1. Data Communications Protocol Certificates: Certifying that each proposed DDC system component complies with ASHRAE 135.
  - 2. Data Communications Protocol Certificates: Certifying that each proposed DDC system component complies with LonWorks.
- E. Product Test Reports: For each product that requires testing to be performed by manufacturer.
- F. Preconstruction Test Reports: For each separate test performed.
- G. Source quality-control reports.
- H. Field quality-control reports.
- I. Sample Warranty: For manufacturer's warranty.

## 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For DDC system to include in emergency, operation and maintenance manuals.
  - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
    - a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format.
    - b. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
    - c. As-built versions of submittal Product Data.
    - d. Names, addresses, e-mail addresses and 24-hour telephone numbers of Installer and service representatives for DDC system and products.
    - e. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control and changing set points and variables.
    - f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
    - g. Engineering, installation, and maintenance manuals that explain how to:
      - 1) Design and install new points, panels, and other hardware.
      - 2) Perform preventive maintenance and calibration.
      - 3) Debug hardware problems.
      - 4) Repair or replace hardware.
    - h. Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
    - i. Backup copy of graphic files, programs, and database on electronic media such as DVDs.
    - j. List of recommended spare parts with part numbers and suppliers.
    - k. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
    - l. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
    - m. Licenses, guarantees, and warranty documents.
    - n. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
    - o. Owner training materials.

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials and parts that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

- B. Include product manufacturers' recommended parts lists for proper product operation over four-year period following warranty period. Parts list shall be indicated for each year.
- C. Furnish parts, as indicated by manufacturer's recommended parts list, for product operation during one-year period following warranty period.
- D. Furnish quantity indicated of matching product(s) in Project inventory for each unique size and type of following:
  - 1. Network Controller: One.
  - 2. Programmable Application Controller: One.
  - 3. Application-Specific Controller: One.
  - 4. Room Carbon Dioxide Sensor and Transmitter: One.
  - 5. Room Pressure Sensor and Transmitter: One.
  - 6. Room Temperature Sensor and Transmitter: One.
  - 7. General-Purpose Relay: One.
  - 8. Multifunction Time-Delay Relay: One.
  - 9. Latching Relay: One.
  - 10. Current-Sensing Relay: One.
  - 11. Combination On-Off Status Sensor and On-Off Relay: One.
  - 12. Transformer: One.
  - 13. DC Power Supply: One.
  - 14. Supply of 20 percent spare fiber-optic cable splice organizer cabinets for several re-terminations.

## 1.8 QUALITY ASSURANCE

- A. DDC System Manufacturer Qualifications:
  - 1. Nationally recognized manufacturer of DDC systems and products.
  - 2. DDC systems with similar requirements to those indicated for a continuous period of five years within time of bid.
  - 3. DDC systems and products that have been successfully tested and in use on at least five past projects.
  - 4. Having complete published catalog literature, installation, operation and maintenance manuals for all products intended for use.
  - 5. Having full-time in-house employees for the following:
    - a. Product research and development.
    - b. Product and application engineering.
    - c. Product manufacturing, testing and quality control.
    - d. Technical support for DDC system installation training, commissioning and troubleshooting of installations.
    - e. Owner operator training.
- B. DDC System Provider Qualifications:
  - 1. Authorized representative of, and trained by, DDC system manufacturer.
  - 2. In-place facility located within 250 miles of Project.

3. Demonstrated past experience with installation of DDC system products being installed for period within five consecutive years before time of bid.
4. Demonstrated past experience on five projects of similar complexity, scope and value.
5. Each person assigned to Project shall have demonstrated past experience.
6. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
7. Service and maintenance staff assigned to support Project during warranty period.
8. Product parts inventory to support on-going DDC system operation for a period of not less than 5 years after Substantial Completion.
9. DDC system manufacturer's backing to take over execution of Work if necessary to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's corporate officer, if requested.

C. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

D. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
4. AWS D1.4/D1.4M, "Structural Welding Code - Reinforcing Steel."

E. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

## 1.9 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on field mockups.

1. Build mockup at testing agency facility using personnel, materials, and methods of construction that will be used at Project site.
2. Notify Architect seven days in advance of dates and times of tests.

B. Preconstruction Testing: Performed by a qualified testing agency on manufacturer's standard assemblies.

## 1.10 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace products that fail in materials or workmanship within specified warranty period.

1. Failures shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner.
2. Include updates or upgrades to software and firmware if necessary to resolve deficiencies.

- a. Install updates only after receiving Owner's written authorization.
3. Warranty service shall occur during normal business hours and commence within 24 hours of Owner's warranty service request.
4. Warranty Period: Two year(s) from date of Substantial Completion.
  - a. For Gateway: Two-year parts and labor warranty for each.

## PART 2 - PRODUCTS

### 2.1 DDC SYSTEM DESCRIPTION

- A. Microprocessor-based monitoring and control including analog/digital conversion and program logic. A control loop or subsystem in which digital and analog information is received and processed by a microprocessor, and digital control signals are generated based on control algorithms and transmitted to field devices to achieve a set of predefined conditions.
  1. DDC system shall consist of a high-speed, peer-to-peer network of distributed DDC controllers, other network devices, operator interfaces, and software.
- 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.

### 2.2 WEB ACCESS

- A. DDC system shall be Web based or Web compatible.
  1. Web-Based Access to DDC System:
    - a. DDC system software shall be based on server thin-client architecture, designed around open standards of Web technology. DDC system server shall be accessed using a Web browser over DDC system network, using Owner's LAN, and remotely over Internet through Owner's LAN.
    - b. Intent of thin-client architecture is to provide operators complete access to DDC system via a Web browser. No special software other than a Web browser shall be required to access graphics, point displays, and trends; to configure trends, points, and controllers; and to edit programming.
    - c. Web access shall be password protected.
  2. Web-Compatible Access to DDC System:
    - a. Operator workstation and or server shall perform overall system supervision and configuration, graphical user interface, management report generation, and alarm annunciation.
    - b. DDC system shall support Web browser access to building data. Operator using a standard Web browser shall be able to access control graphics and change adjustable set points.
    - c. Web access shall be password protected.

## 2.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional to design DDC system to satisfy requirements indicated.
1. System Performance Objectives:
    - a. DDC system shall manage HVAC systems.
    - b. DDC system control shall operate HVAC systems to achieve optimum operating costs while using least possible energy and maintaining specified performance.
    - c. DDC system shall respond to power failures, HVAC equipment failures, and adverse and emergency conditions encountered through connected I/O points.
    - d. DDC system shall operate while unattended by an operator and through operator interaction.
    - e. DDC system shall record trends and transaction of events and produce report information such as performance, energy, occupancies, and equipment operation.
- B. Surface-Burning Characteristics: Products installed in ducts, equipment, and return-air paths shall 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. DDC System Speed:
1. Response Time of Connected I/O:
    - a. AI point values connected to DDC system shall be updated at least every five seconds for use by DDC controllers. Points used globally shall also comply with this requirement.
    - b. BI point values connected to DDC system shall be updated at least every five seconds for use by DDC controllers. Points used globally shall also comply with this requirement.
    - c. AO points connected to DDC system shall begin to respond to controller output commands within two second(s). Global commands shall also comply with this requirement.
    - d. BO point values connected to DDC system shall respond to controller output commands within two second(s). Global commands shall also comply with this requirement.
  2. Display of Connected I/O:
    - a. Analog point COV connected to DDC system shall be updated and displayed at least every 10 seconds for use by operator.
    - b. Binary point COV connected to DDC system shall be updated and displayed at least every 10 seconds for use by operator.
    - c. Alarms of analog and digital points connected to DDC system shall be displayed within 45 seconds of activation or change of state.
    - d. Graphic display refresh shall update within eight seconds.

- e. Point change of values and alarms displayed from workstation to workstation when multiple operators are viewing from multiple workstations shall not exceed graphic refresh rate indicated.
- D. Network Bandwidth: Design each network of DDC system to include at least 30 percent available spare bandwidth with DDC system operating under normal and heavy load conditions indicated. Calculate bandwidth usage, and apply a safety factor to ensure that requirement is satisfied when subjected to testing under worst case conditions.
- E. DDC System Data Storage:
  - 1. Include server(s) with disk drive data storage to archive not less than 24 consecutive months of historical data for all I/O points connected to system, including alarms, event histories, transaction logs, trends and other information indicated.
  - 2. When logged onto a server, operator shall be able to also interact with any DDC controller connected to DDC system as required for functional operation of DDC system.
  - 3. Server(s) shall be used for application configuration; for archiving, reporting and trending of data; for operator transaction archiving and reporting; for network information management; for alarm annunciation; and for operator interface tasks and controls application management.
  - 4. Server(s) shall use IT industry-standard database platforms such as Microsoft SQL Server and Microsoft Data Engine (MSDE).
- F. Future Expandability:
  - 1. DDC system size shall be expandable to an ultimate capacity of at least three times total I/O points indicated.
  - 2. Additional DDC controllers, I/O and associated wiring shall be all that is needed to achieve ultimate capacity. Initial network infrastructure shall be designed and installed to support ultimate capacity.
  - 3. Operator interfaces installed initially shall not require hardware and software additions and revisions for ultimate capacity.
- G. Input Point Displayed Accuracy: Input point displayed values shall meet following end-to-end overall system accuracy, including errors associated with meter, sensor, transmitter, lead wire or cable, and analog to digital conversion.
  - 1. Energy:
    - a. Thermal: Within 5 percent of reading.
    - b. Electric Power: Within 1 percent of reading.
    - c. Requirements indicated on Drawings for meters not supplied by utility.
  - 2. Flow:
    - a. Air: Within 5 percent of design flow rate.
    - b. Air (Terminal Units): Within 10 percent of design flow rate.
    - c. Water: Within 2 percent of design flow rate.
    - d. Steam: Within 5 percent of design flow rate.
  - 3. Gas:

- a. Carbon Dioxide: Within 50 ppm.
  - b. Carbon Monoxide: Within 5 percent of reading.
  - c. Oxygen: Within 5 percent of reading.
  - d. Refrigerant: Within 50 ppm.
4. Moisture (Relative Humidity):
- a. Air: Within 5 percent RH.
5. Level: Within 5 percent of reading.
6. Pressure:
- a. Air, Ducts and Equipment: 1 percent of instrument.
  - b. Space: Within 1 percent of instrument.
  - c. Water: Within 1 percent of instrument.
  - d. Steam: Within 1 percent of instrument.
7. Speed: Within 10 percent of reading.
8. Temperature, Dew Point:
- a. Air: Within 1 deg F.
  - b. Space: Within 1 deg F.
  - c. Outdoor: Within 3 deg F.
9. Temperature, Dry Bulb:
- a. Air: Within 1 deg F.
  - b. Space: Within 1 deg F.
  - c. Outdoor: Within 1 deg F.
  - d. Heating Hot Water: Within 1 deg F.
  - e. Temperature Difference: Within 0.25 deg F.
  - f. .
10. Temperature, Wet Bulb:
- a. Air: Within 1 deg F.
  - b. Space: Within 1 deg F.
  - c. Outdoor: Within 2 deg F.
11. Vibration: Within 5 percent of reading.
- H. Precision of I/O Reported Values: Values reported in database and displayed shall have following precision:
- 1. Current:
    - a. Milliampere: Nearest 1/100th of a milliampere.
    - b. Amperes: Nearest 1/10th of an ampere up to 100 A; nearest ampere for 100 A and more.
  - 2. Energy:

- a. Electric Power:
  - 1) Rate (Watts): Nearest 1/10th of a watt through 1000 W.
  - 2) Rate (Kilowatts): Nearest 1/10th of a kilowatt through 1000 kW; nearest kilowatt above 1000 kW.
  - 3) Usage (Kilowatt-Hours): Nearest kilowatt through 10,000 kW; nearest 10 kW between 10,000 and 100,000 kW; nearest 100 kW for above 100,000 kW.
  
- b. Thermal, Rate:
  - 1) Heating: For Btu/h, nearest Btu/h up to 1000 Btu/h; nearest 10 Btu/h between 1000 and 10,000 Btu/h; nearest 100 Btu/h for above 10,000 Btu/h. For Mbh, round to nearest Mbh up to 1000 Mbh; nearest 10 Mbh between 1000 and 10,000 Mbh; nearest 100 Mbh above 10,000 Mbh.
  - 2) Cooling: For tons, nearest ton up to 1000 tons; nearest 10 tons between 1000 and 10,000 tons; nearest 100 tons above 10,000 tons.
  
- c. Thermal, Usage:
  - 1) Heating: For Btu, nearest Btu up to 1000 Btu; nearest 10 Btu between 1000 and 10,000 Btu; nearest 100 Btu for above 10,000 Btu. For Mbtu, round to nearest Mbtu up to 1000 Mbtu; nearest 10 Mbtu between 1000 and 10,000 Mbtu; nearest 100 Mbtu above 10,000 Mbtu.
  - 2) Cooling: For ton-hours, nearest ton-hours up to 1000 tons-hours; nearest 10 ton-hours between 1000 and 10,000 ton-hours; nearest 100 tons above 10,000 tons.
  
- 3. Flow:
  - a. Air: Nearest 1/10th of a cfm through 100 cfm; nearest cfm between 100 and 1000 cfm; nearest 10 cfm between 1000 and 10,000 cfm; nearest 100 cfm above 10,000 cfm.
  - b. Water: Nearest 1/10th gpm through 100 gpm; nearest gpm between 100 and 1000 gpm; nearest 10 gpm between 1000 and 10,000 gpm; nearest 100 gpm above 10,000 gpm.
  - c. Steam: Nearest 1/10th lb/hr through 100 lbs/hr; nearest lbs/hr between 100 and 1000 lbs/hr; nearest 10 lbs/hr above 1000 lbs/hr.
  
- 4. Gas:
  - a. Carbon Dioxide (ppm): Nearest ppm.
  - b. Carbon Monoxide (ppm): Nearest ppm.
  - c. Oxygen (Percentage): Nearest 1/10th of 1 percent.
  - d. Refrigerant (ppm): Nearest ppm.
  
- 5. Moisture (Relative Humidity):
  - a. Relative Humidity (Percentage): Nearest 1 percent.

6. Level: Nearest 1/100th of an inch through 10 inches, nearest 1/10 of an inch between 10 and 100 inches, nearest inch above 100 inches.
  7. Speed:
    - a. Rotation (rpm): Nearest 1 rpm.
    - b. Velocity: Nearest 1/10th fpm through 100 fpm; nearest fpm between 100 and 1000 fpm; nearest 10 fpm above 1000 fpm.
  8. Position, Dampers and Valves (Percentage Open): Nearest 1 percent.
  9. Pressure:
    - a. Air, Ducts and Equipment: Nearest 1/10th in. w.c..
    - b. Space: Nearest 1/100th in. w.c. .
    - c. Steam: Nearest 1/10th psig through 100 psig, nearest psig above 100 psig.
    - d. Water: Nearest 1/10 psig through 100 psig, nearest psig above 100 psig.
  10. Temperature:
    - a. Air, Ducts and Equipment: Nearest 1/10th of a degree.
    - b. Outdoor: Nearest degree.
    - c. Space: Nearest 1/10th of a degree.
    - d. Chilled Water: Nearest 1/10th of a degree.
    - e. Condenser Water: Nearest 1/10th of a degree.
    - f. Heating Hot Water: Nearest degree.
    - g. Heat Recovery Runaround: Nearest 1/10th of a degree.
    - h. Steam: Nearest degree.
  11. Vibration: Nearest 1/10th in/s.
  12. Voltage: Nearest 1/10 volt up to 100 V; nearest volt above 100 V.
- I. Control Stability: Control variables indicated within the following limits:
1. Flow:
    - a. Air, Ducts and Equipment, except Terminal Units: Within 5 percent of design flow rate.
    - b. Air, Terminal Units: Within 10 percent of design flow rate.
    - c. Water: Within 2 percent of design flow rate.
  2. Gas:
    - a. Carbon Dioxide: Within 50 ppm.
    - b. Carbon Monoxide: Within 5 percent of reading.
    - c. Oxygen: Within 5 percent of reading.
  3. Moisture (Relative Humidity):
    - a. Air: Within 5 percent RH.
    - b. Space: Within 5 percent RH.
    - c. Outdoor: Within 5 percent RH.

4. Level: Within 5 percent of reading.
  5. Pressure:
    - a. Air, Ducts and Equipment: 1 percent of instrument range.
    - b. Space: Within 1 percent of instrument range.
    - c. Water: Within 1 percent of instrument range.
    - d. Steam: Within 1 percent of instrument.
  6. Temperature, Dew Point:
    - a. Air: Within 1 deg F.
    - b. Space: Within 1 deg F.
  7. Temperature, Dry Bulb:
    - a. Air: Within 2 deg F.
    - b. Space: Within 2 deg F.
    - c. Heating Hot Water: Within 1 deg F.
  8. Temperature, Wet Bulb:
    - a. Air: Within 1 deg F.
    - b. Space: Within 1 deg F.
- J. Environmental Conditions for Controllers, Gateways, and Routers:
1. Products shall operate without performance degradation under ambient environmental temperature, pressure and humidity conditions encountered for installed location.
    - a. If product alone cannot comply with requirement, install product in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated, cooled and ventilated as required by product and application.
  2. Products shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Products not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Installed location shall dictate the following NEMA 250 enclosure requirements:
    - a. Outdoors, Protected: Type 2.
    - b. Outdoors, Unprotected: Type 4.
    - c. Indoors, Heated with Filtered Ventilation: Type 1.
    - d. Indoors, Heated with Non-Filtered Ventilation: Type 2.
    - e. Indoors, Heated and Air Conditioned: .
    - f. Mechanical Equipment Rooms:
      - 1) Chiller and Boiler Rooms: Type 12.
      - 2) Air-Moving Equipment Rooms: Type 1.
    - g. Localized Areas Exposed to Washdown: Type 4.

- h. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: Type 2.
- i. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: Type 4.
- j. Hazardous Locations: Explosion-proof rating for condition.

K. Environmental Conditions for Instruments and Actuators:

- 1. Instruments and actuators shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.
  - a. If instruments and actuators alone cannot comply with requirement, install instruments and actuators in protective enclosures that are isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated and ventilated as required by instrument and application.
- 2. Instruments, actuators and accessories shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Instruments and actuators not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Installed location shall dictate the following NEMA 250 enclosure requirements:
  - a. Outdoors, Protected: Type 2.
  - b. Outdoors, Unprotected: Type 4.
  - c. Indoors, Heated with Filtered Ventilation: Type 1.
  - d. Indoors, Heated with Non-Filtered Ventilation: Type 2.
  - e. Indoors, Heated and Air-conditioned: Type 1.
  - f. Mechanical Equipment Rooms:
    - 1) Chiller and Boiler Rooms: Type 12.
    - 2) Air-Moving Equipment Rooms: Type 1.
  - g. Localized Areas Exposed to Washdown: Type 4.
  - h. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: Type 2.
  - i. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: Type 4.
  - j. Hazardous Locations: Explosion-proof rating for condition.

L. Electric Power Quality:

- 1. Power-Line Surges:
  - a. Protect DDC system products connected to ac power circuits from power-line surges to comply with requirements of IEEE C62.41.
  - b. Do not use fuses for surge protection.
  - c. Test protection in the normal mode and in the common mode, using the following two waveforms:

- 1) 10-by-1000-mic.sec. waveform with a peak voltage of 1500 V and a peak current of 60 A.
- 2) 8-by-20-mic.sec. waveform with a peak voltage of 1000 V and a peak current of 500 A.

2. Power Conditioning:

- a. Protect DDC system products connected to ac power circuits from irregularities and noise rejection. Characteristics of power-line conditioner shall be as follows:

- 1) At 85 percent load, output voltage shall not deviate by more than plus or minus 1 percent of nominal when input voltage fluctuates between minus 20 percent to plus 10 percent of nominal.
- 2) During load changes from zero to full load, output voltage shall not deviate by more than plus or minus 3 percent of nominal.
- 3) Accomplish full correction of load switching disturbances within five cycles, and 95 percent correction within two cycles of onset of disturbance.
- 4) Total harmonic distortion shall not exceed 3-1/2 percent at full load.

3. Ground Fault: Protect products from ground fault by providing suitable grounding. Products shall not fail due to ground fault condition.

M. Backup Power Source:

1. HVAC systems and equipment served by a backup power source shall have associated DDC system products that control such systems and equipment also served from a backup power source.

N. UPS:

1. DDC system products powered by UPS units shall include the following:

- a. Desktop operator workstations.
- b. Printers.
- c. Servers.
- d. Gateways.
- e. DDC controllers, except application-specific controllers.

2. DDC system instruments and actuators powered by UPS units shall include the following:

- a. Instruments associated with the following systems controlled by DDC system:

- 1) Forced air system.
- 2) Floor heating system.

- b. Dampers and actuators associated with the following systems controlled by DDC system:

- 1) Forced air system.
- 2) Floor heating system.

- c. Valves and actuators associated with the following systems controlled by DDC system:
  - 1) Forced air system.
  - 2) Floor heating system.
- O. Continuity of Operation after Electric Power Interruption:
  - 1. Equipment and associated factory-installed controls, field-installed controls, electrical equipment, and power supply connected to building normal and backup power systems shall automatically return equipment and associated controls to operating state occurring immediately before loss of normal power, without need for manual intervention by operator when power is restored either through backup power source or through normal power if restored before backup power is brought online.

## 2.4 SYSTEM ARCHITECTURE

- A. System architecture shall consist of no more than two levels of LANs.
  - 1. Level one LAN shall connect network controllers and operator workstations.
  - 2. Level one LAN shall connect programmable application controllers to other programmable application controllers, and to network controllers.
  - 3. Level two LAN shall connect application-specific controllers to programmable application controllers and network controllers.
  - 4. Level two LAN shall connect application-specific controllers to application-specific controllers.
- B. Minimum Data Transfer and Communication Speed:
  - 1. LAN Connecting Operator Workstations and Network Controllers: 10 Mbps.
  - 2. LAN Connecting Programmable Application Controllers: 1000 kbps.
  - 3. LAN Connecting Application-Specific Controllers: 115,000 bps.
- C. DDC system shall consist of dedicated LANs that are not shared with other building systems and tenant data and communication networks.
- D. System architecture shall be modular and have inherent ability to expand to not less than two times system size indicated with no impact to performance indicated.
- E. System architecture shall perform modifications without having to remove and replace existing network equipment.
- F. Number of LANs and associated communication shall be transparent to operator. All I/O points residing on any LAN shall be capable of global sharing between all system LANs.
- G. System design shall eliminate dependence on any single device for system alarm reporting and control execution. Each controller shall operate independently by performing its' own control, alarm management and historical data collection.
- H. Special Network Architecture Requirements:

1. Air-Handling Systems: For control applications of an air-handling system that consists of air-handling unit(s) and VAV terminal units, include a dedicated LAN of application-specific controllers serving VAV terminal units connected directly to controller that is controlling air-handling system air-handling unit(s). Basically, create a DDC system LAN that aligns with air-handling system being controlled.

## 2.5 DDC SYSTEM OPERATOR INTERFACES

- A. Operator Means of System Access: Operator shall be able to access entire DDC system through any of multiple means, including, but not limited to, the following:
  1. Desktop and portable operator workstation with hardwired connection through LAN port.
  2. Portable operator terminal with hardwired connection through LAN port.
  3. Portable operator workstation with wireless connection through LAN router.
  4. PDA with wireless connection through LAN router.
  5. Remote connection using outside of system personal computer or PDA through Web access.
  6. Remote connection using portable operator workstation and telephone dial-up modem.
- B. Access to system, regardless of operator means used, shall be transparent to operator.
- C. Network Ports: For hardwired connection of desktop or portable operator workstation. Network port shall be easily accessible, properly protected, clearly labeled, and installed at the following locations:
  1. Each mechanical equipment room.
  2. Each boiler room.
  3. Each chiller room or outdoor chiller yard.
  4. Each cooling tower location.
  5. Each different roof level with roof-mounted air-handling units or rooftop units.
  6. Security system command center.
  7. Fire-alarm system command center.
- D. Desktop Workstations:
  1. Connect to DDC system Level one LAN through a communications port directly on LAN or through a communications port on a DDC controller.
  2. Able to communicate with any device located on any DDC system LAN.
  3. Able to communicate, with modems, remotely with any device connected to any DDC system LAN.
  4. Communication via a modem shall not interfere with LAN activity and LAN activity shall not prevent workstation from handling incoming calls.
- E. Portable Workstations:
  1. Connect to DDC system Level one LAN through a communications port directly on LAN or through a communications port on a DDC controller.
  2. Able to communicate with any device located on any DDC system LAN.

3. Connect to DDC system Level two or Level three LAN through a communications port on an application-specific controller, or a room temperature sensor connected to an application-specific controller.
4. Connect to system through a wireless router connected to Level one LAN.
5. Portable workstation shall be able to communicate with any device connected to any system LAN regardless of point of physical connection to system.
6. Monitor, program, schedule, adjust set points, and report capabilities of I/O connected anywhere in system.
7. Have dynamic graphic displays that are identical to desktop workstations.

F. POT:

1. Connect DDC controller through a communications port local to controller.
2. Able to communicate with any DDC system controller that is directly connected or with LAN or connected to DDC system.

G. Personal Digital Assistant:

1. Connect to system through a wireless router connected to LAN.
2. Able to communicate with any DDC controller connected to DDC system.

H. Telephone Communications:

1. Through use of a standard modem, operator shall be able to communicate with any device connected to any system LAN.
2. Have auto-dial and auto-answer communications to allow desktop and portable workstations and DDC controllers to communicate with remote workstations and remote DDC controllers via telephone lines.

a. Desktop and Portable Operator Workstation Computers with Modems:

- 1) Operators shall be able to perform all control functions, report functions, and database generation and modification functions as if directly connected to system LAN.
- 2) Have routines to automatically answer calls, and either file or display information sent remotely.
- 3) Communications taking place over telephone lines shall be completely transparent to operator.
- 4) Dial-up program shall maintain a user-definable cross-reference and associated telephone numbers so it is not required to remember or manually dial telephone numbers.

b. DDC Controllers:

- 1) Not have modems unless specifically indicated for a unique controller.
- 2) Controllers with modems shall automatically place calls to report critical alarms, or to upload trend and historical information for archiving.
- 3) Analyze and prioritize alarms to minimize initiation of calls.
- 4) Buffer noncritical alarms in memory and report them as a group of alarms, or until an operator manually requests an upload.

- 5) Make provisions for handling busy signals, no-answers, and incomplete data transfers.
- 6) Call default devices when communications cannot be established with primary devices.

I. Critical Alarm Reporting:

1. Operator-selected critical alarms shall be sent by DDC system to notify operator of critical alarms that require immediate attention.
2. DDC system shall send alarm notification to multiple recipients that are assigned for each alarm.
3. DDC system shall notify recipients by any or all means, including e-mail, text message, and prerecorded phone message to mobile and landline phone numbers.

J. Simultaneous Operator Use: Capable of accommodating up to five simultaneous operators that are accessing DDC system through any one of operator interfaces indicated.

## 2.6 NETWORKS

A. Acceptable networks for connecting operator workstations and network controllers include the following:

1. ATA 878.1, ARCNET.
2. CEA-709.1-C.
3. IP.
4. IEEE 8802-3, Ethernet.

B. Acceptable networks for connecting programmable application controllers include the following:

1. ATA 878.1, ARCNET.
2. CEA-709.1-C.
3. IP.
4. IEEE 8802-3, Ethernet.

C. Acceptable networks for connecting application-specific controllers include the following:

1. ATA 878.1, ARCNET.
2. CEA-709.1-C.
3. EIA-485A.
4. IP.
5. IEEE 8802-3, Ethernet.

## 2.7 NETWORK COMMUNICATION PROTOCOL

A. Network communication protocol(s) used throughout entire DDC system shall be open to public and available to other companies for use in making future modifications to DDC system.

B. ASHRAE 135 Protocol:

1. ASHRAE 135 communication protocol shall be sole and native protocol used throughout entire DDC system.
2. DDC system shall not require use of gateways except to integrate HVAC equipment and other building systems and equipment, not required to use ASHRAE 135 communication protocol.
3. If used, gateways shall connect to DDC system using ASHRAE 135 communication protocol and Project object properties and read/write services indicated by interoperability schedule.
4. Operator workstations, controllers and other network devices shall be tested and listed by BACnet Testing Laboratories.

C. CEA-709.1-C Protocol:

1. DDC system shall be an open implementation of LonWorks technology using CEA 709.1-C communication protocol and using LonMark SNVTs as defined in LonMark SNVT list exclusively for communication throughout DDC system.
2. LNS shall be used for all network management including addressing and binding of network variables.
  - a. Final LNS database shall be submitted with Project closeout submittals.
  - b. All devices shall be online and commissioned into LNS database.
3. All devices connected to DDC system network(s) shall use CEA-709.1-C protocol and be installed so SCPT output from any node on network can be bound to any other node in the domain.

D. Industry Standard Protocols:

1. DDC system shall use any one or a combination of the following industry standard protocols for network communication while complying with other DDC system requirements indicated:
  - a. ASHRAE 135.
  - b. CEA-709.1-C.
  - c. Modbus Application Protocol Specification V1.1b.
2. Operator workstations and network controllers shall communicate through ASHRAE 135 or CEA-709.1-C protocol.
3. Portions of DDC system networks using ASHRAE 135 communication protocol shall be an open implementation of network devices complying with ASHRAE 135. Network devices shall be tested and listed by BACnet Testing Laboratories.
4. Portions of DDC system networks using CEA-709.1-C communication protocol shall be an open implementation of LonWorks technology using CEA-709.1-C communication protocol and using LonMark SNVTs as defined in LonMark SNVT list exclusively for DDC system.
5. Portions of DDC system networks using Modbus Application Protocol Specification V1.1b communication protocol shall be an open implementation of network devices and technology complying with Modbus Application Protocol Specification V1.1b.
6. Gateways shall be used to connect networks and network devices using different protocols.

## 2.8 SYSTEM SOFTWARE

### A. System Software Minimum Requirements:

1. Real-time multitasking and multiuser 64-bit operating system that allows concurrent multiple operator workstations operating and concurrent execution of multiple real-time programs and custom program development.
2. Operating system shall be capable of operating DOS and Microsoft Windows applications.
3. Database management software shall manage all data on an integrated and non-redundant basis. Additions and deletions to database shall be without detriment to existing data. Include cross linkages so no data required by a program can be deleted by an operator until that data have been deleted from respective programs.
4. Network communications software shall manage and control multiple-network communications to provide exchange of global information and execution of global programs.
5. Operator interface software shall include day-to-day operator transaction processing, alarm and report handling, operator privilege level and data segregation control, custom programming, and online data modification capability.
6. Scheduling software shall schedule centrally based time and event, temporary, and exception day programs.

### B. Operator Interface Software:

1. Minimize operator training through use of English language pronouncing and English language point identification.
2. Minimize use of a typewriter-style keyboard through use of a pointing device similar to a mouse.
3. Operator sign-off shall be a manual operation or, if no keyboard or mouse activity takes place, an automatic sign-off.
4. Automatic sign-off period shall be programmable from one to 60 minutes in one-minute increments on a per operator basis.
5. Operator sign-on and sign-off activity shall be recorded and sent to printer.
6. Security Access:
  - a. Operator access to DDC system shall be under password control.
  - b. An alphanumeric password shall be field assignable to each operator.
  - c. Operators shall be able to access DDC system by entry of proper password.
  - d. Operator password shall be same regardless of which computer or other interface means is used.
  - e. Additions or changes made to passwords shall be updated automatically.
  - f. Each operator shall be assigned an access level to restrict access to data and functions the operator is capable of performing.
  - g. Software shall have at least five access levels.
  - h. Each menu item shall be assigned an access level so that a one-for-one correspondence between operator assigned access level(s) and menu item access level(s) is required to gain access to menu item.
  - i. Display menu items to operator with those capable of access highlighted. Menu and operator access level assignments shall be online programmable and under password control.

7. Data Segregation:
  - a. Include data segregation for control of specific data routed to a workstation, to an operator or to a specific output device, such as a printer.
  - b. Include at least 32 segregation groups.
  - c. Segregation groups shall be selectable such as "fire points," "fire points on second floor," "space temperature points," "HVAC points," and so on.
  - d. Points shall be assignable to multiple segregation groups. Display and output of data to printer or monitor shall occur where there is a match of operator or peripheral segregation group assignment and point segregations.
  - e. Alarms shall be displayed and printed at each peripheral to which segregation allows, but only those operators assigned to peripheral and having proper authorization level will be allowed to acknowledge alarms.
  - f. Operators and peripherals shall be assignable to multiple segregation groups and all assignments are to be online programmable and under password control.
  
8. Operators shall be able to perform commands including, but not limited to, the following:
  - a. Start or stop selected equipment.
  - b. Adjust set points.
  - c. Add, modify, and delete time programming.
  - d. Enable and disable process execution.
  - e. Lock and unlock alarm reporting for each point.
  - f. Enable and disable totalization for each point.
  - g. Enable and disable trending for each point.
  - h. Override control loop set points.
  - i. Enter temporary override schedules.
  - j. Define holiday schedules.
  - k. Change time and date.
  - l. Enter and modify analog alarm limits.
  - m. Enter and modify analog warning limits.
  - n. View limits.
  - o. Enable and disable demand limiting.
  - p. Enable and disable duty cycle.
  - q. Display logic programming for each control sequence.
  
9. Reporting:
  - a. Generated automatically and manually.
  - b. Sent to displays, printers and disk files.
  - c. Types of Reporting:
    - 1) General listing of points.
    - 2) List points currently in alarm.
    - 3) List of off-line points.
    - 4) List points currently in override status.
    - 5) List of disabled points.
    - 6) List points currently locked out.
    - 7) List of items defined in a "Follow-Up" file.
    - 8) List weekly schedules.
    - 9) List holiday programming.

10) List of limits and deadbands.

10. Summaries: For specific points, for a logical point group, for an operator selected group(s), or for entire system without restriction due to hardware configuration.

C. Graphic Interface Software:

1. Include a full interactive graphical selection means of accessing and displaying system data to operator. Include at least five levels with the penetration path operator assignable (for example, site, building, floor, air-handling unit, and supply temperature loop). Native language descriptors assigned to menu items are to be operator defined and modifiable under password control.
2. Include a hierarchical-linked dynamic graphic operator interface for accessing and displaying system data and commanding and modifying equipment operation. Interface shall use a pointing device with pull-down or penetrating menus, color and animation to facilitate operator understanding of system.
3. Include at least 10 levels of graphic penetration with the hierarchy operator assignable.
4. Descriptors for graphics, points, alarms and such shall be modified through operator's workstation under password control.
5. Graphic displays shall be online user definable and modifiable using the hardware and software provided.
6. Data to be displayed within a graphic shall be assignable regardless of physical hardware address, communication or point type.
7. Graphics are to be online programmable and under password control.
8. Points may be assignable to multiple graphics where necessary to facilitate operator understanding of system operation.
9. Graphics shall also contain software points.
10. Penetration within a graphic hierarchy shall display each graphic name as graphics are selected to facilitate operator understanding.
11. Back-trace feature shall permit operator to move upward in the hierarchy using a pointing device. Back trace shall show all previous penetration levels. Include operator with option of showing each graphic full screen size with back trace as horizontal header or by showing a "stack" of graphics, each with a back trace.
12. Display operator accessed data on the monitor.
13. Operator shall select further penetration using pointing device to click on a site, building, floor, area, equipment, and so on. Defined and linked graphic below that selection shall then be displayed.
14. Include operator with means to directly access graphics without going through penetration path.
15. Dynamic data shall be assignable to graphics.
16. Display points (physical and software) with dynamic data provided by DDC system with appropriate text descriptors, status or value, and engineering unit.
17. Use color, rotation, or other highly visible means, to denote status and alarm states. Color shall be variable for each class of points, as chosen by operator.
18. Points shall be dynamic with operator adjustable update rates on a per point basis from one second to over a minute.
19. For operators with appropriate privilege, points shall be commanded directly from display using pointing device.
  - a. For an analog command point such as set point, current conditions and limits shall be displayed and operator can position new set point using pointing device.

- b. For a digital command point such as valve position, valve shall show its current state such as open or closed and operator could select alternative position using pointing device.
    - c. Keyboard equivalent shall be available for those operators with that preference.
  - 20. Operator shall be able to split or resize viewing screen into quadrants to show one graphic on one quadrant of screen and other graphics or spreadsheet, bar chart, word processing, curve plot and other information on other quadrants on screen. This feature shall allow real-time monitoring of one part of system while displaying other parts of system or data to better facilitate overall system operation.
  - 21. Help Features:
    - a. On-line context-sensitive help utility to facilitate operator training and understanding.
    - b. Bridge to further explanation of selected keywords. Document shall contain text and graphics to clarify system operation.
      - 1) If help feature does not have ability to bridge on keywords for more information, a complete set of user manuals shall be provided in an indexed word-processing program, which shall run concurrently with operating system software.
    - c. Available for Every Menu Item:
      - 1) Index items for each system menu item.
  - 22. Graphic generation software shall allow operator to add, modify, or delete system graphic displays.
    - a. Include libraries of symbols depicting HVAC symbols such as fans, coils, filters, dampers, valves pumps, and electrical symbols similar to those indicated.
    - b. Graphic development package shall use a pointing device in conjunction with a drawing program to allow operator to perform the following:
      - 1) Define background screens.
      - 2) Define connecting lines and curves.
      - 3) Locate, orient and size descriptive text.
      - 4) Define and display colors for all elements.
      - 5) Establish correlation between symbols or text and associated system points or other displays.
- D. Project-Specific Graphics: Graphics documentation including, but not limited to, the following:
- 1. Site plan showing each building, and additional site elements, which are being controlled or monitored by DDC system.
  - 2. Plan for each building floor, including interstitial floors, and each roof level of each building, showing the following:
    - a. Room layouts with room identification and name.
    - b. Locations and identification of all monitored and controlled HVAC equipment and other equipment being monitored and controlled by DDC system.

- c. Location and identification of each hardware point being controlled or monitored by DDC system.
3. Control schematic for each of following, including a graphic system schematic representation with point identification, set point and dynamic value indication, sequence of operation and control logic diagram.
4.
  - a. Heating hot-water system.
  - b. Air-handling system and unit.
  - c. Fan.
  - d. Pump.
  - e. VAV Boxes
  - f. Cabinet Unit Heaters
  - g. Radiant Floor Systems
5. Graphic display for each piece of equipment connected to DDC system through a data communications link. Include dynamic indication of all points associated with equipment.
6. DDC system network riser diagram that shows schematic layout for entire system including all networks and all controllers, gateways operator workstations and other network devices.

E. Customizing Software:

1. Software to modify and tailor DDC system to specific and unique requirements of equipment installed, to programs implemented and to staffing and operational practices planned.
2. Online modification of DDC system configuration, program parameters, and database using menu selection and keyboard entry of data into preformatted display templates.
3. As a minimum, include the following modification capability:
  - a. Operator assignment shall include designation of operator passwords, access levels, point segregation and auto sign-off.
  - b. Peripheral assignment capability shall include assignment of segregation groups and operators to consoles and printers, designation of backup workstations and printers, designation of workstation header points and enabling and disabling of print-out of operator changes.
  - c. System configuration and diagnostic capability shall include communications and peripheral port assignments, DDC controller assignments to network, DDC controller enable and disable, assignment of command trace to points and application programs and initiation of diagnostics.
  - d. System text addition and change capability shall include English or native language descriptors for points, segregation groups and access levels and action messages for alarms, run time and trouble condition.
  - e. Time and schedule change capability shall include time and date set, time and occupancy schedules, exception and holiday schedules and daylight savings time schedules.
  - f. Point related change capability shall include the following:
    - 1) System and point enable and disable.
    - 2) Run-time enable and disable.

- 3) Assignment of points to segregation groups, calibration tables, lockout, and run time and to a fixed I/O value.
  - 4) Assignment of alarm and warning limits.
- g. Application program change capability shall include the following:
- 1) Enable and disable of software programs.
  - 2) Programming changes.
  - 3) Assignment of comfort limits, global points, time and event initiators, time and event schedules and enable and disable time and event programs.
4. Software shall allow operator to add points, or groups of points, to DDC system and to link them to energy optimization and management programs. Additions and modifications shall be online programmable using operator workstation, downloaded to other network devices and entered into their databases. After verification of point additions and associated program operation, database shall be uploaded and recorded on hard drive and disk for archived record.
  5. Include high-level language programming software capability for implementation of custom DDC programs. Software shall include a compiler, linker, and up- and down-load capability.
  6. Include a library of DDC algorithms, intrinsic control operators, arithmetic, logic and relational operators for implementation of control sequences. Also include, as a minimum, the following:
    - a. Proportional control (P).
    - b. Proportional plus integral (PI).
    - c. Proportional plus integral plus derivative (PID).
    - d. Adaptive and intelligent self-learning control.
      - 1) Algorithm shall monitor loop response to output corrections and adjust loop response characteristics according to time constant changes imposed.
      - 2) Algorithm shall operate in a continuous self-learning manner and shall retain in memory a stored record of system dynamics so that on system shut down and restart, learning process starts from where it left off.
  7. Fully implemented intrinsic control operators including sequence, reversing, ratio, time delay, time of day, highest select AO, lowest select AO, analog controlled digital output, analog control AO, and digitally controlled AO.
  8. Logic operators such as "And," "Or," "Not," and others that are part of a standard set available with a high-level language.
  9. Arithmetic operators such as "Add," "Subtract," "Multiply," "Divide," and others that are part of a standard set available with a high-level language.
  10. Relational operators such as "Equal To," "Not Equal To," "Less Than," "Greater Than," and others that are part of a standard set available with a high-level language.

F. Alarm Handling Software:

1. Include alarm handling software to report all alarm conditions monitored and transmitted through DDC controllers, gateways and other network devices.

2. Include first in, first out handling of alarms according to alarm priority ranking, with most critical alarms first, and with buffer storage in case of simultaneous and multiple alarms.
3. Alarm handling shall be active at all times to ensure that alarms are processed even if an operator is not currently signed on to DDC system.
4. Alarms display shall include the following:
  - a. Indication of alarm condition such as "Abnormal Off," "Hi Alarm," and "Low Alarm."
  - b. "Analog Value" or "Status" group and point identification with native language point descriptor such as "Space Temperature, Building 110, 2nd Floor, Room 212."
  - c. Discrete per point alarm action message, such as "Call Maintenance Dept. Ext-5561."
  - d. Include extended message capability to allow assignment and printing of extended action messages. Capability shall be operator programmable and assignable on a per point basis.
5. Alarms shall be directed to appropriate operator workstations, printers, and individual operators by privilege level and segregation assignments.
6. Send e-mail alarm messages to designated operators.
7. Send e-mail, page, text and voice messages to designated operators for critical alarms.
8. Alarms shall be categorized and processed by class.
  - a. Class 1:
    - 1) Associated with fire, security and other extremely critical equipment monitoring functions; have alarm, trouble, return to normal, and acknowledge conditions printed and displayed.
    - 2) Unacknowledged alarms to be placed in unacknowledged alarm buffer.
    - 3) All conditions shall cause an audible sound and shall require individual acknowledgment to silence audible sound.
  - b. Class 2:
    - 1) Critical, but not life-safety related, and processed same as Class 1 alarms, except do not require individual acknowledgment.
    - 2) Acknowledgement may be through a multiple alarm acknowledgment.
  - c. Class 3:
    - 1) General alarms; printed, displayed and placed in unacknowledged alarm buffer queues.
    - 2) Each new alarm received shall cause an audible sound. Audible sound shall be silenced by "acknowledging" alarm or by pressing a "silence" key.
    - 3) Acknowledgement of queued alarms shall be either on an individual basis or through a multiple alarm acknowledgment.
    - 4) Alarms returning to normal condition shall be printed and not cause an audible sound or require acknowledgment.
  - d. Class 4:

- 1) Routine maintenance or other types of warning alarms.
  - 2) Alarms to be printed only, with no display, no audible sound and no acknowledgment required.
9. Include an unacknowledged alarm indicator on display to alert operator that there are unacknowledged alarms in system. Operator shall be able to acknowledge alarms on an individual basis or through a multiple alarm acknowledge key, depending on alarm class.
  10. To ensure that no alarm records are lost, it shall be possible to assign a backup printer to accept alarms in case of failure of primary printer.
- G. Reports and Logs:
1. Include reporting software package that allows operator to select, modify, or create reports using DDC system I/O point data available.
  2. Each report shall be definable as to data content, format, interval and date.
  3. Report data shall be sampled and stored on DDC controller, within storage limits of DDC controller, and then uploaded to archive on workstation server for historical reporting.
  4. Operator shall be able to obtain real-time logs of all I/O points by type or status, such as alarm, point lockout, or normal.
  5. Reports and logs shall be stored on workstation and server hard drives in a format that is readily accessible by other standard software applications, including spreadsheets and word processing.
  6. Reports and logs shall be readily printed and set to be printed either on operator command or at a specific time each day.
- H. Standard Reports: Standard DDC system reports shall be provided and operator shall be able to customize reports later.
1. All I/O: With current status and values.
  2. Alarm: All current alarms, except those in alarm lockout.
  3. Disabled I/O: All I/O points that are disabled.
  4. Alarm Lockout I/O: All I/O points in alarm lockout, whether manual or automatic.
  5. Alarm Lockout I/O in Alarm: All I/O in alarm lockout that are currently in alarm.
  6. Logs:
    - a. Alarm history.
    - b. System messages.
    - c. System events.
    - d. Trends.
- I. Custom Reports: Operator shall be able to easily define any system data into a daily, weekly, monthly, or annual report. Reports shall be time and date stamped and shall contain a report title.
- J. Standard Trends:
1. Trend all I/O point present values, set points, and other parameters indicated for trending.
  2. Trends shall be associated into groups, and a trend report shall be set up for each group.
  3. Trends shall be stored within DDC controller and uploaded to hard drives automatically on reaching 75 of DDC controller buffer limit, or by operator request, or by archiving time schedule.

4. Preset trend intervals for each I/O point after review with Owner.
  5. Trend intervals shall be operator selectable from 10 seconds up to 60 minutes. Minimum number of consecutive trend values stored at one time shall be 100 per variable.
  6. When drive storage memory is full, most recent data shall overwrite oldest data.
  7. Archived and real-time trend data shall be available for viewing numerically and graphically by operators.
- K. Custom Trends: Operator shall be able to define a custom trend log for any I/O point in DDC system.
1. Each trend shall include interval, start time, and stop time.
  2. Data shall be sampled and stored on DDC controller, within storage limits of DDC controller, and then uploaded to archive on workstation server hard drives.
  3. Data shall be retrievable for use in spreadsheets and standard database programs.
- L. Programming Software:
1. Include programming software to execute sequences of operation indicated.
  2. Include programming routines in simple and easy to follow logic with detailed text comments describing what the logic does and how it corresponds to sequence of operation.
  3. Programming software shall be any of the following:
    - a. Graphic Based: Programming shall use a library of function blocks made from preprogrammed code designed for DDC control systems.
      - 1) Function blocks shall be assembled with interconnection lines that represent to control sequence in a flowchart.
      - 2) Programming tools shall be viewable in real time to show present values and logical results of each function block.
    - b. Menu Based: Programming shall be done by entering parameters, definitions, conditions, requirements and constraints.
    - c. Line by Line and Text Based: Programming shall declare variable types such as local, global, real, integer, and so on, at the beginning of the program. Use descriptive comments frequently to describe programming code.
  4. Include means for detecting programming errors and testing software control strategies with a simulation tool before implementing in actual control. Simulation tool may be inherent with programming software or as a separate product.
- M. Database Management Software:
1. Where a separate SQL database is used for information storage, DDC system shall include database management software that separates database monitoring and managing functions by supporting multiple separate windows.
  2. Database secure access shall be accomplished using standard SQL authentication including ability to access data for use outside of DDC system applications.
  3. Database management function shall include summarized information on trend, alarm, event, and audit for the following database management actions:

- a. Backup.
  - b. Purge.
  - c. Restore.
4. Database management software shall support the following:
- a. Statistics: Display database server information and trend, alarm, event, and audit information on database.
  - b. Maintenance: Include method of purging records from trend, alarm, event and audit databases by supporting separate screens for creating a backup before purging, selecting database, and allowing for retention of a selected number of day's data.
  - c. Backup: Include means to create a database backup file and select a storage location.
  - d. Restore: Include a restricted means of restoring a database by requiring operator to have proper security level.
5. Database management software shall include information of current database activity, including the following:
- a. Ready.
  - b. Purging record from a database.
  - c. Action failed.
  - d. Refreshing statistics.
  - e. Restoring database.
  - f. Shrinking a database.
  - g. Backing up a database.
  - h. Resetting Internet information services.
  - i. Starting network device manager.
  - j. Shutting down the network device manager.
  - k. Action successful.
6. Database management software monitoring functions shall continuously read database information once operator has logged on.
7. Include operator notification through on-screen pop-up display and e-mail message when database value has exceeded a warning or alarm limit.
8. Monitoring settings window shall have the following sections:
- a. Allow operator to set and review scan intervals and start times.
  - b. E-mail: Allow operator to create and review e-mail and phone text messages to be delivered when a warning or an alarm is generated.
  - c. Warning: Allow operator to define warning limit parameters, set reminder frequency and link e-mail message.
  - d. Alarm: Allow operator to define alarm limit parameters, set reminder frequency and link e-mail message.
  - e. Database Login: Protect system from unauthorized database manipulation by creating a read access and a write access for each of trend, alarm, event and audit databases as well as operator proper security access to restore a database.
9. Monitoring settings taskbar shall include the following informational icons:

- a. Normal: Indicates by color and size, or other easily identifiable means that all databases are within their limits.
- b. Warning: Indicates by color and size, or other easily identifiable means that one or more databases have exceeded their warning limit.
- c. Alarm: Indicates by color and size, or other easily identifiable means that one or more databases have exceeded their alarm limit.

## 2.9 OFFICE APPLICATION SOFTWARE

- A. Include current version of office application software at time of Substantial Completion.
- B. Office application software package shall include multiple separate applications and use a common platform for all applications, similar to Microsoft's "Office Professional."
  - 1. Database.
  - 2. E-mail.
  - 3. Presentation.
  - 4. Publisher.
  - 5. Spreadsheet.
  - 6. Word processing.

## 2.10 ASHRAE 135 GATEWAYS

- A. Include BACnet communication ports, whenever available as an equipment OEM standard option, for integration via a single communication cable. BACnet-controlled plant equipment includes, but is not limited to, boilers, chillers, and variable-speed drives.
- B. Include gateways to connect BACnet to legacy systems, existing non-BACnet devices, and existing non-BACnet DDC-controlled equipment, only when specifically requested and approved by Owner.
- C. Include with each gateway an interoperability schedule showing each point or event on legacy side that BACnet "client" will read, and each parameter that BACnet network will write to. Describe this interoperability of BACnet services, or BIBBs, defined in ASHRAE 135, Annex K.
- D. Gateway Minimum Requirements:
  - 1. Read and view all readable object properties on non-BACnet network to BACnet network and vice versa where applicable.
  - 2. Write to all writeable object properties on non-BACnet network from BACnet network and vice versa where applicable.
  - 3. Include single-pass (only one protocol to BACnet without intermediary protocols) translation from non-BACnet protocol to BACnet and vice versa.
  - 4. Comply with requirements of Data Sharing Read Property, Data Sharing Write Property, Device Management Dynamic Device Binding-B, and Device Management Communication Control BIBBs according to ASHRAE 135.
  - 5. Hardware, software, software licenses, and configuration tools for operator-to-gateway communications.

6. Backup programming and parameters on CD media and the ability to modify, download, backup, and restore gateway configuration.

## 2.11 CEA-709.1-C NETWORK HARDWARE

### A. Routers:

1. Network routers, including routers configured as repeaters, shall comply with requirements of CEA-709.1-C and include connection between two or more CEA-709.3 TP/FT-10 channels or between two or more CEA-709.3 TP/FT-10 channels and a TP/XF-1250 channel.
2. IP Routers:
  - a. Perform layer three routing of CEA-709.1-C packets over an IP network according to CEA-852-B.
  - b. Include appropriate connection to the IP network and connections to CEA-709.3 TP/FT-10 or TP/XF-1250 network.
  - c. Support the Dynamic Host Configuration Protocol for IP configuration and use of an CEA-852-B Configuration Server (for CEA-852-B configuration), but shall not rely on these services for configuration.
  - d. Capable of manual configuration via a console RS-232 port.

### B. Gateways:

1. Perform bidirectional protocol translation from one non-CEA-709.1-C protocol to CEA-709.1-C.
2. Incorporate a network connection to a TP/FT-10 network according to CEA-709.3 and a connection for a non-CEA-709.1-C network.

## 2.12 DDC CONTROLLERS

- A. DDC system shall consist of a combination of network controllers, programmable application controllers and application-specific controllers to satisfy performance requirements indicated.
- B. DDC controllers shall perform monitoring, control, energy optimization and other requirements indicated.
- C. DDC controllers shall use a multitasking, multiuser, real-time digital control microprocessor with a distributed network database and intelligence.
- D. Each DDC controller shall be capable of full and complete operation as a completely independent unit and as a part of a DDC system wide distributed network.
- E. Environment Requirements:
  1. Controller hardware shall be suitable for the anticipated ambient conditions.
  2. Controllers located in conditioned space shall be rated for operation at 32 to 120 deg F.
  3. Controllers located outdoors shall be rated for operation at 40 to 150 deg F.
- F. Power and Noise Immunity:

1. Controller shall operate at 90 to 110 percent of nominal voltage rating and shall perform an orderly shutdown below 80 percent of nominal voltage.
2. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios with up to 5 W of power located within 36 inches of enclosure.

G. DDC Controller Spare Processing Capacity:

1. Include spare processing memory for each controller. RAM, PROM, or EEPROM will implement requirements indicated with the following spare memory:
  - a. Network Controllers: 50 percent.
  - b. Programmable Application Controllers: Not less than 60 percent.
  - c. Application-Specific Controllers: Not less than 70 percent.
2. Memory shall support DDC controller's operating system and database and shall include the following:
  - a. Monitoring and control.
  - b. Energy management, operation and optimization applications.
  - c. Alarm management.
  - d. Historical trend data of all connected I/O points.
  - e. Maintenance applications.
  - f. Operator interfaces.
  - g. Monitoring of manual overrides.

H. DDC Controller Spare I/O Point Capacity: Include spare I/O point capacity for each controller as follows:

1. Network Controllers:
  - a. 10 percent of each AI, AO, BI, and BO point connected to controller.
  - b. Minimum Spare I/O Points per Controller:
    - 1) AIs: Two.
    - 2) AOs: Two.
    - 3) BIs: Three.
    - 4) BOs: Three.
2. Programmable Application Controllers:
  - a. 10 percent of each AI, AO, BI, and BO point connected to controller.
  - b. Minimum Spare I/O Points per Controller:
    - 1) AIs: Two.
    - 2) AOs: Two.
    - 3) BIs: Three.
    - 4) BOs: Three.
3. Application-Specific Controllers:
  - a. 10 percent of each AI, AO, BI, and BO point connected to controller.

b. Minimum Spare I/O Points per Controller:

- 1) AIs: One.
- 2) AOs: One.
- 3) BIs: One.
- 4) BOs: One.

I. Maintenance and Support: Include the following features to facilitate maintenance and support:

1. Mount microprocessor components on circuit cards for ease of removal and replacement.
2. Means to quickly and easily disconnect controller from network.
3. Means to quickly and easily access connect to field test equipment.
4. Visual indication that controller electric power is on, of communication fault or trouble, and that controller is receiving and sending signals to network.

J. General Requirements for CEA-709.1-C DDC Controllers:

1. Controllers shall be LonMark certified.
2. Distinguishable and accessible switch, button, or pin, when pressed shall broadcast its 48-bit Node ID and Program ID over network.
3. TP/FT-10 transceiver according to CEA-709.3 and connections for TP/FT-10 control network wiring.
4. TP/XF-1250 transceiver according to CEA-709.3 and connections for TP/XF-1250 control network wiring.
5. Communicate using CEA-709.1-C protocol.
6. Controllers configured into subnets, as required, to comply with performance requirements indicated.
7. Network communication through LNS network management and database standard for CEA-709.1-C network devices.
8. Locally powered, not powered through network connection.
9. Functionality required to support applications indicated, including, but not limited to, the following:
  - a. Input and outputs indicated and as required to support sequence of operation and application in which it is used. SNVTs shall have meaningful names identifying the value represented by an SNVT. Unless an SNVT of an appropriate engineering type is unavailable, all network variables shall be of an SNVT with engineering units appropriate to value the variable represents.
  - b. Configurable through SCPTs defined in LonMark SCPT List, operator-defined UCPTs, network configuration inputs (NCIs) of an SNVT type defined in LonMark SNVT List, NCIs of an operator-defined network variable type, or hardware settings on controller itself for all settings and parameters used by application in which it is used.
10. Programmable controllers shall conform to LonMark Interoperability Guidelines and have LonMark certification.

K. Input and Output Point Interface:

1. Hardwired input and output points shall connect to network, programmable application and application-specific controllers.

2. Input and output points shall be protected so shorting of point to itself, to another point, or to ground will not damage controller.
3. Input and output points shall be protected from voltage up to 24 V of any duration so that contact will not damage controller.
4. AIs:
  - a. AIs shall include monitoring of low-voltage (zero- to 10-V dc), current (4 to 20 mA) and resistance signals from thermistor and RTD sensors.
  - b. AIs shall be compatible with, and field configurable to, sensor and transmitters installed.
  - c. Controller AIs shall perform analog-to-digital (A-to-D) conversion with a minimum resolution of 8 bits or better to comply with accuracy requirements indicated.
  - d. Signal conditioning including transient rejection shall be provided for each AI.
  - e. Capable of being individually calibrated for zero and span.
  - f. Incorporate common-mode noise rejection of at least 50 dB from zero to 100 Hz for differential inputs, and normal-mode noise rejection of at least 20 dB at 60 Hz from a source impedance of 10000 ohms.
5. AOs:
  - a. Controller AOs shall perform analog-to-digital (A-to-D) conversion with a minimum resolution of 8 bits or better to comply with accuracy requirements indicated.
  - b. Output signals shall have a range of 4 to 20 mA dc as required to include proper control of output device.
  - c. Capable of being individually calibrated for zero and span.
  - d. AOs shall not exhibit a drift of greater than 0.4 percent of range per year.
6. BIs:
  - a. Controller BIs shall accept contact closures and shall ignore transients of less than 5-ms duration.
  - b. Isolation and protection against an applied steady-state voltage of up to 180-V ac peak.
  - c. BIs shall include a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against effects of contact bounce and noise.
  - d. BIs shall sense "dry contact" closure without external power (other than that provided by the controller) being applied.
  - e. Pulse accumulation input points shall comply with all requirements of BIs and accept up to 10 pulses per second for pulse accumulation. Buffer shall be provided to totalize pulses. Pulse accumulator shall accept rates of at least 20 pulses per second. The totalized value shall be reset to zero on operator's command.
7. BOs:
  - a. Controller BOs shall include relay contact closures or triac outputs for momentary and maintained operation of output devices.
    - 1) Relay contact closures shall have a minimum duration of 0.1 second. Relays shall include at least 180 V of isolation. Electromagnetic interference

suppression shall be provided on all output lines to limit transients to non-damaging levels. Minimum contact rating shall be 1 A at 24-V ac.

2) Triac outputs shall include at least 180 V of isolation. Minimum contact rating shall be 1 A at 24-V ac.

- b. BOs shall include for two-state operation or a pulsed low-voltage signal for pulse-width modulation control.
- c. BOs shall be selectable for either normally open or normally closed operation.
- d. Include tristate outputs (two coordinated BOs) for control of three-point floating-type electronic actuators without feedback.

## 2.13 NETWORK CONTROLLERS

### A. General Network Controller Requirements:

- 1. Include adequate number of controllers to achieve performance indicated.
- 2. System shall consist of one or more independent, standalone, microprocessor-based network controllers to manage global strategies indicated.
- 3. Controller shall have enough memory to support its operating system, database, and programming requirements.
- 4. Data shall be shared between networked controllers and other network devices.
- 5. Operating system of controller shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
- 6. Controllers that perform scheduling shall have a real-time clock.
- 7. Controller shall continually check status of its processor and memory circuits. If an abnormal operation is detected, controller shall assume a predetermined failure mode and generate an alarm notification.
- 8. Controllers shall be fully programmable.

### B. Communication:

- 1. Network controllers shall communicate with other devices on DDC system Level one network.
- 2. Network controller also shall perform routing if connected to a network of programmable application and application-specific controllers.

### C. Operator Interface:

- 1. Controller shall be equipped with a service communications port for connection to a portable operator's workstation.
- 2. Local Keypad and Display:
  - a. Equip controller with local keypad and digital display for interrogating and editing data.
  - b. Use of keypad and display shall require security password.

### D. Serviceability:

1. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Controller shall maintain BIOS and programming information in event of a power loss for at least 72 hours.

## 2.14 PROGRAMMABLE APPLICATION CONTROLLERS

### A. General Programmable Application Controller Requirements:

1. Include adequate number of controllers to achieve performance indicated.
2. Controller shall have enough memory to support its operating system, database, and programming requirements.
3. Data shall be shared between networked controllers and other network devices.
4. Operating system of controller shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
5. Controllers that perform scheduling shall have a real-time clock.
6. Controller shall continually check status of its processor and memory circuits. If an abnormal operation is detected, controller shall assume a predetermined failure mode and generate an alarm notification.
7. Controllers shall be fully programmable.

### B. Communication:

1. Programmable application controllers shall communicate with other devices on network.

### C. Operator Interface:

1. Controller shall be equipped with a service communications port for connection to a portable operator's workstation.
2. Local Keypad and Display:
  - a. Equip controller with local keypad and digital display for interrogating and editing data.
  - b. Use of keypad and display shall require security password.

### D. Serviceability:

1. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Controller shall maintain BIOS and programming information in event of a power loss for at least 72 hours.

## 2.15 APPLICATION-SPECIFIC CONTROLLERS

- A. Description: Microprocessor-based controllers, which through hardware or firmware design are dedicated to control a specific piece of equipment. Controllers are not fully user-programmable but are configurable and customizable for operation of equipment they are designed to control.
  - 1. Capable of standalone operation and shall continue to include control functions without being connected to network.
  - 2. Data shall be shared between networked controllers and other network devices.
- B. Communication: Application-specific controllers shall communicate with other application-specific controller and devices on network, and to programmable application and network controllers.
- C. Operator Interface: Controller shall be equipped with a service communications port for connection to a portable operator's workstation. Connection shall extend to port on space temperature sensor that is connected to controller.
- D. Serviceability:
  - 1. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
  - 2. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
  - 3. Controller shall use nonvolatile memory and maintain all BIOS and programming information in event of power loss.

## 2.16 CONTROLLER SOFTWARE

- A. General Controller Software Requirements:
  - 1. Software applications shall reside and operate in controllers. Editing of applications shall occur at operator workstations.
  - 2. I/O points shall be identified by up to 30-character point name and up to 16-character point descriptor. Same names shall be used at operator workstations.
  - 3. Control functions shall be executed within controllers using DDC algorithms.
  - 4. Controllers shall be configured to use stored default values to ensure fail-safe operation. Default values shall be used when there is a failure of a connected input instrument or loss of communication of a global point value.
- B. Security:
  - 1. Operator access shall be secured using individual security passwords and user names.
  - 2. Passwords shall restrict operator to points, applications, and system functions as assigned by system manager.
  - 3. Operator log-on and log-off attempts shall be recorded.
  - 4. System shall protect itself from unauthorized use by automatically logging off after last keystroke. The delay time shall be operator-definable.

- C. Scheduling: Include capability to schedule each point or group of points in system. Each schedule shall consist of the following:
1. Weekly Schedule:
    - a. Include separate schedules for each day of week.
    - b. Each schedule should include the capability for start, stop, optimal start, optimal stop, and night economizer.
    - c. Each schedule may consist of up to 10 events.
    - d. When a group of objects are scheduled together, include capability to adjust start and stop times for each member.
  2. Exception Schedules:
    - a. Include ability for operator to designate any day of the year as an exception schedule.
    - b. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed, it will be discarded and replaced by regular schedule for that day of week.
  3. Holiday Schedules:
    - a. Include capability for operator to define up to 99 special or holiday schedules.
    - b. Schedules may be placed on scheduling calendar and will be repeated each year.
    - c. Operator shall be able to define length of each holiday period.
- D. System Coordination:
1. Include standard application for proper coordination of equipment.
  2. Application shall include operator with a method of grouping together equipment based on function and location.
  3. Group may then be used for scheduling and other applications.
- E. Binary Alarms:
1. Each binary point shall be set to alarm based on operator-specified state.
  2. Include capability to automatically and manually disable alarming.
- F. Analog Alarms:
1. Each analog object shall have both high and low alarm limits.
  2. Alarming shall be able to be automatically and manually disabled.
- G. Alarm Reporting:
1. Operator shall be able to determine action to be taken in event of an alarm.
  2. Alarms shall be routed to appropriate operator workstations based on time and other conditions.
  3. Alarm shall be able to start programs, print, be logged in event log, generate custom messages, and display graphics.

H. Remote Communication:

1. System shall have ability to dial out in the event of an alarm.

I. Electric Power Demand Limiting:

1. Demand-limiting program shall monitor building or other operator-defined electric power consumption from signals connected to electric power meter or from a watt transducer or current transformer.
2. Demand-limiting program shall predict probable power demand such that action can be taken to prevent exceeding demand limit. When demand prediction exceeds demand limit, action will be taken to reduce loads in a predetermined manner. When demand prediction indicates demand limit will not be exceeded, action will be taken to restore loads in a predetermined manner.
3. Demand reduction shall be accomplished by the following means:
  - a. Reset air-handling unit supply temperature set points.
  - b. Reset space temperature set points.
  - c. De-energize equipment based on priority.
4. Demand-limiting parameters, frequency of calculations, time intervals, and other relevant variables shall be based on the means by which electric power service provider computes demand charges.
5. Include demand-limiting prediction and control for any individual meter monitored by system or for total of any combination of meters.
6. Include means operator to make the following changes online:
  - a. Addition and deletion of loads controlled.
  - b. Changes in demand intervals.
  - c. Changes in demand limit for meter(s).
  - d. Maximum shutoff time for equipment.
  - e. Minimum shutoff time for equipment.
  - f. Select rotational or sequential shedding and restoring.
  - g. Shed and restore priority.
7. Include the following information and reports, to be available on an hourly, daily, weekly, monthly and annual basis:
  - a. Total electric consumption.
  - b. Peak demand.
  - c. Date and time of peak demand.
  - d. Daily peak demand.

J. Maintenance Management: System shall monitor equipment status and generate maintenance messages based on operator-designated run-time, starts, and calendar date limits.

K. Sequencing: Include application software based on sequences of operation indicated to properly sequence chillers, boilers, and other applicable HVAC equipment.

L. Control Loops:

1. Support any of the following control loops, as applicable to control required:
  - a. Two-position (on/off, open/close, slow/fast) control.
  - b. Proportional control.
  - c. Proportional plus integral (PI) control.
  - d. Proportional plus integral plus derivative (PID) control.
    - 1) Include PID algorithms with direct or reverse action and anti-windup.
    - 2) Algorithm shall calculate a time-varying analog value used to position an output or stage a series of outputs.
    - 3) Controlled variable, set point, and PID gains shall be operator-selectable.
  - e. Adaptive (automatic tuning).

M. Staggered Start: Application shall prevent all controlled equipment from simultaneously restarting after a power outage. Order which equipment (or groups of equipment) is started, along with the time delay between starts, shall be operator-selectable.

N. Energy Calculations:

1. Include software to allow instantaneous power or flow rates to be accumulated and converted to energy usage data.
2. Include an algorithm that calculates a sliding-window average (rolling average). Algorithm shall be flexible to allow window intervals to be operator specified (such as 15, 30, or 60 minutes).
3. Include an algorithm that calculates a fixed-window average. A digital input signal shall define start of window period (such as signal from utility meter) to synchronize fixed-window average with that used by utility.

O. Anti-Short Cycling:

1. BO points shall be protected from short cycling.
2. Feature shall allow minimum on-time and off-time to be selected.

P. On and Off Control with Differential:

1. Include an algorithm that allows a BO to be cycled based on a controlled variable and set point.
2. Algorithm shall be direct- or reverse-acting and incorporate an adjustable differential.

Q. Run-Time Totalization:

1. Include software to totalize run-times for all BI and BO points.
2. A high run-time alarm shall be assigned, if required, by operator.

## 2.17 ENCLOSURES

A. General Enclosure Requirements:

1. House each controller and associated control accessories in a single enclosure. Enclosure shall serve as central tie-in point for control devices such as switches, transmitters, transducers, power supplies and transformers.
2. Do not house more than one controller in a single enclosure.
3. Include enclosure door with key locking mechanism. Key locks alike for all enclosures and include one pair of keys per enclosure.
4. Equip doors of enclosures housing controllers and components with analog or digital displays with windows to allow visual observation of displays without opening enclosure door.
5. Individual wall-mounted single-door enclosures shall not exceed 36 inches wide and 48 inches high.
6. Individual wall-mounted double-door enclosures shall not exceed 60 inches wide and 36 inches high.
7. Include wall-mounted enclosures with brackets suitable for mounting enclosures to wall or freestanding support stand as indicated.
8. Supply each enclosure with a complete set of as-built schematics, tubing, and wiring diagrams and product literature located in a pocket on inside of door.

B. Internal Arrangement:

1. Internal layout of enclosure shall group and protect pneumatic, electric, and electronic components associated with a controller, but not an integral part of controller.
2. Arrange layout to group similar products together.
3. Include a barrier between line-voltage and low-voltage electrical and electronic products.
4. Factory or shop install products, tubing, cabling and wiring complying with requirements and standards indicated.
5. Terminate field cable and wire using heavy-duty terminal blocks.
6. Include spare terminals, equal to not less than 10 percent of used terminals.
7. Include spade lugs for stranded cable and wire.
8. Install a maximum of two wires on each side of a terminal.
9. Include enclosure field power supply with a toggle-type switch located at entrance inside enclosure to disconnect power.
10. Include enclosure with a line-voltage nominal 20-A GFCI duplex receptacle for service and testing tools. Wire receptacle on hot side of enclosure disconnect switch and include with a 5-A circuit breaker.
11. Mount products within enclosure on removable internal panel(s).
12. Include products mounted in enclosures with engraved, laminated phenolic nameplates (black letters on a white background). The nameplates shall have at least 1/4-inch-high lettering.
13. Route tubing cable and wire located inside enclosure within a raceway with a continuous removable cover.
14. Label each end of cable, wire and tubing in enclosure following an approved identification system that extends from field I/O connection and all intermediate connections throughout length to controller connection.
15. Size enclosure internal panel to include at least 25 percent spare area on face of panel.

C. Environmental Requirements:

1. Evaluate temperature and humidity requirements of each product to be installed within each enclosure.

2. Calculate enclosure internal operating temperature considering heat dissipation of all products installed within enclosure and ambient effects (solar, conduction and wind) on enclosure.
3. Where required by application, include temperature-controlled electrical heat to maintain inside of enclosure above minimum operating temperature of product with most stringent requirement.
4. Where required by application, include temperature-controlled ventilation fans with filtered louver(s) to maintain inside of enclosure below maximum operating temperature of product with most stringent requirement.

D. Wall-Mounted, NEMA 250, Type 1:

1. Enclosure shall be NRTL listed according to UL 50 or UL 50E.
2. Construct enclosure of steel, not less than:
  - a. Enclosure size less than 24 in.: 0.053 in. or 0.067 in. thick.
  - b. Enclosure size 24 in. and larger: 0.067 in. or 0.093 in. thick.
3. Finish enclosure inside and out with polyester powder coating that is electrostatically applied and then baked to bond to substrate.
  - a. Exterior color shall be white.
  - b. Interior color shall be white.
4. Hinged door full size of front face of enclosure and supported using:
  - a. Enclosures sizes less than 36 in. tall: Multiple butt hinges.
  - b. Enclosures sizes 36 in. tall and larger: Continuous piano hinges.
5. Removable internal panel with a white polyester powder coating that is electrostatically applied and then baked to bond to substrate.
  - a. Size less than 24 in.: Solid steel, 0.053 in. thick.
  - b. Size 24 in. and larger: Solid aluminum, 0.10 in. or steel, 0.093 in. thick.
6. Internal panel mounting hardware, grounding hardware and sealing washers.
7. Grounding stud on enclosure body.
8. Thermoplastic pocket on inside of door for record Drawings and Product Data.

E. Wall Mounted NEMA 250, Types 4 and 12:

1. Enclosure shall be NRTL listed according to UL 508A.
2. Seam and joints are continuously welded and ground smooth.
3. Where recessed enclosures are indicated, include enclosures with face flange for flush mounting.
4. Externally formed body flange around perimeter of enclosure face for continuous perimeter seamless gasket door seal.
5. Single-door enclosure sizes up to 60 inches tall by 36 inches wide.
6. Double-door enclosure sizes up to 36 inches tall by 60 inches wide.
7. Construct enclosure of steel, not less than the following:

- a. Size Less Than 24 Inches: 0.053 inch or 0.067 inch thick.
  - b. Size 24 Inches and Larger: 0.067 inch thick.
8. Finish enclosure with polyester powder coating that is electrostatically applied and then baked to bond to substrate.
- a. Exterior color shall be white.
  - b. Interior color shall be white.
9. Corner-formed door, full size of enclosure face, supported using multiple concealed hinges with easily removable hinge pins.
- a. Sizes through 24 Inches Tall: Two hinges.
  - b. Sizes between 24 Inches through 48 Inches Tall: Three hinges.
  - c. Sizes Larger 48 Inches Tall: Four hinges.
10. Double-door enclosures with overlapping door design to include unobstructed full-width access.
- a. Single-door enclosures 48 inches and taller, and all double-door enclosures, with three-point (top, middle and bottom) latch system.
11. Removable internal panel with a white polyester powder coating that is electrostatically applied and then baked to bond to substrate.
- a. Size Less Than 24 Inches: Solid or perforated steel, 0.053 inch thick.
  - b. Size 24 Inches and Larger: Solid aluminum, 0.10 inch or steel, 0.093 inch thick.
12. Internal panel mounting studs with hardware, grounding hardware, and sealing washers.
13. Grounding stud on enclosure body.
14. Thermoplastic pocket on inside of door for record Drawings and Product Data.

F. Accessories:

1. Electric Heater:
- a. Aluminum housing with brushed finish.
  - b. Thermostatic control with adjustable set point from zero to 100 deg F.
  - c. Capacity: 100, 200, 400, and 800 W as required by application.
  - d. Fan draws cool air from bottom of enclosure and passes air across thermostat and heating elements before being released into enclosure cavity. Heated air is discharged through the top of heater.
2. Ventilation Fans, Filtered Intake and Exhaust Grilles:
- a. Number and size of fans, filters and grilles as required by application.
  - b. Compact cooling fans engineered for 50,000 hours of continuous operation without lubrication or service.
  - c. Fans capable of being installed on any surface and in any position within enclosure for spot cooling or air circulation.
  - d. Thermostatic control with adjustable set point from 32 to 140 deg F.

- e. Airflow Capacity at Zero Pressure:
    - 1) 4-Inch Fan: 100 cfm.
    - 2) 6-Inch Fan: 240 cfm.
    - 3) 10-Inch Fan: 560 cfm.
  - f. Maximum operating temperature of 158 deg F.
  - g. 4-inch fan thermally protected and provided with permanently lubricated ball-bearings.
  - h. 6- and 10-inch fans with ball-bearing construction and split capacitor motors thermally protected to avoid premature failure.
  - i. Dynamically balanced impellers molded from polycarbonate material.
  - j. Fan furnished with power cord and polarized plug for power connection.
  - k. Fan brackets, finger guards and mounting hardware provided with fans to complete installation.
  - l. Removable Intake and Exhaust Grilles: ABS plastic or stainless steel of size to match fan size and suitable for NEMA 250, Types 1 and 12 enclosures.
  - m. Filters for NEMA 250, Type 1 Enclosures: Washable foam or aluminum, of a size to match intake grille.
  - n. Filters for NEMA 250, Type 12 Enclosures: Disposable, of a size to match intake grille.
3. Framed Fixed Window Kit for NEMA 250, Types 4, 4X, and 12 Enclosures:
    - a. 0.25-inch-thick, scratch-resistant acrylic or polycarbonate window mounted in a metal frame matching adjacent door material.
    - b. Enclosure types, except NEMA 250 Type 1, shall have a continuous gasket material around perimeter of window and frame to provide watertight seal.
    - c. Window kit shall be factory or shop installed before shipment to Project.
  4. Frameless Fixed Window Kit for NEMA 250, Type 1 Enclosures:
    - a. 0.125-inch-thick, polycarbonate window mounted in enclosure door material.
    - b. Window attached to door with screw fasteners and continuous strip of high-strength double-sided tape around window perimeter.
    - c. Window kit shall be factory or shop installed before shipment to Project.
  5. Frame Fixed or Hinged Window Kit for NEMA 250, Types 1 and 12 Enclosures:
    - a. 0.25-inch-thick, scratch-resistant acrylic or polycarbonate window mounted in a metal frame matching adjacent door material.
    - b. Enclosure types, except NEMA 250 Type 1, shall have a continuous gasket material around perimeter of window and frame to provide watertight seal.
    - c. Window kit shall be factory or shop installed before shipment to Project.
  6. Bar handle with keyed cylinder lock set.

## 2.18 RELAYS

### A. General-Purpose Relays:

1. Relays shall be heavy duty and rated for at least 10 A at 250-V ac and 60 Hz.
2. Relays shall be either double pole double throw (DPDT) or three-pole double throw, depending on the control application.
3. Use a plug-in-style relay with an eight-pin octal plug for DPDT relays and an 11-pin octal plug for three-pole double-throw relays.
4. Construct the contacts of either silver cadmium oxide or gold.
5. Enclose the relay in a clear transparent polycarbonate dust-tight cover.
6. Relays shall have LED indication and a manual reset and push-to-test button.
7. Performance:
  - a. Mechanical Life: At least 10 million cycles.
  - b. Electrical Life: At least 100,000 cycles at rated load.
  - c. Pickup Time: 15 ms or less.
  - d. Dropout Time: 10 ms or less.
  - e. Pull-in Voltage: 85 percent of rated voltage.
  - f. Dropout Voltage: 50 percent of nominal rated voltage.
  - g. Power Consumption: 2 VA.
  - h. Ambient Operating Temperatures: Minus 40 to 115 deg F.
8. Equip relays with coil transient suppression to limit transients to non-damaging levels.
9. Plug each relay into an industry-standard, 35-mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
10. Relay socket shall have screw terminals. Mold into the socket the coincident screw terminal numbers and associated octal pin numbers.

B. Multifunction Time-Delay Relays:

1. Relays shall be continuous duty and rated for at least 10 A at 240-V ac and 60 Hz.
2. Relays shall be DPDT relay with up to eight programmable functions to provide on/off delay, interval and recycle timing functions.
3. Use a plug-in-style relay with either an 8- or 11-pin octal plug.
4. Construct the contacts of either silver cadmium oxide or gold.
5. Enclose the relay in a dust-tight cover.
6. Include knob and dial scale for setting delay time.
7. Performance:
  - a. Mechanical Life: At least 10 million cycles.
  - b. Electrical Life: At least 100,000 cycles at rated load.
  - c. Timing Ranges: Multiple ranges from 0.1 seconds to 100 minutes.
  - d. Repeatability: Within 2 percent.
  - e. Recycle Time: 45 ms.
  - f. Minimum Pulse Width Control: 50 ms.
  - g. Power Consumption: 5 VA or less at 120-V ac.
  - h. Ambient Operating Temperatures: Minus 40 to 115 deg F.
8. Equip relays with coil transient suppression to limit transients to non-damaging levels.
9. Plug each relay into an industry-standard, 35-mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
10. Relay socket shall have screw terminals. Mold into the socket the coincident screw terminal numbers and associated octal pin numbers.

C. Latching Relays:

1. Relays shall be continuous duty and rated for at least 10 A at 250-V ac and 60 Hz.
2. Relays shall be either DPDT or three-pole double throw, depending on the control application.
3. Use a plug-in-style relay with a multibladed plug.
4. Construct the contacts of either silver cadmium oxide or gold.
5. Enclose the relay in a clear transparent polycarbonate dust-tight cover.
6. Performance:
  - a. Mechanical Life: At least 10 million cycles.
  - b. Electrical Life: At least 100,000 cycles at rated load.
  - c. Pickup Time: 15 ms or less.
  - d. Dropout Time: 10 ms or less.
  - e. Pull-in Voltage: 85 percent of rated voltage.
  - f. Dropout Voltage: 50 percent of nominal rated voltage.
  - g. Power Consumption: 2 VA.
  - h. Ambient Operating Temperatures: Minus 40 to 115 deg F.
7. Equip relays with coil transient suppression to limit transients to non-damaging levels.
8. Plug each relay into an industry-standard, 35-mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
9. Relay socket shall have screw terminals. Mold into the socket the coincident screw terminal numbers and associated octal pin numbers.

D. Current Sensing Relay:

1. Monitors ac current.
2. Independent adjustable controls for pickup and dropout current.
3. Energized when supply voltage is present and current is above pickup setting.
4. De-energizes when monitored current is below dropout current.
5. Dropout current is adjustable from 50 to 95 percent of pickup current.
6. Include a current transformer, if required for application.
7. House current sensing relay and current transformer in its own enclosure. Use NEMA 250, Type 12 enclosure for indoors and NEMA 250, Type 4 for outdoors.

E. Combination On-Off Status Sensor and On-Off Relay:

1. Description:
  - a. On-off control and status indication in a single device.
  - b. LED status indication of activated relay and current trigger.
  - c. Closed-Open-Auto override switch located on the load side of the relay.
2. Performance:
  - a. Ambient Temperature: Minus 30 to 140 deg F.
  - b. Voltage Rating: Single-phase loads rated for 300-V ac. Three-phase loads rated for 600-V ac.
3. Status Indication:

- a. Current Sensor: Integral sensing for single-phase loads up to 20 A and external solid or split sensing ring for three-phase loads up to 150 A.
- b. Current Sensor Range: As required by application.
- c. Current Set Point: Fixed or adjustable as required by application.
- d. Current Sensor Output:
  - 1) Solid-state, single-pole double-throw contact rated for 30-V ac and dc and for 0.4 A.
  - 2) Solid-state, single-pole double-throw contact rated for 120-V ac and 1.0 A.
  - 3) Analog, zero- to 5- or 10-V dc.
  - 4) Analog, 4 to 20 mA, loop powered.
- 4. Relay: Single-pole double-throw, continuous-duty coil; rated for 10-million mechanical cycles.
- 5. Enclosure: NEMA 250, Type 1 enclosure.

## 2.19 ELECTRICAL POWER DEVICES

### A. Transformers:

- 1. Transformer shall be sized for the total connected load, plus an additional 25 percent of connected load.
- 2. Transformer shall be at least 40 VA.
- 3. Transformer shall have both primary and secondary fuses.

### B. DC Power Supply:

- 1. Plug-in style suitable for mating with a standard eight-pin octal socket. Include the power supply with a mating mounting socket.
- 2. Enclose circuitry in a housing.
- 3. Include both line and load regulation to ensure a stable output. To protect both the power supply and the load, power supply shall have an automatic current limiting circuit.
- 4. Performance:
  - a. Output voltage nominally 25-V dc within 5 percent.
  - b. Output current up to 100 mA.
  - c. Input voltage nominally 120-V ac, 60 Hz.
  - d. Load regulation within 0.5 percent from zero- to 100-mA load.
  - e. Line regulation within 0.5 percent at a 100-mA load for a 10 percent line change.
  - f. Stability within 0.1 percent of rated volts for 24 hours after a 20-minute warmup.

## 2.20 UNINTERRUPTABLE POWER SUPPLY (UPS) UNITS

### A. 250 through 1000 VA:

- 1. UPS units shall provide continuous, regulated output power without using their batteries during brown-out, surge, and spike conditions.
- 2. Load served shall not exceed 75 percent of UPS rated capacity, including power factor of connected loads.

- a. Larger-capacity units shall be provided for systems with larger connected loads.
  - b. UPS shall provide five minutes of battery power.
3. Performance:
- a. Input Voltage: Single phase, 120- or 230-V ac, compatible with field power source.
  - b. Load Power Factor Range (Crest Factor): 0.65 to 1.0.
  - c. Output Voltage: 101- to 132-V ac, while input voltage varies between 89 and 152-V ac.
  - d. On Battery Output Voltage: Sine wave.
  - e. Inverter overload capacity shall be minimum 150 percent for 30 seconds.
  - f. Recharge time shall be a maximum of six hours to 90 percent capacity after full discharge to cutoff.
  - g. Transfer Time: 6 ms.
  - h. Surge Voltage Withstand Capacity: IEEE C62.41, Categories A and B; 6 kV/200 and 500 A; 100-kHz ringwave.
4. UPS shall be automatic during fault or overload conditions.
5. Unit with integral line-interactive, power condition topology to eliminate all power contaminants.
6. Include front panel with power switch and visual indication of power, battery, fault and temperature.
7. Unit shall include an audible alarm of faults and front panel silence feature.
8. Unit with four NEMA WD 1, NEMA WD 6 Configuration 5-15R receptacles.
9. UPS shall include dry contacts (digital output points) for low battery condition and battery-on (primary utility power failure) and connect the points to the DDC system.
10. Batteries shall be sealed lead-acid type and be maintenance free. Battery replacement shall be front accessible by user without dropping load.
11. Include tower models installed in ventilated cabinets to the particular installation location.
- B. 1000 through 3000 VA:
- 1. UPS units shall provide continuous, regulated output power without using their batteries during brown-out, surge, and spike conditions.
  - 2. Load served shall not exceed 75 percent of UPS rated capacity, including power factor of connected loads.
    - a. Larger-capacity units, or multiple units, shall be provided for systems with larger connected loads.
    - b. UPS shall provide five minutes of battery power.
3. Performance:
- a. Input Voltage: Single phase, 120-V ac, plus 20 to minus 30 percent.
  - b. Power Factor: Minimum 0.97 at full load.
  - c. Output Voltage: Single phase, 120-V ac, within 3 percent, steady state with rated output current of 10.0 A, 30.0-A peak.
  - d. Inverter overload capacity shall be minimum 150 percent for 30 seconds.
  - e. Recharge time shall be a maximum of eight hours to 90 percent capacity.

4. UPS bypass shall be automatic during fault or overload conditions.
5. UPS shall include dry contacts (digital output points) for low battery condition and battery-on (primary utility power failure) and connect the points to the DDC system.
6. Batteries shall be sealed lead-acid type and be maintenance free.
7. Include tower models installed in ventilated cabinets or rack models installed on matching racks, as applicable to the particular installation location and space availability/configuration.

## 2.21 PIPING AND TUBING

### A. Pneumatic, and Pressure Instrument Signal Air, Tubing and Piping:

1. Products in this paragraph are intended for use with the following:
  - a. Main air and signal air to pneumatically controlled instruments, actuators and other control devices and accessories.
  - b. Signal air between pressure instruments, such as sensors, switches, transmitters, controllers, and accessories.
2. Copper Tubing:
  - a. Seamless phosphor deoxidized copper, soft annealed or drawn tempered, with chemical and physical properties according to ASTM B 75.
  - b. Performance, dimensions, weight and tolerance according to ASTM B 280.
  - c. Diameter, as required by application, not less than nominal 0.25 inch.
  - d. Wall thickness, as required by the application, but not less than 0.030 inch.
3. Copper Tubing Connectors and Fittings:
  - a. Brass, compression type.
  - b. Brass, solder-joint type.
4. Polyethylene Tubing:
  - a. Fire-resistant black virgin polyethylene according to ASTM D 1248, Type 1, Class C and Grade 5.
  - b. Tubing shall comply with stress crack test according to ASTM D 1693.
  - c. Diameter, as required by application, of not less than nominal 0.25 inch.
5. Polyethylene Tubing Connectors and Fittings:
  - a. Brass, barbered fittings.
  - b. Brass, compression type.

### B. Process Tubing:

1. Products in this paragraph are intended for signals to instruments connected to liquid and steam systems.
2. Copper Tubing:

- a. Seamless phosphor deoxidized copper, soft annealed or drawn tempered with chemical and physical properties according to ASTM B 75.
  - b. Performance, dimensions, weight and tolerance according to ASTM B 280.
  - c. Diameter, as required by application, of not less than nominal 0.25 inch.
  - d. Wall thickness, as required by application, but not less than 0.030 inch.
3. Copper Tubing Connectors and Fittings:
- a. Brass, compression type.
  - b. Brass, solder-joint type.

## 2.22 CONTROL WIRE AND CABLE

### A. Wire: Single conductor control wiring above 24 V.

- 1. Wire size shall be at least No. 16 AWG.
- 2. Conductor shall be 7/24 soft annealed copper strand with 2- to 2.5-inch lay.
- 3. Conductor insulation shall be 600 V, Type THWN or Type THHN, and 90 deg C according to UL 83.
- 4. Conductor colors shall be black (hot), white (neutral), and green (ground).
- 5. Furnish wire on spools.

### B. Single Twisted Shielded Instrumentation Cable above 24 V:

- 1. Wire size shall be a minimum No. 18 AWG.
- 2. Conductors shall be a twisted, 7/24 soft annealed copper strand with a 2- to 2.5-inch lay.
- 3. Conductor insulation shall have a Type THHN/THWN or Type TFN rating.
- 4. Shielding shall be 100 percent type, 0.35/0.5-mil aluminum/Mylar tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
- 5. Outer jacket insulation shall have a 600-V, 90-deg C rating and shall be Type TC cable.
- 6. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red and white.
- 7. Furnish wire on spools.

### C. Single Twisted Shielded Instrumentation Cable 24 V and Less:

- 1. Wire size shall be a minimum No. 18 AWG.
- 2. Conductors shall be a twisted, 7/24 soft annealed copper stranding with a 2- to 2.5-inch lay.
- 3. Conductor insulation shall have a nominal 15-mil thickness, constructed from flame-retardant PVC.
- 4. Shielding shall be 100 percent type, 1.35-mil aluminum/polymer tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
- 5. Outer jacket insulation shall have a 300-V, 105-deg C rating and shall be Type PLTC cable.
- 6. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red and white.
- 7. Furnish wire on spools.

- D. LAN and Communication Cable: Comply with DDC system manufacturer requirements for network being installed.
1. Cable shall be plenum rated.
  2. Cable shall comply with NFPA 70.
  3. Cable shall have a unique color that is different from other cables used on Project.
  4. Copper Cable for Ethernet Network:
    - a. 1000BASE-T or 1000BASE-TX.
    - b. TIA/EIA 586, Category 5e or Category 6.
    - c. Minimum No. 24 AWG solid.
    - d. Shielded Twisted Pair (STP) or Unshielded Twisted Pair (UTP).
    - e. Thermoplastic insulated conductors, enclosed in a thermoplastic outer jacket, Class CMP as plenum rated.

## 2.23 RACEWAYS FOR CONTROL WIRING, CABLING, AND TUBING

- A. Metal Conduits, Tubing, and Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Appleton
    - b. Atkore International
    - c. Current Technology Inc.
    - d. Electri-Flex Company
    - e. Plasti-Bond
    - f. Republic Conduit
    - g. Southwire Company
    - h. Western Tube and Conduit
    - i. Wheatland Tube Company
    - j. Zekelman Industries
  2. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  3. GRC: Comply with NEMA ANSI C80.1 and UL 6.
  4. ARC: Comply with NEMA ANSI C80.5 and UL 6A.
  5. IMC: Comply with NEMA ANSI C80.6 and UL 1242.
  6. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
    - a. Comply with NEMA RN 1.
    - b. Coating Thickness: 0.040 inch, minimum.
  7. EMT: Comply with NEMA ANSI C80.3 and UL 797.
  8. FMC: Comply with UL 1; zinc-coated steel or aluminum.
  9. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
  10. Fittings for Metal Conduit: Comply with NEMA ANSI FB 1 and UL 514B.

- a. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
  - b. Fittings for EMT:
    - 1) Material: Steel or die cast.
    - 2) Type: Setscrew or compression.
  - c. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
  - d. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
11. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.
- B. Metal Wireways and Auxiliary Gutters:
- 1. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
    - a. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 2. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
  - 3. Wireway Covers: Hinged type unless otherwise indicated.
  - 4. Finish: Manufacturer's standard enamel finish.
- C. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color as selected by Architect.

## 2.24 CONTROL POWER WIRING AND RACEWAYS

- A. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" electrical power conductors and cables.

## 2.25 ACCESSORIES

- A. Damper Blade Limit Switches:
  - 1. Sense positive open and/or closed position of the damper blades.
  - 2. NEMA 250, Type 13, oil-tight construction.
  - 3. Arrange for the mounting application.
  - 4. Additional waterproof enclosure when required by its environment.

5. Arrange to prevent "over-center" operation.

B. Manual Valves:

1. Needle Type:

- a. PTFE packing.
- b. Construct of brass for use with copper and polyethylene tubing and of stainless steel for use with stainless-steel tubing.
- c. Aluminum T-bar handle.
- d. Include tubing connections.

2. Ball Type:

- a. Body: Bronze ASTM B 62 or ASTM B 61.
- b. Ball: Type 316 stainless steel.
- c. Stem: Type 316 stainless steel.
- d. Seats: Reinforced PTFE.
- e. Packing Ring: Reinforced PTFE.
- f. Lever: Stainless steel with a vinyl grip.
- g. 600 WOG.
- h. Threaded end connections.

## 2.26 IDENTIFICATION

A. Instrument Air Pipe and Tubing:

1. Engraved tag shall bear the following information:

- a. Service (Example): "Instrument Air."
- b. Pressure Range (Example): 0 to 30 psig.

2. Letter size shall be a minimum of 0.25 inch high.

3. Tag shall consist of white lettering on blue background.

4. Tag shall be engraved phenolic consisting of three layers of rigid laminate. Top and bottom layers are color-coded blue with contrasting white center exposed by engraving through outer layer.

5. Include tag with a brass grommet, chain and S-hook.

B. Control Equipment, Instruments, and Control Devices:

1. Engraved tag bearing unique identification.

- a. Include instruments with unique identification identified by equipment being controlled or monitored, followed by point identification.

2. Tag shall consist of white lettering on black background.

3. Tag shall be engraved phenolic consisting of three layers of rigid laminate. Top and bottom layers are color-coded black with contrasting white center exposed by engraving through outer layer.

4. Tag shall be fastened with drive pins.
5. Instruments, control devices and actuators with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require an additional tag.

C. Valve Tags:

1. Brass tags and brass chains attached to valve.
2. Tags shall be at least 1.5 inches in diameter.
3. Include tag with unique valve identification indicating control influence such as flow, level, pressure, or temperature; followed by location of valve, and followed by three-digit sequential number. For example: TV-1.001.
4. Valves with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require an additional tag.

D. Raceway and Boxes:

1. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
2. Paint cover plates on junction boxes and conduit same color as the tape banding for conduits. After painting, label cover plate "HVAC Controls," using an engraved phenolic tag.
3. For raceways housing pneumatic tubing, add a phenolic tag labeled "HVAC Instrument Air Tubing."
4. For raceways housing air signal tubing, add a phenolic tag labeled "HVAC Air Signal Tubing."

E. Equipment Warning Labels:

1. Acrylic label with pressure-sensitive adhesive back and peel-off protective jacket.
2. Lettering size shall be at least 14-point type with white lettering on red background.
3. Warning label shall read "CAUTION-Equipment operated under remote automatic control and may start or stop at any time without warning. Switch electric power disconnecting means to OFF position before servicing."
4. Lettering shall be enclosed in a white line border. Edge of label shall extend at least 0.25 inch

## 2.27 SOURCE QUALITY CONTROL

- A. Product(s) and material(s) will be considered defective if it does not pass tests and inspections.
- B. Prepare test and inspection reports.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
  - 1. Verify compatibility with and suitability of substrates.
- B. Examine roughing-in for products to verify actual locations of connections before installation.
  - 1. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
  - 2. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.
- C. Examine walls, floors, roofs, and ceilings for suitable conditions where product will be installed.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 DDC SYSTEM INTERFACE WITH OTHER SYSTEMS AND EQUIPMENT

- A. Communication Interface to Equipment with Integral Controls:
  - 1. DDC system shall have communication interface with equipment having integral controls and having a communication interface for remote monitoring or control.
  - 2. Equipment to Be Connected:
    - a. Air-terminal units specified in Section 233600 "Air Terminal Units."
    - b. Boilers specified in Section 235216 "Condensing Boilers."
    - c. Air, handling units specified in Section 237416.13 "Packaged, Large-Capacity, Air Conditioning Units"
    - d. Generator sets specified in Section 263213 "Engine Generators."
    - e. Refrigerant monitoring.
- B. Communication Interface to Other Building Systems:
  - 1. DDC system shall have a communication interface with systems having a communication interface.
  - 2. Systems to Be Connected:
    - a. Automated water treatment systems specified in Section 232513 "Water Treatment for Closed-Loop Hydronic Systems."

### 3.3 CONTROL DEVICES FOR INSTALLATION BY INSTALLERS

- A. Deliver selected control devices, specified in indicated HVAC instrumentation and control device Sections, to identified equipment and systems manufacturers for factory installation and to identified installers for field installation.
- B. Deliver the following to duct fabricator and Installer for installation in ductwork. Include installation instructions to Installer and supervise installation for compliance with requirements.
- C. Deliver the following to plumbing and HVAC piping installers for installation in piping. Include installation instructions to Installer and supervise installation for compliance with requirements.
  - 1. DDC control valves, which are specified in Section 230923.11 "Control Valves."
  - 2. Pipe-mounted sensors, switches and transmitters.

### 3.4 CONTROL DEVICES FOR EQUIPMENT MANUFACTURER FACTORY INSTALLATION

- A. Deliver the following to air-handling unit manufacturer for factory installation. Include installation instructions to air-handling unit manufacturer.
  - 1. Programmable application or application-specific controller.
  - 2. Relays.
- B. Deliver the following to terminal unit manufacturer for factory installation. Include installation instructions to terminal unit manufacturer.
  - 1. Programmable application or application-specific controller.
  - 2. Electric damper actuator. Dampers actuators are specified in Section 230923.12 "Control Dampers."
  - 3. Unit-mounted flow and pressure sensors, transmitters and transducers. Flow sensors, transmitters, and transducers.
  - 4. Pressure sensors, switches, and transmitters.
  - 5. Unit-mounted temperature sensors.
  - 6. Relays.

### 3.5 GENERAL INSTALLATION REQUIREMENTS

- A. Install products to satisfy more stringent of all requirements indicated.
- B. Install products level, plumb, parallel, and perpendicular with building construction.
- C. Support products, tubing, piping wiring and raceways. Brace products to prevent lateral movement and sway or a break in attachment when subjected to a force.
- D. If codes and referenced standards are more stringent than requirements indicated, comply with requirements in codes and referenced standards.
- E. Fabricate openings and install sleeves in ceilings, floors, roof, and walls required by installation of products. Before proceeding with drilling, punching, and cutting, check for concealed work to avoid damage. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

- F. Firestop penetrations made in fire-rated assemblies.
- G. Seal penetrations made in acoustically rated assemblies. Comply with requirements in Section 079200 "Joint Sealants."
- H. Welding Requirements:
  - 1. Restrict welding and burning to supports and bracing.
  - 2. No equipment shall be cut or welded without approval. Welding or cutting will not be approved if there is risk of damage to adjacent Work.
  - 3. Welding, where approved, shall be by inert-gas electric arc process and shall be performed by qualified welders according to applicable welding codes.
  - 4. If requested on-site, show satisfactory evidence of welder certificates indicating ability to perform welding work intended.
- I. Fastening Hardware:
  - 1. Stillson wrenches, pliers, and other tools that damage surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening fasteners.
  - 2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
  - 3. Lubricate threads of bolts, nuts and screws with graphite and oil before assembly.
- J. If product locations are not indicated, install products in locations that are accessible and that will permit service and maintenance from floor, equipment platforms, or catwalks without removal of permanently installed furniture and equipment.
- K. Corrosive Environments:
  - 1. Avoid or limit use of materials in corrosive airstreams and environments.
  - 2. When conduit is in contact with a corrosive airstream and environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
  - 3. Where instruments are located in a corrosive airstream and are not corrosive resistant from manufacturer, field install products in NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

### 3.6 POT INSTALLATION

- A. Install one portable operator terminal(s).
- B. Turn over POTs to Owner at Substantial Completion.
- C. Install software on each POT and verify that software functions properly.

### 3.7 GATEWAY INSTALLATION

- A. Install gateways if required for DDC system communication interface requirements indicated.

1. Install gateway(s) required to suit indicated requirements.
- B. Test gateway to verify that communication interface functions properly.

### 3.8 ROUTER INSTALLATION

- A. Install routers if required for DDC system communication interface requirements indicated.
1. Install router(s) required to suit indicated requirements.
- B. Test router to verify that communication interface functions properly.

### 3.9 CONTROLLER INSTALLATION

- A. Install controllers in enclosures to comply with indicated requirements.
- B. Connect controllers to field power supply and to UPS units where indicated.
- C. Install controller with latest version of applicable software and configure to execute requirements indicated.
- D. Test and adjust controllers to verify operation of connected I/O to achieve performance indicated requirements while executing sequences of operation.
- E. Installation of Network Controllers:
1. Quantity and location of network controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
  2. Install controllers in a protected location that is easily accessible by operators.
  3. Top of controller shall be within 72 inches of finished floor.
- F. Installation of Programmable Application Controllers:
1. Quantity and location of programmable application controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
  2. Install controllers in a protected location that is easily accessible by operators.
  3. Top of controller shall be within 72 inches of finished floor.
- G. Application-Specific Controllers:
1. Quantity and location of application-specific controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
  2. For controllers not mounted directly on equipment being controlled, install controllers in a protected location that is easily accessible by operators.

### 3.10 ENCLOSURES INSTALLATION

- A. Install the following items in enclosures, to comply with indicated requirements:

1. Gateways.
2. Routers.
3. Controllers.
4. Electrical power devices.
5. UPS units.
6. Relays.
7. Accessories.
8. Instruments.
9. Actuators

B. Attach wall-mounted enclosures to wall using the following types of steel struts:

1. For NEMA 250, Type 1 Enclosures: Use painted steel strut and hardware.
2. For NEMA 250, Type 4 Enclosures and Enclosures Located Outdoors: Use stainless-steel strut and hardware.
3. Install plastic caps on exposed cut edges of strut.

C. Align top or bottom of adjacent enclosures of like size.

D. Install floor-mounted enclosures located in mechanical equipment rooms on concrete housekeeping pads. Attach enclosure legs using galvanized- or stainless-steel anchors.

E. Install continuous and fully accessible wireways to connect conduit, wire, and cable to multiple adjacent enclosures. Wireway used for application shall have protection equal to NEMA 250 rating of connected enclosures.

### 3.11 ELECTRIC POWER CONNECTIONS

A. Connect electrical power to DDC system products requiring electrical power connections.

B. Design of electrical power to products not indicated with electric power is delegated to DDC system provider and installing trade. Work shall comply with NFPA 70 and other requirements indicated.

C. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical power conductors and cables.

### 3.12 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements in Section 260553 "Identification for Electrical Systems" for identification products and installation.

B. Install engraved phenolic nameplate with unique identification on face for each of the following:

1. Operator workstation.
2. Printer.
3. Gateway.

4. Router.
  5. DDC controller.
  6. Enclosure.
  7. Electrical power device.
  8. UPS unit.
  9. Accessory.
- C. Install engraved phenolic nameplate with unique instrument identification on face of each instrument connected to a DDC controller.
- D. Install engraved phenolic nameplate with identification on face of each control damper and valve actuator connected to a DDC controller.
- E. Where product is installed above accessible tile ceiling, also install matching engraved phenolic nameplate with identification on face of ceiling grid located directly below.
- F. Where product is installed above an inaccessible ceiling, also install engraved phenolic nameplate with identification on face of access door directly below.
- G. Warning Labels:
1. Shall be permanently attached to equipment that can be automatically started by DDC control system.
  2. Shall be located in highly visible location near power service entry points.

### 3.13 NETWORK INSTALLATION

- A. Install copper cable when connecting between the following network devices located in same building:
1. Operator workstations.
  2. Operator workstations and network controllers.
  3. Network controllers.
- B. Install copper cable when connecting between the following:
1. Gateways.
  2. Gateways and network controllers or programmable application controllers.
  3. Routers.
  4. Routers and network controllers or programmable application controllers.
  5. Network controllers and programmable application controllers.
  6. Programmable application controllers.
  7. Programmable application controllers and application-specific controllers.
  8. Application-specific controllers.
- C. Install network cable in continuous raceway.
1. Where indicated on Drawings, cable trays may be used for copper cable in lieu of conduit.

### 3.14 NETWORK NAMING AND NUMBERING

A. Coordinate with Owner and provide unique naming and addressing for networks and devices.

B. ASHRAE 135 Networks:

1. MAC Address:

- a. Every network device shall have an assigned and documented MAC address unique to its network.
- b. Ethernet Networks: Document MAC address assigned at its creation.
- c. ARCNET or MS/TP networks: Assign from 00 to 64.

2. Network Numbering:

- a. Assign unique numbers to each new network.
- b. Provide ability for changing network number through device switches or operator interface.
- c. DDC system, with all possible connected LANs, can contain up to 65,534 unique networks.

3. Device Object Identifier Property Number:

- a. Assign unique device object identifier property numbers or device instances for each device network.
- b. Provide for future modification of device instance number by device switches or operator interface.
- c. LAN shall support up to 4,194,302 unique devices.

4. Device Object Name Property Text:

- a. Device object name property field shall support 32 minimum printable characters.
- b. Assign unique device "Object Name" property names with plain-English descriptive names for each device.
  - 1) Example 1: Device object name for device controlling boiler plant at Building 1000 would be "HW System B1000."
  - 2) Example 2: Device object name for a VAV terminal unit controller could be "VAV unit 102".

5. Object Name Property Text for Other Than Device Objects:

- a. Object name property field shall support 32 minimum printable characters.
- b. Assign object name properties with plain-English names descriptive of application.
  - 1) Example 1: "Zone 1 Temperature."
  - 2) Example 2 "Fan Start and Stop."

6. Object Identifier Property Number for Other Than Device Objects:

- a. Assign object identifier property numbers according to Drawings or tables indicated.

- b. If not indicated, object identifier property numbers may be assigned at Installer's discretion but must be approved by Owner in advance, be documented and be unique for like object types within device.

### 3.15 PIPING AND TUBING INSTALLATION

#### A. Above-Grade Pneumatic and Air Signal Piping and Tubing Installation:

##### 1. Material Application:

- a. Install copper tubing, except as follows:
  - 1) Tubing Exposed to View: Polyethylene tubing installed in raceways may be used in lieu of copper tubing.
  - 2) Concealed Tubing: Polyethylene tubing may be used in lieu of copper tubing when concealed behind accessible ceilings and concealed in walls and connecting wall-mounted instruments with recessed connections.
- b. Install copper tubing, unless other accessible materials are indicated, for air signals to instruments including, but not limited to, the following:
  - 1) Sensors.
  - 2) Switches.
  - 3) Transmitters.
- c. Install drawn-temper copper tubing, except within 36 inches of device terminations tubing shall be annealed-tempered copper tubing.
- d. Install compression fittings to connect copper tubing to instruments, control devices, and accessories.
- e. Install barbed or compression fittings to connect polyethylene tubing to instruments, control devices, and accessories.

##### 2. Routing:

- a. Do not expose tubing in finished spaces, such as spaces with ceilings; occupied spaces, offices, and conference rooms, unless expressly approved in writing by Architect. Tubing may be exposed in areas without ceilings.
- b. Where tubing is installed in finished occupied spaces, install the tubing in surface metal raceway with appropriate fittings only where not feasible to conceal in wall, above ceiling or behind architectural enclosures or covers.
- c. Install piping and tubing plumb and parallel to and at right angles with building construction.
- d. Install multiple runs of tubing or piping in equally spaced parallel lines.
- e. Piping and tubing shall not interfere with access to valves, equipment, duct and equipment access doors, or obstruct personnel access and passageways of any kind.
- f. Coordinate with other trades before installation to prevent proposed piping and tubing from interfering with pipe, duct, terminal equipment, light fixtures, conduit and cable tray space. If changes to Shop Drawings are necessary due to field coordination, document changes on record Drawings.

- g. Install vibration loops in copper tubing when connecting to instrument and actuators that vibrate.
3. Support:
    - a. According to MSS SP-69, Table 3, except support spacing shall not exceed 60 inches.
    - b. Support copper tubing with copper hangers, clips, and tube trays.
    - c. Do not use tape for support or dielectric isolation.
    - d. Install supports at each change in direction and at each branch take off.
    - e. Attached supports to building structure independent of work of other trades. Support from ducts, pipes, cable trays, and conduits is prohibited.
    - f. Attached support from building structure with threaded rods, structural shapes, or channel strut.
    - g. Install and brace supports to carry static load plus a safety margin, which will allow tubing to be serviced.
    - h. Brace supports to prevent lateral movement.
    - i. Paint steel support members that are not galvanized or zinc coated.
    - j. Support polyethylene tubing same as copper tubing.
  4. Do not attach piping and tubing to equipment that may be removed frequently for maintenance or that may impart vibration and expansion from temperature change.
  5. Protect exposed tubing in mechanical equipment rooms from mechanical damage within 76 inches above floor. Use aluminum channel reversed and secured over tubing to protect tubing from damage.
  6. Joining and Makeup:
    - a. Where joining and mating dissimilar metals where galvanic action could occur, install dielectric isolation.
    - b. Install a dirt leg with an isolation valve and threaded plug at each main air, connection to a panel, pneumatic pilot positioner and PRV station.
    - c. Make threaded joints for connecting to instrument equipment with connectors with a compression tubing connector on one end and threaded connection on other end.
    - d. Make tubing bends with a tube-bending tool. Hard bends, wrinkled or flattened bends are unacceptable.
    - e. Install tube fittings according to manufacturer's written instructions.
    - f. Do not make tubing connections to a fitting before completing makeup of the connection.
    - g. Align tubing with the fitting. Avoid springing tube into position, as this may result in excessive stress on both tubing and fitting with possible resulting leaks.
    - h. Do not install fittings close to a bend. A length of straight tubing, not deformed by bending, is required for a proper connection.
    - i. Check tubing for correct diameter and wall thickness.
    - j. Tube ends shall be cut square and deburred. Exercise care during cutting to keep tubing round.
    - k. Thread pipe on a threading machine. Ream inner edges of pipe ends, file and grind to remove burrs.
    - l. Wrap pipe threads of fittings on pneumatic lines with a single wrap of PTFE tape.
    - m. Protect piping and tubing from entrance of foreign matter.

7. Conduit in which nonmetallic tubing is installed shall not exceed 50 percent fill. Support conduit according to NFPA 70 unless otherwise indicated.

B. Identify piping and tubing as follows:

1. Every 50 feet of straight run.
2. At least once for each branch within 36 inches of main tee.
3. At each change in direction.
4. Within 36 inches of each ceiling, floor, roof and wall penetration.
5. Where exposed to and where concealed from view, including above ceiling plenums, shafts, and chases.
6. At each valve.
7. Mark each instrument tube connection with a number-coded identification. Each unique tube shall have same unique number at instrument connection and termination at opposite end of tube.

C. Isolation Valves Installation:

1. Install valves full size of piping and tubing.
2. Install at the following locations:
  - a. At each branch.
  - b. Before and after each PRV.
  - c. Before and after each air dryer.
  - d. At each control device.
3. Valves shall be located to be readily accessible from floor.

D. Process Tubing Installation:

1. Install process tubing for signal to instruments in liquid and steam systems. Instruments include, but are not limited to, the following:
  - a. Meters.
  - b. Sensors.
  - c. Switches.
  - d. Transmitters.
2. Support tubing according to MSS SP-69, Table 3, but at intervals no less than 60 inches.
3. Install NPS 1/2 process tubing for industrial-grade sensors, transmitters, and switches. Install stainless-steel bushings where required.
4. Make tubing bends with a bending tool. Flattened or wrinkled bends are unacceptable.
5. Support tubing independent of other trades.
6. Route tubing parallel to and at right angles to building construction.
7. Install tubing concealed in areas with ceilings.
8. Install a dirt leg with an isolation valve and threaded plug in drain valve at each connection to a transmitter and switch.
9. Insulate process piping connected to hot water and steam systems for personnel protection if the surface temperature exceeds 120 deg F. Only insulate piping within maintenance personnel reach from floor, platform, or catwalk.

10. Wrap pipe threads of fitting in process tubing with service temperatures below 350 deg F with a single wrap of PTFE tape.
11. Coat pipe threads of fittings on process tubing in services with temperatures exceeding 350 deg F with pipe compound before being made up to reduce the possibility of galling.
12. Do not make tubing connections to a fitting before completing makeup of the connection.
13. Check tubing for correct diameter and wall thickness. Cut the tube ends square and deburred. Exercise care during cutting to keep tubing round.
14. Do not install fittings close to a bend. A length of straight tubing, not deformed by bending, is required for a proper connection.
15. Align tubing with fitting when installed. Avoid springing tube into position.
16. Install tubing with extreme care exercised to keep foreign matter out of system. Open tubing ends shall be kept plugged to keep out dust, dirt and moisture.
17. Do not attach tubing to equipment that may be removed frequently for maintenance or may impart vibration and expansion from temperature change.
18. Protect exposed tubing in mechanical equipment rooms from inadvertent mechanical damage within 76 inches above floor. Use aluminum channel reversed and secured over tubing to protect tubing from damage.

E. Isolation Valves Installation:

1. Install valves full size of piping and tubing.
2. Install isolation valves at the following locations:
  - a. Process connection.
  - b. Inlet to each instrument including, sensors, transmitters, switches, gages, and other control devices.
3. Locate valves to be readily accessible from floor.

3.16 CONTROL WIRE, CABLE AND RACEWAYS INSTALLATION

- A. Comply with NECA 1.
- B. Comply with TIA 568-C.1.
- C. Wiring Method: Install cables in raceways and cable trays except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
  1. Install plenum cable in environmental air spaces, including plenum ceilings.
- D. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- E. Field Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- F. Conduit Installation:

1. Install conduit expansion joints where conduit runs exceed 200 feet, and conduit crosses building expansion joints.
2. Coordinate conduit routing with other trades to avoid conflicts with ducts, pipes and equipment and service clearance.
3. Maintain at least 3-inch separation where conduits run axially above or below ducts and pipes.
4. Limit above-grade conduit runs to 100 feet without pull or junction box.
5. Do not install raceways or electrical items on any "explosion-relief" walls, or rotating equipment.
6. Do not fasten conduits onto the bottom side of a metal deck roof.
7. Flexible conduit is permitted only where flexibility and vibration control is required.
8. Limit flexible conduit to 3 feet long.
9. Conduit shall be continuous from outlet to outlet, from outlet to enclosures, pull and junction boxes, and shall be secured to boxes in such manner that each system shall be electrically continuous throughout.
10. Direct bury conduits underground or install in concrete-encased duct bank where indicated.
  - a. Use rigid, nonmetallic, Schedule 80 PVC.
  - b. Provide a burial depth according to NFPA 70, but not less than 24 inches.
11. Secure threaded conduit entering an instrument enclosure, cabinet, box, and trough, with a locknut on outside and inside, such that conduit system is electrically continuous throughout. Provide a metal bushing on inside with insulated throats. Locknuts shall be the type designed to bite into the metal or, on inside of enclosure, shall have a grounding wedge lug under locknut.
12. Conduit box-type connectors for conduit entering enclosures shall have an insulated throat.
13. Connect conduit entering enclosures in wet locations with box-type connectors or with watertight sealing locknuts or other fittings.
14. Offset conduits where entering surface-mounted equipment.
15. Seal conduit runs used by sealing fittings to prevent the circulation of air for the following:
  - a. Conduit extending from interior to exterior of building.
  - b. Conduit extending into pressurized duct and equipment.
  - c. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.

G. Wire and Cable Installation:

1. Cables serving a common system may be grouped in a common raceway. Install control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
2. Install cables with protective sheathing that is waterproof and capable of withstanding continuous temperatures of 90 deg C with no measurable effect on physical and electrical properties of cable.
  - a. Provide shielding to prevent interference and distortion from adjacent cables and equipment.

3. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
5. UTP Cable Installation:
  - a. Comply with TIA 568-C.2.
  - b. Do not untwist UTP cables more than 1/2 inch from the point of termination, to maintain cable geometry.
6. Installation of Cable Routed Exposed under Raised Floors:
  - a. Install plenum-rated cable only.
  - b. Install cabling after the flooring system has been installed in raised floor areas.
  - c. Coil cable 6 feet long not less than 12 inches in diameter below each feed point.
7. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire shall have a unique tag.
8. Provide strain relief.
9. Terminate wiring in a junction box.
  - a. Clamp cable over jacket in junction box.
  - b. Individual conductors in the stripped section of the cable shall be slack between the clamping point and terminal block.
10. Terminate field wiring and cable not directly connected to instruments and control devices having integral wiring terminals using terminal blocks.
11. Install signal transmission components according to IEEE C2, REA Form 511a, NFPA 70, and as indicated.
12. Keep runs short. Allow extra length for connecting to terminal boards. Do not bend flexible coaxial cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
13. Ground wire shall be copper and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.
14. Wire and cable shall be continuous from terminal to terminal without splices.
15. Use insulated spade lugs for wire and cable connection to screw terminals.
16. Use shielded cable to transmitters.
17. Use shielded cable to temperature sensors.
18. Perform continuity and meager testing on wire and cable after installation.
19. Do not install bruised, kinked, scored, deformed, or abraded wire and cable. Remove and discard wire and cable if damaged during installation, and replace it with new cable.
20. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
21. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
22. Protection from Electro-Magnetic Interference (EMI): Provide installation free of (EMI). As a minimum, comply with the following requirements:

- a. Comply with BICSI TDMM and TIA 569-C for separating unshielded cable from potential EMI sources, including electrical power lines and equipment.
- b. Separation between open cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
  - 1) Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
  - 2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
  - 3) Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
- c. Separation between cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
  - 1) Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
  - 2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
  - 3) Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
- d. Separation between cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
  - 1) Electrical Equipment Rating Less Than 2 kVA: No requirement.
  - 2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
  - 3) Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
- e. Separation between Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches.
- f. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches.

### 3.17 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - 3. Testing of Pneumatic and Air-Signal Tubing:
    - a. Test for leaks and obstructions.
    - b. Disconnect each pipe and tubing line before a test is performed, and blowout dust, dirt, trash, condensate and other foreign materials with compressed air. Use commercially pure compressed air or nitrogen as distributed in gas cylinders. Air

from an oil-free compressor with an air dryer is an acceptable alternative for the test.

- c. After foreign matter is expelled and line is free from obstructions, plug far end of tubing run.
- d. Connect a pressure source to near end of run with a needle valve between air supply and tubing run.
- e. Connect a pressure gage accurate to within 0.5 percent of test between the shutoff needle valve and tubing run under test.
- f. For system pressures above 30 psig, apply a pressure of 1.5 times operating pressure. Record pressure in tubing run every 10 minutes for one hour. Allowable drop in pressure in one-hour period shall not exceed 1 psig.
- g. For system pressures 30 psig and below, apply a pressure of 2.0 times operating pressure to piping and tubing run. Record pressure in tubing run every 5 minutes for one hour. Allowable drop in pressure in one-hour period shall not exceed 0.5 psig.

D. Testing:

1. Perform preinstallation, in-progress, and final tests, supplemented by additional tests, as necessary.
2. Preinstallation Cable Verification: Verify integrity and serviceability for new cable lengths before installation. This assurance may be provided by using vendor verification documents, testing, or other methods. As a minimum, furnish evidence of verification for cable attenuation and bandwidth parameters.
3. In-Progress Testing: Perform standard tests for correct pair identification and termination during installation to ensure proper installation and cable placement. Perform tests in addition to those specified if there is any reason to question condition of material furnished and installed. Testing accomplished is to be documented by agency conducting tests. Submit test results for Project record.
4. Final Testing: Perform final test of installed system to demonstrate acceptability as installed. Testing shall be performed according to a test plan supplied by DDC system manufacturer. Defective Work or material shall be corrected and retested. As a minimum, final testing for cable system, including spare cable, shall verify conformance of attenuation, length, and bandwidth parameters with performance indicated.
5. Test Equipment: Use a fiber-optic time domain reflectometer for testing of length and optical connectivity.
6. Test Results: Record test results and submit copy of test results for Project record.

3.18 DDC SYSTEM I/O CHECKOUT PROCEDURES

- A. Check installed products before continuity tests, leak tests and calibration.
- B. Check instruments for proper location and accessibility.
- C. Check instruments for proper installation on direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
- D. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material and support.

- E. For pneumatic products, verify that air supply for each product is properly installed.
- F. Control Damper Checkout:
  - 1. Verify that control dampers are installed correctly for flow direction.
  - 2. Verify that proper blade alignment, either parallel or opposed, has been provided.
  - 3. Verify that damper frame attachment is properly secured and sealed.
  - 4. Verify that damper actuator and linkage attachment is secure.
  - 5. Verify that actuator wiring is complete, enclosed and connected to correct power source.
  - 6. Verify that damper blade travel is unobstructed.

- G. Control Valve Checkout:
  - 1. For pneumatic valves, verify that pressure gages are provided in each air line to valve actuator and positioner.
  - 2. Verify that control valves are installed correctly for flow direction.
  - 3. Verify that valve body attachment is properly secured and sealed.
  - 4. Verify that valve actuator and linkage attachment is secure.
  - 5. Verify that actuator wiring is complete, enclosed and connected to correct power source.
  - 6. Verify that valve ball, disc or plug travel is unobstructed.
  - 7. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace the valve if leaks persist.

- H. Instrument Checkout:
  - 1. Verify that instrument is correctly installed for location, orientation, direction and operating clearances.
  - 2. Verify that attachment is properly secured and sealed.
  - 3. Verify that conduit connections are properly secured and sealed.
  - 4. Verify that wiring is properly labeled with unique identification, correct type and size and is securely attached to proper terminals.
  - 5. Inspect instrument tag against approved submittal.
  - 6. For instruments with tubing connections, verify that tubing attachment is secure and isolation valves have been provided.
  - 7. For flow instruments, verify that recommended upstream and downstream distances have been maintained.
  - 8. For temperature instruments:
    - a. Verify sensing element type and proper material.
    - b. Verify length and insertion.

### 3.19 DDC SYSTEM I/O ADJUSTMENT, CALIBRATION AND TESTING:

- A. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
- B. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.

- C. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
- D. Equipment and procedures used for calibration shall comply with instrument manufacturer's written instructions.
- E. Provide diagnostic and test equipment for calibration and adjustment.
- F. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. An installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
- G. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
- H. If after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.
- I. Comply with field testing requirements and procedures indicated by ASHRAE's Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.
- J. Analog Signals:
  - 1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
  - 2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
  - 3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.
- K. Digital Signals:
  - 1. Check digital signals using a jumper wire.
  - 2. Check digital signals using an ohmmeter to test for contact making or breaking.
- L. Control Dampers:
  - 1. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
  - 2. Stroke control dampers with pilot positioners. Adjust damper and positioner following manufacturer's recommended procedure, so damper is 100 percent closed, 50 percent closed and 100 percent open at proper air pressure.
  - 3. Check and document open and close cycle times for applications with a cycle time less than 30 seconds.
  - 4. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.
- M. Control Valves:
  - 1. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.

2. Stroke control valves with pilot positioners. Adjust valve and positioner following manufacturer's recommended procedure, so valve is 100 percent closed, 50 percent closed and 100 percent open at proper air pressures.
3. Check and document open and close cycle times for applications with a cycle time less than 30 seconds.
4. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

N. Meters: Check sensors at zero, 50, and 100 percent of Project design values.

O. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

P. Switches: Calibrate switches to make or break contact at set points indicated.

Q. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistant source.

### 3.20 DDC SYSTEM CONTROLLER CHECKOUT

A. Verify power supply.

1. Verify voltage, phase and hertz.
2. Verify that protection from power surges is installed and functioning.
3. Verify that ground fault protection is installed.
4. If applicable, verify if connected to UPS unit.
5. If applicable, verify if connected to a backup power source.
6. If applicable, verify that power conditioning units, transient voltage suppression and high-frequency noise filter units are installed.

B. Verify that wire and cabling is properly secured to terminals and labeled with unique identification.

C. Verify that spare I/O capacity is provided.

### 3.21 DDC CONTROLLER I/O CONTROL LOOP TESTS

A. Testing:

1. Test every I/O point connected to DDC controller to verify that safety and operating control set points are as indicated and as required to operate controlled system safely and at optimum performance.
2. Test every I/O point throughout its full operating range.
3. Test every control loop to verify operation is stable and accurate.
4. Adjust control loop proportional, integral and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop's precision and stability via trend logs.

5. Test and adjust every control loop for proper operation according to sequence of operation.
6. Test software and hardware interlocks for proper operation. Correct deficiencies.
7. Operate each analog point at the following:
  - a. Upper quarter of range.
  - b. Lower quarter of range.
  - c. At midpoint of range.
8. Exercise each binary point.
9. For every I/O point in DDC system, read and record each value at operator workstation, at DDC controller and at field instrument simultaneously. Value displayed at operator workstation, at DDC controller and at field instrument shall match.
10. Prepare and submit a report documenting results for each I/O point in DDC system and include in each I/O point a description of corrective measures and adjustments made to achieve desired results.

### 3.22 DDC SYSTEM VALIDATION TESTS

- A. Perform validation tests before requesting final review of system. Before beginning testing, first submit Pretest Checklist and Test Plan.
- B. After approval of Test Plan, execute all tests and procedures indicated in plan.
- C. After testing is complete, submit completed test checklist.
- D. Pretest Checklist: Submit the following list with items checked off once verified:
  1. Detailed explanation for any items that are not completed or verified.
  2. Required mechanical installation work is successfully completed and HVAC equipment is working correctly.
  3. HVAC equipment motors operate below full-load amperage ratings.
  4. Required DDC system components, wiring, and accessories are installed.
  5. Installed DDC system architecture matches approved Drawings.
  6. Control electric power circuits operate at proper voltage and are free from faults.
  7. Required surge protection is installed.
  8. DDC system network communications function properly, including uploading and downloading programming changes.
  9. Using BACnet protocol analyzer, verify that communications are error free.
  10. Each controller's programming is backed up.
  11. Equipment, products, tubing, wiring cable and conduits are properly labeled.
  12. All I/O points are programmed into controllers.
  13. Testing, adjusting and balancing work affecting controls is complete.
  14. Dampers and actuators zero and span adjustments are set properly.
  15. Each control damper and actuator goes to failed position on loss of power.
  16. Valves and actuators zero and span adjustments are set properly.
  17. Each control valve and actuator goes to failed position on loss of power.
  18. Meter, sensor and transmitter readings are accurate and calibrated.
  19. Control loops are tuned for smooth and stable operation.
  20. View trend data where applicable.

21. Each controller works properly in standalone mode.
22. Safety controls and devices function properly.
23. Interfaces with fire-alarm system function properly.
24. Electrical interlocks function properly.
25. Operator workstations and other interfaces are delivered, all system and database software is installed, and graphic are created.
26. Record Drawings are completed.

E. Test Plan:

1. Prepare and submit a validation test plan including test procedures for performance validation tests.
2. Test plan shall address all specified functions of DDC system and sequences of operation.
3. Explain detailed actions and expected results to demonstrate compliance with requirements indicated.
4. Explain method for simulating necessary conditions of operation used to demonstrate performance.
5. Include a test checklist to be used to check and initial that each test has been successfully completed.
6. Submit test plan documentation 20 business days before start of tests.

F. Validation Test:

1. Verify operating performance of each I/O point in DDC system.
  - a. Verify analog I/O points at operating value.
  - b. Make adjustments to out-of-tolerance I/O points.
    - 1) Identify I/O points for future reference.
    - 2) Simulate abnormal conditions to demonstrate proper function of safety devices.
    - 3) Replace instruments and controllers that cannot maintain performance indicated after adjustments.
2. Simulate conditions to demonstrate proper sequence of control.
3. Readjust settings to design values and observe ability of DDC system to establish desired conditions.
4. After 24 Hours following Initial Validation Test:
  - a. Re-check I/O points that required corrections during initial test.
  - b. Identify I/O points that still require additional correction and make corrections necessary to achieve desired results.
5. After 24 Hours of Second Validation Test:
  - a. Re-check I/O points that required corrections during second test.
  - b. Continue validation testing until I/O point is normal on two consecutive tests.
6. Completely check out, calibrate, and test all connected hardware and software to ensure that DDC system performs according to requirements indicated.

7. After validation testing is complete, prepare and submit a report indicating all I/O points that required correction and how many validation re-tests it took to pass. Identify adjustments made for each test and indicate instruments that were replaced.

G. DDC System Response Time Test:

1. Simulate HLC.
  - a. Heavy load shall be an occurrence of 50 percent of total connected binary COV, one-half of which represent an "alarm" condition, and 50 percent of total connected analog COV, one-half of which represent an "alarm" condition, that are initiated simultaneously on a one-time basis.
2. Initiate 10 successive occurrences of HLC and measure response time to typical alarms and status changes.
3. Measure with a timer having at least 0.1-second resolution and 0.01 percent accuracy.
4. Purpose of test is to demonstrate DDC system, as follows:
  - a. Reaction to COV and alarm conditions during HLC.
  - b. Ability to update DDC system database during HLC.
5. Passing test is contingent on the following:
  - a. Alarm reporting at printer beginning no more than two seconds after the initiation (time zero) of HLC.
  - b. All alarms, both binary and analog, are reported and printed; none are lost.
  - c. Compliance with response times specified.
6. Prepare and submit a report documenting HLC tested and results of test including time stamp and print out of all alarms.

H. DDC System Network Bandwidth Test:

1. Test network bandwidth usage on all DDC system networks to demonstrate bandwidth usage under DDC system normal operating conditions and under simulated HLC.
2. To pass, none of DDC system networks shall use more than 70 percent of available bandwidth under normal and HLC operation.

### 3.23 FINAL REVIEW

A. Submit written request to Architect and Construction Manager when DDC system is ready for final review. Written request shall state the following:

1. DDC system has been thoroughly inspected for compliance with contract documents and found to be in full compliance.
2. DDC system has been calibrated, adjusted and tested and found to comply with requirements of operational stability, accuracy, speed and other performance requirements indicated.
3. DDC system monitoring and control of HVAC systems results in operation according to sequences of operation indicated.

4. DDC system is complete and ready for final review.
- B. Review by Architect and Construction Manager shall be made after receipt of written request. A field report shall be issued to document observations and deficiencies.
  - C. Take prompt action to remedy deficiencies indicated in field report and submit a second written request when all deficiencies have been corrected. Repeat process until no deficiencies are reported.
  - D. Should more than two reviews be required, DDC system manufacturer and Installer shall compensate entity performing review for total costs, labor and expenses, associated with third and subsequent reviews. Estimated cost of each review shall be submitted and approved by DDC system manufacturer and Installer before making the review.
  - E. Prepare and submit closeout submittals when no deficiencies are reported.
  - F. A part of DDC system final review shall include a demonstration to parties participating in final review.
    1. Provide staff familiar with DDC system installed to demonstrate operation of DDC system during final review.
    2. Provide testing equipment to demonstrate accuracy and other performance requirements of DDC system that is requested by reviewers during final review.
    3. Demonstration shall include, but not be limited to, the following:
      - a. Accuracy and calibration of 10 I/O points randomly selected by reviewers. If review finds that some I/O points are not properly calibrated and not satisfying performance requirements indicated, additional I/O points may be selected by reviewers until total I/O points being reviewed that satisfy requirements equals quantity indicated.
      - b. HVAC equipment and system hardwired and software safeties and life-safety functions are operating according to sequence of operation. Up to 10 I/O points shall be randomly selected by reviewers. Additional I/O points may be selected by reviewers to discover problems with operation.
      - c. Correct sequence of operation after electrical power interruption and resumption after electrical power is restored for randomly selected HVAC systems.
      - d. Operation of randomly selected dampers and valves in normal-on, normal-off and failed positions.
      - e. Reporting of alarm conditions for randomly selected alarms, including different classes of alarms, to ensure that alarms are properly received by operators and operator workstations.
      - f. Trends, summaries, logs and reports set-up for Project.
      - g. For up to three HVAC systems randomly selected by reviewers, use graph trends to show that sequence of operation is executed in correct manner and that HVAC systems operate properly through complete sequence of operation including different modes of operations indicated. Show that control loops are stable and operating at set points and respond to changes in set point of 20 percent or more.
      - h. Software's ability to communicate with controllers, operator workstations, uploading and downloading of control programs.
      - i. Software's ability to edit control programs off-line.

- j. Data entry to show Project-specific customizing capability including parameter changes.
- k. Step through penetration tree, display all graphics, demonstrate dynamic update, and direct access to graphics.
- l. Execution of digital and analog commands in graphic mode.
- m. Spreadsheet and curve plot software and its integration with database.
- n. Online user guide and help functions.
- o. Multitasking by showing different operations occurring simultaneously on four quadrants of split screen.
- p. System speed of response compared to requirements indicated.
- q. For Each Network and Programmable Application Controller:
  - 1) Memory: Programmed data, parameters, trend and alarm history collected during normal operation is not lost during power failure.
  - 2) Operator Interface: Ability to connect directly to each type of digital controller with a portable operator workstation and PDA. Show that maintenance personnel interface tools perform as indicated in manufacturer's technical literature.
  - 3) Standalone Ability: Demonstrate that controllers provide stable and reliable standalone operation using default values or other method for values normally read over network.
  - 4) Electric Power: Ability to disconnect any controller safely from its power source.
  - 5) Wiring Labels: Match control drawings.
  - 6) Network Communication: Ability to locate a controller's location on network and communication architecture matches Shop Drawings.
  - 7) Nameplates and Tags: Accurate and permanently attached to control panel doors, instrument, actuators and devices.
- r. For Each Operator Workstation:
  - 1) I/O points lists agree with naming conventions.
  - 2) Graphics are complete.
  - 3) UPS unit, if applicable, operates.
- s. Communications and Interoperability: Demonstrate proper interoperability of data sharing, alarm and event management, trending, scheduling, and device and network management. Requirements must be met even if only one manufacturer's equipment is installed.
  - 1) Data Presentation: On each operator workstation, demonstrate graphic display capabilities.
  - 2) Reading of Any Property: Demonstrate ability to read and display any used readable object property of any device on network.
  - 3) Set Point and Parameter Modifications: Show ability to modify set points and tuning parameters indicated.
  - 4) Peer-to-Peer Data Exchange: Network devices are installed and configured to perform without need for operator intervention to implement Project sequence of operation and to share global data.
  - 5) Alarm and Event Management: Alarms and events are installed and prioritized according to Owner. Demonstrate that time delays and other

- logic are set up to avoid nuisance tripping. Show that operators with sufficient privileges are permitted.
- 6) Schedule Lists: Schedules are configured for start and stop, mode change, occupant overrides, and night setback as defined in sequence of operations.
  - 7) Schedule Display and Modification: Ability to display any schedule with start and stop times for calendar year. Show that all calendar entries and schedules are modifiable from any connected operator workstation by an operator with sufficient privilege.
  - 8) Archival Storage of Data: Data archiving is handled by operator workstation and server and local trend archiving and display is accomplished.
  - 9) Modification of Trend Log Object Parameters: Operator with sufficient privilege can change logged data points, sampling rate, and trend duration.
  - 10) Device and Network Management:
    - a) Display of network device status.
    - b) Display of BACnet Object Information.
    - c) Silencing devices transmitting erroneous data.
    - d) Time synchronization.
    - e) Remote device re-initialization.
    - f) Backup and restore network device programming and master database(s).
    - g) Configuration management of routers.

### 3.24 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from 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.

### 3.25 MAINTENANCE SERVICE

- A. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by DDC system manufacturer's authorized service representative. Include annual preventive maintenance, repair or replacement of worn or defective components, cleaning, calibration and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

### 3.26 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for one year(s).
- B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within one year(s) from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule and access system and to upgrade computer equipment if necessary.

### 3.27 DEMONSTRATION

- A. Engage a factory-authorized service representative with complete knowledge of Project-specific system installed to train Owner's maintenance personnel to adjust, operate, and maintain DDC system.
- B. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner, General Contractor, and the Commissioning Professional. Provide competent, factory-authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, troubleshooting, routine servicing and maintenance of the installed systems. The instruction shall be scheduled in coordination with the Owner and the Commissioning Professional after submission and approval of formal training agendas. Refer to Sections 01 9113 General Commissioning Requirements.
- C. Training Schedule:
  1. Schedule training with Owner 20 business days before expected Substantial Completion.
  2. Schedule training to provide Owner with at least 10 business days of notice in advance of training.
  3. Training shall occur within normal business hours at a mutually agreed on time. Unless otherwise agreed to, training shall occur Monday through Friday, except on U.S. Federal holidays, with two morning sessions and two afternoon sessions. Each morning session and afternoon session shall be split in half with 15-minute break between sessions. Morning and afternoon sessions shall be separated by-minute lunch period. Training, including breaks and excluding lunch period, shall not exceed hours per day.
  4. Provide staggered training schedule as requested by Owner.
- D. Training Attendee List and Sign-in Sheet:
  1. Request from Owner in advance of training a proposed attendee list with name, phone number and e-mail address.
  2. Provide a preprinted sign-in sheet for each training session with proposed attendees listed and no fewer than six blank spaces to add additional attendees.
  3. Preprinted sign-in sheet shall include training session number, date and time, instructor name, phone number and e-mail address, and brief description of content to be covered during session. List attendees with columns for name, phone number, e-mail address and a column for attendee signature or initials.
  4. Circulate sign-in sheet at beginning of each session and solicit attendees to sign or initial in applicable location.
  5. At end of each training day, send Owner an e-mail with an attachment of scanned copy (PDF) of circulated sign-in sheet for each session.
- E. Training Attendee Headcount:
  1. Plan in advance of training for two attendees.
  2. Make allowance for Owner to add up to one attendee(s) at time of training.

3. Headcount may vary depending on training content covered in session. Attendee access may be restricted to some training content for purposes of maintaining system security.
- F. Training Attendee Prior Knowledge: For guidance in planning required training and instruction, assume attendees have the following:
1. High school education and degree.
  2. Basic user knowledge of computers and office applications.
  3. Basic knowledge of HVAC systems.
  4. Basic knowledge of DDC systems.
  5. Basic knowledge of DDC system and products installed.
- G. Attendee Training Manuals:
1. Provide each attendee with a color hard copy of all training materials and visual presentations.
  2. Hard-copy materials shall be organized in a three-ring binder with table of contents and individual divider tabs marked for each logical grouping of subject matter. Organize material to provide space for attendees to take handwritten notes within training manuals.
  3. In addition to hard-copy materials included in training manual, provide each binder with a sleeve or pocket that includes a DVD or flash drive with PDF copy of all hard-copy materials.
- H. Instructor Requirements:
1. One or multiple qualified instructors, as required, to provide training.
  2. Instructors shall have not less than five years of providing instructional training on not less than past projects with similar DDC system scope and complexity to DDC system installed.
- I. Organization of Training Sessions:
1. Organize training sessions into logical groupings of technical content and to reflect different levels of operators having access to system. Plan training sessions to accommodate the following three levels of operators:
    - a. Daily operators.
    - b. Advanced operators.
    - c. System managers and administrators.
  2. Plan and organize training sessions to group training content to protect DDC system security. Some attendees may be restricted to some training sessions that cover restricted content for purposes of maintaining DDC system security.
- J. Training Outline:
1. Submit training outline for Owner review at least 10 business day before scheduling training.
  2. Outline shall include a detailed agenda for each training day that is broken down into each of four training sessions that day, training objectives for each training session and synopses for each lesson planned.

K. On-Site Training:

1. Owner will provide conditioned classroom or workspace with ample desks or tables, chairs, power and data connectivity for instructor and each attendee.
2. Instructor shall provide training materials, projector and other audiovisual equipment used in training.
3. Provide as much of training located on-site as deemed feasible and practical by Owner.
4. On-site training shall include regular walk-through tours, as required, to observe each unique product type installed with hands-on review of operation, calibration and service requirements.
5. Operator workstation provided with DDC system shall be used in training. If operator workstation is not indicated, provide a temporary workstation to convey training content.

L. Off-Site Training:

1. Provide conditioned training rooms and workspace with ample tables desks or tables, chairs, power and data connectivity for each attendee.
2. Provide capability to remotely access to Project DDC system for use in training.
3. Provide a workstation for use by each attendee.

M. Training Content for Daily Operators:

1. Basic operation of system.
2. Understanding DDC system architecture and configuration.
3. Understanding each unique product type installed including performance and service requirements for each.
4. Understanding operation of each system and equipment controlled by DDC system including sequences of operation, each unique control algorithm and each unique optimization routine.
5. Operating operator workstations, printers and other peripherals.
6. Logging on and off system.
7. Accessing graphics, reports and alarms.
8. Adjusting and changing set points and time schedules.
9. Recognizing DDC system malfunctions.
10. Understanding content of operation and maintenance manuals including control drawings.
11. Understanding physical location and placement of DDC controllers and I/O hardware.
12. Accessing data from DDC controllers.
13. Operating portable operator workstations.
14. Review of DDC testing results to establish basic understanding of DDC system operating performance and HVAC system limitations as of Substantial Completion.
15. Running each specified report and log.
16. Displaying and demonstrating each data entry to show Project-specific customizing capability. Demonstrating parameter changes.
17. Stepping through graphics penetration tree, displaying all graphics, demonstrating dynamic updating, and direct access to graphics.
18. Executing digital and analog commands in graphic mode.
19. Demonstrating control loop precision and stability via trend logs of I/O for not less than 10 percent of I/O installed.
20. Demonstrating DDC system performance through trend logs and command tracing.
21. Demonstrating scan, update, and alarm responsiveness.

22. Demonstrating spreadsheet and curve plot software, and its integration with database.
23. Demonstrating on-line user guide, and help function and mail facility.
24. Demonstrating multitasking by showing dynamic curve plot, and graphic construction operating simultaneously via split screen.
25. Demonstrating the following for HVAC systems and equipment controlled by DDC system:
  - a. Operation of HVAC equipment in normal-off, -on and failed conditions while observing individual equipment, dampers and valves for correct position under each condition.
  - b. For HVAC equipment with factory-installed software, show that integration into DDC system is able to communicate with DDC controllers or gateways, as applicable.
  - c. Using graphed trends, show that sequence of operation is executed in correct manner, and HVAC systems operate properly through complete sequence of operation including seasonal change, occupied and unoccupied modes, warm-up and cool-down cycles and other modes of operation indicated.
  - d. Hardware interlocks and safeties function properly and DDC system performs correct sequence of operation after electrical power interruption and resumption after power is restored.
  - e. Reporting of alarm conditions for each alarm, and confirm that alarms are received at assigned locations, including operator workstations.
  - f. Each control loop responds to set point adjustment and stabilizes within time period indicated.
  - g. Sharing of previously graphed trends of all control loops to demonstrate that each control loop is stable and set points are being maintained.

N. Training Content for Advanced Operators:

1. Making and changing workstation graphics.
2. Creating, deleting and modifying alarms including annunciation and routing.
3. Creating, deleting and modifying point trend logs including graphing and printing on an ad-hoc basis and operator-defined time intervals.
4. Creating, deleting and modifying reports.
5. Creating, deleting and modifying points.
6. Creating, deleting and modifying programming including ability to edit control programs off-line.
7. Creating, deleting and modifying system graphics and other types of displays.
8. Adding DDC controllers and other network communication devices such as gateways and routers.
9. Adding operator workstations.
10. Performing DDC system checkout and diagnostic procedures.
11. Performing DDC controllers operation and maintenance procedures.
12. Performing operator workstation operation and maintenance procedures.
13. Configuring DDC system hardware including controllers, workstations, communication devices and I/O points.
14. Maintaining, calibrating, troubleshooting, diagnosing and repairing hardware.
15. Adjusting, calibrating and replacing DDC system components.

O. Training Content for System Managers and Administrators:

1. DDC system software maintenance and backups.
2. Uploading, downloading and off-line archiving of all DDC system software and databases.
3. Interface with Project-specific, third-party operator software.
4. Understanding password and security procedures.
5. Adding new operators and making modifications to existing operators.
6. Operator password assignments and modification.
7. Operator authority assignment and modification.
8. Workstation data segregation and modification.

P. Video of Training Sessions:

1. Provide a digital video and audio recording of each training session. Create a separate recording file for each session.
2. Stamp each recording file with training session number, session name and date.
3. Provide Owner with two copies of digital files on DVDs or flash drives for later reference and for use in future training.
4. Owner retains right to make additional copies for intended training purposes without having to pay royalties.

### 3.28 FUNCTIONAL PERFORMANCE TESTING

- A. System functional performance testing is part of the Commissioning Process as detailed in Section 01 9113 General Commissioning Requirements. Functional performance testing shall be performed by the contractor and witnessed and documented by the Commissioning Professional. Installation checklists shall be successfully completed by the contractor and submitted to the Commissioning Professional prior to functional performance testing.

END OF SECTION 230923

## SECTION 230923.11 - CONTROL VALVES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes control valves and actuators for DDC systems.
- B. Related Requirements:
  - 1. Section 230993 "Sequence of Operations for HVAC Controls" for requirements that relate to Section 230923.11.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
  - 1. Include diagrams for power, signal, and control wiring.
  - 2. Include diagrams for pneumatic signal and main air tubing.
- C. Delegated-Design Submittal:
  - 1. Schedule and design calculations for control valves and actuators, including the following:
    - a. Flow at project design and minimum flow conditions.
    - b. Pressure differential drop across valve at project design flow condition.
    - c. Maximum system pressure differential drop (pump close-off pressure) across valve at project minimum flow condition.
    - d. Design and minimum control valve coefficient with corresponding valve position.
    - e. Maximum close-off pressure.
    - f. Leakage flow at maximum system pressure differential.
    - g. Torque required at worst case condition for sizing actuator.
    - h. Actuator selection indicating torque provided.

#### 1.3 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASME Compliance: Fabricate and label products to comply with ASME Boiler and Pressure Vessel Code where required by authorities having jurisdiction.
- C. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to size products where indicated as delegated design.
- D. Ground Fault: Products shall not fail due to ground fault condition when suitably grounded.
- E. Determine control valve sizes and flow coefficients by ISA 75.01.01.
- F. Control valve characteristics and rangeability shall comply with ISA 75.11.01.
- G. Selection Criteria:
  - 1. Control valves shall be suitable for operation at following conditions:
    - a. Not less than indicated and as required for system pressures and temperatures.  
Fail positions unless otherwise indicated:
    - b. Heating Hot Water: Open.
  - 2. Minimum Cv shall be calculated at 10 percent of design flow, with a coincident pressure differential equal to the system design pump head.
  - 3. In water systems, select modulating control valves at terminal equipment for a design Cv based on a pressure drop of 5 psig at design flow unless otherwise indicated.

### 2.2 BALL-STYLE CONTROL VALVES

- A. Ball Valves with Single Port and Characterized Disk:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Belimo Aircontrols (USA), Inc.
  - 2. Pressure Rating for NPS 1 and Smaller: Nominal 600 WOG.
  - 3. Pressure Rating for NPS 1-1/2 through NPS 2: Nominal 400 WOG.
  - 4. Close-off Pressure: 200 psig.
  - 5. Process Temperature Range: Zero to 212 deg F.
  - 6. Body and Tail Piece: Cast bronze ASTM B 61, ASTM B 62, ASTM B 584, or forged brass with nickel plating.
  - 7. End Connections: Threaded (NPT) ends.

8. Ball: Chrome-plated brass or bronze.
  9. Stem and Stem Extension:
    - a. Material to match ball.
    - b. Blowout-proof design.
    - c. Sleeve or other approved means to allow valve to be opened and closed without damaging the insulation or the vapor barrier seal.
  10. Ball Seats: Reinforced PTFE.
  11. Stem Seal: Reinforced PTFE packing ring with a threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if an equivalent cycle endurance can be demonstrated by testing.
  12. Flow Characteristic: Equal percentage.
- B. Ball Valves with Two Ports and Characterized Disk:
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Belimo Aircontrols (USA), Inc.
  2. Pressure Rating for NPS 1 and Smaller: Nominal 600 WOG.
  3. Pressure Rating for NPS 1-1/2 through NPS 2: Nominal 400 WOG.
  4. Close-off Pressure: 200 psig.
  5. Process Temperature Range: Zero to 212 deg F.
  6. Body and Tail Piece: Cast bronze ASTM B 61, ASTM B 62, ASTM B 584, or forged brass with nickel plating.
  7. End Connections: Threaded (NPT) ends.
  8. Ball: Chrome-plated brass or bronze.
  9. Stem and Stem Extension:
    - a. Material to match ball.
    - b. Blowout-proof design.
    - c. Sleeve or other approved means to allow valve to be opened and closed without damaging the insulation or the vapor barrier seal.
  10. Ball Seats: Reinforced PTFE.
  11. Stem Seal: Reinforced PTFE packing ring with a threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if an equivalent cycle endurance can be demonstrated by testing.
  12. Flow Characteristics for A-Port: Equal percentage.
  13. Flow Characteristics for B-Port: Modified for constant common port flow.
- C. Pressure-Independent Ball Valves NPS 2 and Smaller:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Belimo Aircontrols (USA), Inc.

- b. HCI; Hydronics Components Inc.
2. Integral Pressure Regulator: Located upstream of ball to regulate pressure, to maintain a constant pressure differential while operating within a pressure differential range of 5 to 50 psig.
  3. Body: Forged brass, nickel plated, and with threaded ends.
  4. Ball: Chrome-plated brass.
  5. Stem and Stem Extension: Chrome-plated brass, blowout-proof design.
  6. Stem sleeve or other approved means to allow valve to be opened and closed without damaging field-applied insulation and insulation vapor barrier seal.
  7. Ball Seats: Reinforced PTFE.
  8. Stem Seal: Reinforced PTFE packing ring stem seal with threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if equivalent cycle endurance can be achieved.
  9. Flow Characteristic: Equal percentage.

## 2.3 BUTTERFLY-STYLE CONTROL VALVES

### A. Commercial-Grade, Two-Way Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Keystone; Tyco Flow Control.
2. Body: Cast iron ASTM A 126, Class B, ductile iron ASTM A 536 or cast steel ASTM A 216/A 216M WCB fully lugged, suitable for mating to ASME B16.5 flanges.
3. Disc: 316 stainless steel.
4. Shaft: 316 or 17-4 PH stainless steel.
5. Seat: Reinforced EPDM or reinforced PTFE with retaining ring.
6. Shaft Bushings: Reinforced PTFE or stainless steel.
7. Replaceable seat, disc, and shaft bushings.
8. Corrosion-resistant nameplate indicating:
  - a. Manufacturer's name, model number, and serial number.
  - b. Body size.
  - c. Body and trim materials.
  - d. Flow arrow.

### B. Commercial-Grade, Three-Way Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Keystone; Tyco Flow Control.
2. Arrangement: Two valves mated to a fabricated tee with interconnecting mechanical linkage.
3. Performance:

- a. Bi-directional bubble tight shutoff at 250 psig.
  - b. Comply with MSS SP-67 or MSS SP-68.
  - c. Rotation: Zero to 90 degrees.
  - d. Linear or modified equal percentage flow characteristic.
4. Body: Cast iron ASTM A 126, Class B, ductile iron ASTM A 536 or cast steel ASTM A 216/A 216M WCB fully lugged, suitable for mating to ASME B16.5 flanges.
  5. Disc: 316 stainless steel.
  6. Shaft: 316 or 17-4 PH stainless steel.
  7. Seat: Reinforced EPDM or reinforced PTFE seat with retaining ring.
  8. Shaft Bushings: Reinforced PTFE or stainless steel.
  9. Replaceable seat, disc, and shaft bushings.
  10. Corrosion-resistant nameplate indicating:
    - a. Manufacturer's name, model number, and serial number.
    - b. Body size.
    - c. Body and trim materials.
    - d. Flow arrow.

## 2.4 GLOBE-STYLE CONTROL VALVES

### A. General Globe-Style Valve Requirements:

1. Globe-style control valve body dimensions shall comply with ISA 75.08.01.
2. Construct the valves to be serviceable from the top.
3. For cage guided valves, trim shall be field interchangeable for different valve flow characteristics, such as equal percentage, linear, and quick opening.
4. Reduced trim for one nominal size smaller shall be available for industrial valves NPS 1 and larger.
5. Replaceable seats and plugs.
6. Furnish each control valve with a corrosion-resistant nameplate indicating the following:
  - a. Manufacturer's name, model number, and serial number.
  - b. Body and trim size.
  - c. Arrow indicating direction of flow.

### B. Two-Way Globe Valves NPS 2 and Smaller:

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. Johnson Controls, Inc.
2. Globe Style: Single port.
3. Body: Cast bronze or forged brass with ASME B16.5, Class 250 rating.
4. End Connections: Threaded.
5. Bonnet: Screwed.
6. Packing: PTFE V-ring.

7. Plug: Top guided.
8. Plug, Seat, and Stem: Brass or stainless steel.
9. Process Temperature Range: 35 to 248 deg F.
10. Ambient Operating Temperature: 35 to 150 deg F.
11. Leakage: FCI 70-2, Class IV.
12. Rangeability: 25 to 1.
13. Equal percentage flow characteristic.

C. Three-Way Globe Valves NPS 2 and Smaller:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Johnson Controls, Inc.
2. Globe Style: Mix flow pattern.
3. Body: Cast bronze or forged brass with ASME B16.5, Class 250 rating.
4. End Connections: Threaded.
5. Bonnet: Screwed.
6. Packing: PTFE V-ring.
7. Plug: Top guided.
8. Plug, Seat, and Stem: Brass or stainless steel.
9. Process Temperature Range: 35 to 248 deg F.
10. Ambient Operating Temperature: 35 to 150 deg F.
11. Leakage: FCI 70-2, Class IV.
12. Rangeability: 25 to 1.
13. Linear flow characteristic.

D. Two-Way Globe Valves NPS 2-1/2 to NPS 6:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Johnson Controls, Inc.
2. Globe Style: Single port.
3. Body: Cast iron complying with ASME B61.1, Class 125.
4. End Connections: Flanged, suitable for mating to ASME B16.5, Class 150 flanges.
5. Bonnet: Bolted.
6. Packing: PTFE cone-ring.
7. Plug: Top or bottom guided.
8. Plug, Seat, and Stem: Brass or stainless steel.
9. Process Temperature Rating: 35 to 281 deg F.
10. Leakage: 0.1 percent of maximum flow.
11. Rangeability: Varies with valve size between 6 and 10 to 1.
12. Modified linear flow characteristic.

## 2.5 SOLENOID VALVES

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. ASCO Valve, Inc.
- B. Description:
1. Action: Either normally open or normally closed in the event of electrical power failure as required by the application.
  2. Size to close against the system pressure.
  3. Manual override capable.
  4. Heavy-duty assembly.
  5. Body: Brass or stainless steel.
  6. Seats and Discs: NBR or PTFE.
  7. Solenoid Enclosure: NEMA 250, Type 4.

## 2.6 ELECTRIC AND ELECTRONIC CONTROL VALVE ACTUATORS

- A. Actuators for Hydronic Control Valves: Capable of closing valve against system pump shutoff head.
- B. Position indicator and graduated scale on each actuator.
- C. Type: Motor operated, with or without gears, electric and electronic.
- D. Voltage: Voltage selection delegated to professional designing control system.
- E. Deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.
- F. Function properly within a range of 85 to 120 percent of nameplate voltage.
- G. Construction:
1. For Actuators Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.
  2. For Actuators from 100 to 400 W: Gears ground steel, oil immersed, shaft hardened steel running in bronze, copper alloy or ball bearings. Operator and gear trains shall be totally enclosed in dustproof cast-iron, cast-steel or cast-aluminum housing.
  3. For Actuators Larger Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.
- H. Field Adjustment:
1. Spring Return Actuators: Easily switchable from fail open to fail closed in the field without replacement.
  2. Gear Type Actuators: External manual adjustment mechanism to allow manual positioning when the actuator is not powered.
- I. Two-Position Actuators: Single direction, spring return or reversing type.
- J. Modulating Actuators:

1. Operation: Capable of stopping at all points across full range, and starting in either direction from any point in range.
  2. Control Input Signal:
    - a. Three Point, Tristate, or Floating Point: Clockwise and counter-clockwise inputs. One input drives actuator to open position and other input drives actuator to close position. No signal of either input remains in last position.
    - b. Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for zero- to 10- or 2- to 10-V dc and 4- to 20-mA signals.
    - c. Pulse Width Modulation (PWM): Actuator drives to a specified position according to pulse duration (length) of signal from a dry contact closure, triac sink, or source controller.
    - d. Programmable Multi-Function:
      - 1) Control Input, Position Feedback, and Running Time: Factory or field programmable.
      - 2) Diagnostic: Feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.
      - 3) Service Data: Include, at a minimum, number of hours powered and number of hours in motion.
- K. Position Feedback:
1. Equip two-position actuators with limits switches or other positive means of a position indication signal for remote monitoring of open and close position.
  2. Equip modulating actuators with a position feedback through current or voltage signal for remote monitoring.
  3. Provide a position indicator and graduated scale on each actuator indicating open and closed travel limits.
- L. Fail-Safe:
1. Where indicated, provide actuator to fail to an end position.
  2. Internal spring return mechanism to drive controlled device to an end position (open or close) on loss of power.
  3. Batteries, capacitors, and other non-mechanical forms of fail-safe operation are acceptable only where uniquely indicated.
- M. Integral Overload Protection:
1. Provide against overload throughout the entire operating range in both directions.
  2. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.
- N. Valve Attachment:
1. Unless otherwise required for valve interface, provide an actuator designed to be directly coupled to valve shaft without the need for connecting linkages.
  2. Attach actuator to valve drive shaft in a way that ensures maximum transfer of power and torque without slippage.

3. Bolt and set screw method of attachment is acceptable only if provided with at least two points of attachment.
- O. Temperature and Humidity:
1. Temperature: Suitable for operating temperature range encountered by application with minimum operating temperature range of minus 20 to plus 120 deg F.
  2. Humidity: Suitable for humidity range encountered by application; minimum operating range shall be from 5 to 95 percent relative humidity, non-condensing.
- P. Enclosure:
1. Suitable for ambient conditions encountered by application.
  2. NEMA 250, Type 2 for indoor and protected applications.
  3. NEMA 250, Type 4 or Type 4X for outdoor and unprotected applications.
  4. Provide actuator enclosure with heater and control where required by application.
- Q. Stroke Time:
1. Operate valve from fully closed to fully open within 15 seconds.
  2. Operate valve from fully open to fully closed within 15 seconds.
  3. Move valve to failed position within 5 seconds.
  4. Select operating speed to be compatible with equipment and system operation.
- R. Sound:
1. Spring Return: 62 dBA.
  2. Non-Spring Return: 45 dBA.

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. Furnish and install products required to satisfy most stringent requirements indicated.
- B. Install products level, plumb, parallel, and perpendicular with building construction.
- C. Properly support instruments, tubing, piping, wiring, and conduits to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a force.
- D. Provide ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
- E. Firestop penetrations made in fire-rated assemblies and seal penetrations made in acoustically rated assemblies.
- F. Fastening Hardware:

1. Stillson wrenches, pliers, and other tools that will cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for assembling and tightening nuts.
  2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
  3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.
- G. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

### 3.2 ELECTRIC POWER

- A. Furnish and install electrical power to products requiring electrical connections.
- B. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

### 3.3 CONTROL VALVES

- A. Install pipe reducers for valves smaller than line size. Position reducers as close to valve as possible but at distance to avoid interference and impact to performance. Install with manufacturer-recommended clearance.
- B. Install flanges or unions to allow drop-in and -out valve installation.
- C. Where indicated, install control valve with three-valve bypass manifold to allow for control valve isolation and removal without interrupting system flow by providing manual throttling valve in bypass pipe.
- D. Install drain valves in piping upstream and downstream of each control valve installed in a three-valve manifold and for each control valve larger than NPS 2.
- E. Install pressure temperature taps in piping upstream and downstream of each control valve larger than NPS 1.
- F. Valve Orientation:
  1. Where possible, install globe and ball valves installed in horizontal piping with stems upright and not more than 15 degrees off of vertical, not inverted.
  2. Install valves in a position to allow full stem movement.
  3. Where possible, install butterfly valves that are installed in horizontal piping with stems in horizontal position and with low point of disc opening with direction of flow.
- G. Clearance:
  1. Locate valves for easy access and provide separate support of valves that cannot be handled by service personnel without hoisting mechanism.
  2. Install valves with at least 12 inches of clear space around valve and between valves and adjacent surfaces.

H. Threaded Valves:

1. Note internal length of threads in valve ends, and proximity of valve internal seat or wall, to determine how far pipe should be threaded into valve.
2. Align threads at point of assembly.
3. Apply thread compound to external pipe threads, except where dry seal threading is specified.
4. Assemble joint, wrench tight. Apply wrench on valve end as pipe is being threaded.

I. Flanged Valves:

1. Align flange surfaces parallel.
2. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

J. Connect electrical devices and components to electrical grounding system. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

K. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

L. Install engraved phenolic nameplate with valve identification on valve and on face of ceiling directly below valves concealed above ceilings.

### 3.4 CHECKOUT PROCEDURES

A. Control Valve Checkout:

1. Check installed products before continuity tests, leak tests, and calibration.
2. Check valves for proper location and accessibility.
3. Check valves for proper installation for direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
4. Verify that control valves are installed correctly for flow direction.
5. Verify that valve body attachment is properly secured and sealed.
6. Verify that valve actuator and linkage attachment are secure.
7. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
8. Verify that valve ball, disc, and plug travel are unobstructed.
9. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace the valve if leaks persist.

### 3.5 ADJUSTMENT, CALIBRATION, AND TESTING

- A. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.

- B. Stroke control valves with pilot positioners. Adjust valve and positioner following manufacturer's recommended procedure, so valve is 100 percent closed, 50 percent closed, and 100 percent open at proper air pressures.
- C. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.
- D. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

END OF SECTION 230923.11

## SECTION 230993.11 - SEQUENCE OF OPERATIONS FOR HVAC DDC

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes control sequences for HVAC systems, subsystems, and equipment.

#### 1.2 SEQUENCE OF OPERATION

##### A. NOTES

1. All Temperature set points and reset schedules shall be adjustable.
2. Provide independent set points for occupied and unoccupied modes.

#### 1.3 OPERATIONS FOR HVAC

##### A. VENTILATION

1. AHU-1 provide ventilation to the building. See the AHU-1 section for more information.

##### B. HEATING

1. The boilers and AHU-1 work in conjunction to provide heating. See the AHU-1 section and boiler section for more information.

##### C. COOLING

1. AHU-1 provides both economizer and mechanical cooling. See the AHU-1 section for more information.

#### 1.4 PACKAGED AHU AHU-1:

- A. AHU-1 is provided with an on board, standalone Variable Air Volume Unit Controller with a BacNet Interface. Connect to BMS interface. Integrate to associated VAV boxes downstream.
- B. MC to install/wire discharge air temperature sensor, return air temperature sensor, outdoor air temperature sensor and discharge duct static pressure sensor provided with the air handler.
- C. SUPPLY FAN START/STOP: The supply fan shall be started according to the office's defined schedule. Initial schedule to be 7am-5pm M-F for testing and startup. Confirm exact schedule with owner.
- D. EXHAUST FAN START/STOP: Per on board controls.

- E. **STATIC PRESSURE CONTROL:** Per on board controls. MC to install and wire duct pressure sensor 2/3 of the way down the supply duct. On board controller will modulate supply fan speed to maintain duct static pressure setpoint. Static pressure setpoint will be reset based on VAV box demand.
  - F. **EXHAUST FAN SPEED:** Per on board Controls. Exhaust fan VFD will modulate to maintain building pressure setpoint. M.C. to provide sensors/wiring required for this operation. AHU controller shall provide 0-10VDC signal to packaged VFD for fan speed control.
  - G. **DISCHARGE AIR CONTROL:** The mixed air dampers, and the cooling valve shall modulate in sequence to maintain the discharge air temperature at set point. Maintain the discharge air temperature at 53°F to 70°F based upon the room with the highest cooling percentage.
  - H. **INTEGRATED DRY BULB ECONOMIZER SWITCHOVER:** Per on board controls. Initial setpoint shall be 55°F DB, adjustable in the field.
  - I. **PREHEAT CONTROL:** Per on board controls. The preheat gas heat shall modulate to maintain the discharge air temperature at the minimum 55°F temperature at set point.
  - J. **FRESH AIR CONTROLS:** Per on board controls. AHU manufacturer to provide factory-installed airflow measuring station for setpoint control. On board controller to provide 0-10 VDC signal for outside air damper modulation control.
  - K. **SMOKE MODE:** MC to coordinate connection to fire alarm system:
    - 1. On an indication of a smoke detector or a fire alarm in the space served by this unit or by the unit smoke detector, the supply fans and exhaust fans shall stop and the outdoor air damper shall close. The unit smoke detector shall be provided and installed by the Electrical Contractor. The smoke dampers throughout the space shall close when the air handler is shut down.
    - 2. Wire as necessary to fire alarm control panel for signals required for smoke sensing.
  - L. **FILTER STATUS:** Per on board controls.
  - M. **SAFETIES:** Per on board controls.
- 1.5 **BOILERS AND HEATING PUMPS – HYDRONIC HOT WATER SYSTEM OPERATION - PRIMARY/SECONDARY (CONDENSING FIRE TUBE BOILER) WITH VARIABLE SPEED PUMPING**
- A. The boiler controller will be provided with a BACnet interface. TC to connect and monitor all setpoints, status and alarms.
  - B. Provide boilers with a dedicated boiler pump from the manufacturer. Interlock factory boiler controller pump relay to activate and deactivate pump.
  - C. Integrated boiler controls shall control the hot water supply to 150°F leaving water temperature. Boiler discharge temperature to be monitored by DDC. Vary the hot water loop

temperature based on the outdoor air temperature based on the following linear schedule (These reset points shall be adjustable via the graphical user interface\):

1. When the Outdoor air temperature is 35°F or lower, the hot water loop temperature shall be 150°F.
  - a. If the Outdoor air temperature is 65°F or higher, the hot water loop temperature shall be maintained at 110°F. These reset points shall be adjustable via the graphical user interface.
  - b. Vary the hot water loop temperature between 110°F and 150°F linearly with the outdoor air temperature between 65°F and 35°F.

D. Provide an outdoor air lockout temperature for the boiler of 90°F (adj.).

E. SECONDARY PUMP CONTROL : HWP-1, HWP-2

1. The lead hot water pump shall run constantly to satisfy the building load.
2. The hot water pump will be operated on a VFD. Adjust the VFD speed to maintain the differential pressure in the system. The initial DP setpoint will be set by the test and balance contractor to maintain design coil flows. The DP setpoint will be reset by coil position.
3. The hot water pumps shall operate in a lead/lag manner with the lead pump operation switching every 200 hours of operation. Alarm at the operator workstation on pump (HWP-1, HWP-2), failure.

F. BOILER CONTROL:

1. Operate the boilers in a lead/lag fashion. The boiler with the lowest run time shall activate as the lead boiler. Alternate lead boiler status every 200 hours of operation. Lead/lag control shall operate via packaged boiler controls.
2. If the lead boiler fails to fire, start the lag boiler and alarm the DDC system.
3. The boiler pump shall start and prove the boiler flow switch.
4. Prove water flow with pipe mounted flow switch.
5. DDC system to enable the factory boiler controller when needed maintain the heating loop set point.
6. Do not turn off the boiler pump until adequate cool down time has been achieved. This should be part of the boiler's packaged controls.

1.6 VAV BOX WITH HOT WATER REHEAT (90F MAXIMUM DISCHARGE TEMP) -

A. OCCUPIED MODE:

1. Outdoor Air Temperature Below 45°F: On a call for heat from the room sensor, the DDC system shall enable the radiant floor heating system and modulate the zone control valves to maintain the space temperature. The VAV box shall run at minimum airflow and the heating valve shall modulate to maintain a discharge air temperature of 72°F. If the space temperature set point is not met with radiant floor system alone, enable heat in the VAV box per its standard operation (see below), while the radiant floor heating still operates.

Outdoor Air Temperature at or Above 45°F: Disable the radiant floor heating system.

2. When the zone temperature is between the occupied heating and cooling set points (inside of the bias), the primary air damper shall be at the minimum CFM and the reheat valve shall be fully closed.
3. On a rise in zone temperature above the cooling set point, the primary air damper shall increase the CFM and the reheat valve remains fully closed.
4. On a drop in zone temperature the system operates as follows to maintain the zone temperature set point:
5. From 0-50% loop signal: The reheat valve modulates open and the damper is controlled to provide a minimum CFM. Set the maximum discharge air temperature at 90°F.
6. From 50% to 100% loop signal, modulate the airflow from minimum to the maximum heating airflow set point as needed to meet the space temperature set point. Once the set point is met, modulate the damper back to minimum set point as needed to maintain the heating set point.

B. UNOCCUPIED (NIGHT SETBACK) MODE: When the air handling unit shuts down, all box controllers are indexed to unoccupied mode.

1. When the zone temperature is between the unoccupied heating and cooling set points (inside of the bias), the primary air damper shall be closed, and the reheat valve shall be fully closed.
2. On a rise in zone temperature above the unoccupied cooling set point, Activate the AHU. The primary air damper shall increase the CFM (if available), and the reheat valve remains fully closed. Shut down the AHU after all spaces meet set point.
3. On a drop in zone temperature below the unoccupied heating set point, the radiant floor heat system shall be enabled.
4. If the radiant floor heat cannot maintain the unoccupied heating set point, activate the AHU. Set the airflow to the maximum heating airflow set point as needed to meet the space temperature set point. Once the set point is met, modulate the damper back to minimum set point as needed to maintain the heating set point. Shut down the AHU after all spaces meet set point.

C. Monitor and Display

1. VAV air flow value
2. VAV air flow set-points (minimum, heating, and cooling).
3. Damper position.
4. Reheat valve position.
5. Inlet air temperature (from the respective AHU's discharge air temperature).
6. Discharge air temperature.
7. Zone Temperature.
8. Zone Temperature Set-point (occupied and unoccupied).
9. Zone Occupancy

## 1.7 CABINET UNIT HEATERS

- A. DDC space temperature sensor shall enable the fan and open the hot water control valve on a call for space heating.
- B. A digital hot water return temperature sensor switch will lock out the fan until the hot water return temperature reaches 80°F.

- C. The fan shall be disabled and valve shall close once the space heating demand has been satisfied.

#### 1.8 IN-FLOOR RADIANT HEATING SYSTEM

- A. When the outdoor air temperature is below 45 deg F: On a call for room heating, as sensed and commanded by the respective room's space temperature sensor, the BMS shall energize the respective radiant heat system pump (ZP-#). The 2-way temperature control valve, as shown in the mechanical drawings, shall be set to maintain a supply water temperature of 100 F (adjustable) to the radiant slab supply manifold.
- B. Upon satisfying the heating set-point, the radiant heat system pump shall be deactivated.
- C. A radiant heat slab sensor, furnished and installed by the temperature control contractor, shall monitor the slab temperature.
- D. Monitor and Display:
  - 1. Room Temperature.
  - 2. Pump Status.
  - 3. Supply Water Temperature to the radiant slab supply manifold.
  - 4. Slab Temperature

#### 1.9 EXHAUST FAN CONTROLS

- A. Reference the exhaust fan schedule on the drawings. The schedule indicates the control schemes for all exhaust fans. Provide DDC controls where indicated.
- B. For fans indicating "operate during occupied hours" or "by DDC" for control method: Provide a schedule for the exhaust fan operation to match owner requirements.
  - 1. DDC System shall enable/disable exhaust fans and monitor status with a current sensor where applicable.
  - 2. Monitor and Display, DDC activated and "run continuously" fans as follows:
    - a. Operating Status.
    - b. If the exhaust fans' status does not match the commanded value, an alarm shall be sent to the BMS.
  - 3. Radon Fan, EF-4: The fan shall run continuously.

#### 1.10 OCCUPANCY OVERRIDE SWITCH

- A. Provide a 3 hour (adj). occupancy override switch on each thermostat. The override switch shall set the corresponding HVAC system to occupied mode.

## PART 2 - EXECUTION

### 2.1 DEMONSTRATION AND TRAINING

- A. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner, General Contractor, and the Commissioning Professional. Provide competent, factory-authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, troubleshooting, routine servicing and maintenance of the installed systems. The instruction shall be scheduled in coordination with the Owner and the Commissioning Professional after submission and approval of formal training agendas. Refer to Sections 01 9113 General Commissioning Requirements.

### 2.2 FUNCTIONAL PERFORMANCE TESTING

- A. System functional performance testing is part of the Commissioning Process as detailed in Section 01 9113 General Commissioning Requirements. Functional performance testing shall be performed by the contractor and witnessed and documented by the Commissioning Professional. Installation checklists shall be successfully completed by the contractor and submitted to the Commissioning Professional prior to functional performance testing.

END OF SECTION 230993.11

## SECTION 231126 - FACILITY LIQUEFIED-PETROLEUM 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.
6. Storage containers.
7. Transport truck unloading facility specialties.
8. Pumps.
9. Vaporizers.
10. Mechanical sleeve seals.

#### 1.2 PERFORMANCE REQUIREMENTS

##### A. Minimum Operating-Pressure Ratings:

1. For Piping Containing Only Vapor:
  - a. Piping and Valves: 125 psig unless otherwise indicated.
2. For Piping Containing Liquid:
  - a. Piping between Shutoff Valves: 350 psig unless otherwise indicated.
  - b. Piping Other Than Above: 250 psig unless otherwise indicated.
  - c. Valves and Fittings: 250 psig unless otherwise indicated.

B. LPG System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig but not more than 10psig and is reduced to secondary pressure of 0.5 psig or less.

C. Seismic Performance: Vaporizers and storage container supports shall withstand the effects of earthquake motions determined according to SEI/ASCE 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."

#### 1.3 SUBMITTALS

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

- B. Seismic Qualification Certificates: Submit certification that vaporizer, storage container supports, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." 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. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Welding certificates.
- D. Field quality-control reports.
- E. Operation and maintenance data.

#### 1.4 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.

### PART 2 - PRODUCTS

#### 2.1 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedules 40 and 80, Type E or 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.
- B. Corrugated, Stainless-Steel Tubing: Comply with ANSI/IAS LC 1.

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. OmegaFlex, Inc.
    - b. Parker Hannifin Corporation; Parflex Division.
    - c. Titeflex.
    - d. Tru-Flex Metal Hose Corp.
  2. Tubing: ASTM A 240/A 240M, corrugated, Series 300 stainless steel.
  3. Coating: PE with flame retardant.
    - a. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 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.
  4. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless-steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.
  5. Striker Plates: Steel, designed to protect tubing from penetrations.
  6. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections shall comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
  7. Operating-Pressure Rating: 5 psig.
- C. Annealed-Temper Copper Tube: Comply with ASTM B 88, Type L.
1. Copper Fittings: ASME B16.22, wrought copper, and streamlined pattern.
  2. Flare Fittings: Comply with ASME B16.26 and SAE J513.
    - a. Copper fittings with long nuts.
    - b. Metal-to-metal compression seal without gasket.
    - c. Dryseal threads complying with ASME B1.20.3.
  3. Protective Coating for Underground Tubing: Factory-applied, extruded PE a minimum of 0.022 inch thick.
- D. PE Pipe: ASTM D 2513, SDR 11.
1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
  2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
  3. Anodeless Service-Line Risers: Factory fabricated and leak tested.
    - a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.

- b. Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B with corrosion-protective coating covering. Vent casing aboveground.
  - c. Aboveground Portion: PE transition fitting.
  - d. Outlet shall be threaded suitable for welded connection.
  - e. Tracer wire connection.
  - f. Ultraviolet shield.
  - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
4. Transition Service-Line Risers: Factory fabricated and leak tested.
- a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53/A 53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
  - b. Outlet shall be threaded suitable for welded connection.
  - c. Bridging sleeve over mechanical coupling.
  - d. Factory-connected anode.
  - e. Tracer wire connection.
  - f. Ultraviolet shield.
  - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

## 2.2 PIPING SPECIALTIES

### A. Flexible Piping Joints:

- 1. Approved for LPG service.
- 2. Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
- 3. Minimum working pressure of 250 psig and 250 deg F operating temperature.
- 4. Threaded-end connections to match equipment connected and shall be capable of minimum 3/4-inch misalignment.
- 5. Maximum 36-inch length for liquid LPG lines.

### B. 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.
- 3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
- 4. Corrugated stainless-steel tubing with polymer coating.
- 5. Operating-Pressure Rating: 0.5 psig.
- 6. End Fittings: Zinc-coated steel.
- 7. Threaded Ends: Comply with ASME B1.20.1.
- 8. Maximum Length: 72 inches.

### C. Quick-Disconnect Devices: Comply with ANSI Z21.41.

- 1. Copper-alloy convenience outlet and matching plug connector.
- 2. Nitrile seals.
- 3. Hand operated with automatic shutoff when disconnected.
- 4. For indoor or outdoor applications.
- 5. Adjustable, retractable restraining cable.

D. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller.
3. Strainer Screen: 40-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

E. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

## 2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for LPG.

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.

C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M.

## 2.4 MANUAL GAS SHUTOFF VALVES

A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.

B. Metallic Valves, NPS 2 and Smaller for Liquid Service: Comply with ASME B16.33 and UL 842.

1. CWP Rating: 250 psig.
2. Threaded Ends: Comply with ASME B1.20.1.
3. Socket ends for brazed joints.
4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Listing by CSA or agency acceptable to authorities having jurisdiction for valves 1 inch and smaller.
6. Valves 1-1/4 inch and larger shall be suitable for LPG service, with "WOG" indicated on valve body.

C. General Requirements for Metallic Valves, NPS 2 and Smaller for Vapor Service: Comply with ASME B16.33.

1. CWP Rating: 125 psig.
2. Threaded Ends: Comply with ASME B1.20.1.
3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.

4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
6. Service Mark: Valves 1-1/4 inch to NPS 2 shall have initials "WOG" permanently marked on valve body.

D. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.

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. BrassCraft Manufacturing Company; a Masco company.
  - b. Conbraco Industries, Inc.; Apollo Div.
  - c. Lyall, R. W. & Company, Inc.
  - d. McDonald, A. Y. Mfg. Co.
  - e. Perfection Corporation; a subsidiary of American Meter Company.
2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated brass.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Separate packnut with adjustable-stem packing threaded ends.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for LPG service with "WOG" indicated on valve body.

E. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

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. BrassCraft Manufacturing Company; a Masco company.
  - b. Conbraco Industries, Inc.; Apollo Div.
  - c. Lyall, R. W. & Company, Inc.
  - d. McDonald, A. Y. Mfg. Co.
  - e. Perfection Corporation; a subsidiary of American Meter Company.
2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.

8. CWP Rating: 600 psig.
  9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  10. Service: Suitable for LPG service with "WOG" indicated on valve body.
- F. Two-Piece, Regular-Port Bronze Ball Valves with Bronze Trim: MSS SP-110.
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. BrassCraft Manufacturing Company; a Masco company.
    - b. Conbraco Industries, Inc.; Apollo Div.
    - c. Lyall, R. W. & Company, Inc.
    - d. McDonald, A. Y. Mfg. Co.
    - e. Perfection Corporation; a subsidiary of American Meter Company.
  2. Body: Bronze, complying with ASTM B 584.
  3. Ball: Chrome-plated bronze.
  4. Stem: Bronze; blowout proof.
  5. Seats: Reinforced TFE.
  6. Packing: Threaded-body packnut design with adjustable-stem packing.
  7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  8. CWP Rating: 600 psig.
  9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  10. Service: Suitable for LPG service with "WOG" indicated on valve body.
- G. 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 or socket 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 LPG service with "WOG" indicated on valve body.
- H. PE Ball Valves: Comply with ASME B16.40.

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. Kerotest Manufacturing Corp.
  - b. Lyall, R. W. & Company, Inc.
  - c. Perfection Corporation; a subsidiary of American Meter Company.
2. Body: PE.
3. Ball: PE.
4. Stem: Acetal.
5. Seats and Seals: Nitrile.
6. Ends: Plain or fusible to match piping.
7. CWP Rating: 80 psig.
8. Operating Temperature: Minus 20 to plus 140 deg F.
9. Operator: Nut or flat head for key operation.
10. Include plastic valve extension.
11. Include tamperproof locking feature for valves where indicated on Drawings.

I. Valve Boxes:

1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of 5 inches in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head and with stem of length required to operate valve.

## 2.5 EARTHQUAKE VALVES

A. Earthquake Valves: Comply with ASCE 25.

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. Vanguard Valves, Inc.
2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
3. Maximum Operating Pressure: 5 psig.
4. Cast-aluminum body with nickel-plated chrome steel internal parts.
5. Nitrile-rubber valve washer.
6. Sight windows for visual indication of valve position.
7. Threaded-end connections complying with ASME B1.20.1.

B. Earthquake Valves: Comply with ASCE 25.

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. Pacific Seismic Products, Inc.
- 2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
- 3. Maximum Operating Pressure: 60 psig.
- 4. Cast-aluminum body with stainless-steel internal parts.
- 5. Nitrile-rubber, reset-stem o-ring seal.
- 6. Valve position, open or closed, indicator.
- 7. Composition valve seat with clapper held by spring or magnet locking mechanism.
- 8. Level indicator.
- 9. End Connections: Threaded for valves NPS 2 and smaller.

## 2.6 PRESSURE REGULATORS

### A. General Requirements:

- 1. Single stage and suitable for LPG.
- 2. Steel jacket and corrosion-resistant components.
- 3. Elevation compensator.
- 4. End Connections: Threaded for regulators NPS 2 and smaller.

### 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: 10 psig.

C. Appliance Pressure Regulators: Comply with ANSI Z21.18.

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. Canadian Meter Company Inc.
  - b. Eaton Corporation; Controls Div.
  - c. Harper Wyman Co.
  - d. Maxitrol Company.
  - e. SCP, Inc.
2. Body and Diaphragm Case: Die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
9. Maximum Inlet Pressure: 1 psig.

2.7 DIELECTRIC UNIONS

- A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
1. Capitol Manufacturing Company.
  2. Central Plastics Company.
  3. Hart Industries International, Inc.
  4. McDonald, A. Y. Mfg. Co.
  5. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
  6. Wilkins; Zurn Plumbing Products Group.
- B. Minimum Operating-Pressure Rating: 150 psig.
- C. Combination fitting of copper alloy and ferrous materials.
- D. Insulating materials suitable for LPG.
- E. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

2.8 STORAGE CONTAINERS

- A. LPG tank to be provided by owner.

## 2.9 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.

## 2.10 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
  - 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. Advance Products & Systems, Inc.
    - b. Calpico Inc.
    - c. Metraflex Company (The).
    - d. 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 and sleeve.
  - 3. Pressure Plates: Stainless steel.
  - 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one nut and bolt for each sealing element.

## 2.11 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 EARTHWORK

- A. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

### 3.2 OUTDOOR PIPING INSTALLATION

- A. Comply with NFPA 58 and NFPA 54 requirements for installation and purging of LPG piping.

- B. Install underground, LPG piping buried at least 36 inches below finished grade. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.
  - 1. If LPG piping is installed less than 36 inches below finished grade, install it in containment conduit.
- C. Install underground, PE, LPG 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. Copper Tubing with Protective Coating:
  - 1. Apply joint cover kits over tubing to cover, seal, and protect joints.
  - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
- F. Install fittings for changes in direction and branch connections.
- G. Exterior-Wall Pipe Penetrations: Seal penetrations using steel or cast-iron 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.
- H. 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.
- I. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Division 23 Section 230519 "Meters and Gages for HVAC Piping."

### 3.3 INDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 for installation and purging of LPG piping.
- 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, 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 LPG 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.
- 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 readily 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.
- T. Do not use LPG piping as grounding electrode.
- U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- V. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

### 3.4 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, or copper connector.
- B. Install underground valves with valve boxes.
- C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
- D. Install earthquake valves aboveground outside buildings according to listing.
- E. Install anode for metallic valves in underground PE piping.

### 3.5 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 ID 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.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Ch. 22, "Pipe and Tube."
- F. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.
- G. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
  - 1. Plain-End Pipe and Fittings: Use butt fusion.
  - 2. Plain-End Pipe and Socket Fittings: Use socket fusion.

### 3.6 HANGER AND SUPPORT INSTALLATION

- A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 23 Section 230548.13 "Vibration Controls for HVAC Piping and Equipment."
- B. Comply with requirements for pipe hangers and supports specified in Division 23 Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- 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.
- D. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:
  - 1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 3/8 inch.
  - 2. NPS 1/2: Maximum span, 72 inches; minimum rod size, 3/8 inch.
  - 3. NPS 3/4 and Larger: Maximum span, 96 inches; minimum rod, 3/8 inch.

### 3.7 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install LPG 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 appliances 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.

### 3.8 TRANSPORT TRUCK UNLOADING FACILITY

- A. Install transport truck unloading in a cast-in-place concrete base, 48 inches square by 36 inches deep. Set top of concrete base at least 6 inches above finished grade.
- B. Install remote emergency shutoff station with cable release in an accessible location, a minimum of 25 feet and a maximum of 100 feet away from transport truck unloading.
- C. Install at least two 6-inch-diameter metal bollards set in and filled with concrete on both sides of transport truck unloading. Bollard length shall be at least 48 inches above and below grade, with concrete encasement a minimum of 12 inches in diameter.

### 3.9 STORAGE CONTAINER INSTALLATION

- A. Fill storage container to at least 80 percent capacity with propane.
- B. Install piping connections with swing joints or flexible connectors to allow for storage container settlement and for thermal expansion and contraction.
- C. Ground containers according to NFPA 780. Grounding is specified in Division 26 Section "Lightning Protection for Structures."
- D. Set storage containers in felt pads on concrete or steel saddles. Install corrosion protection at container-to-felt contact.
- E. Install tie-downs over storage containers on saddles with proper tension.
- F. Set concrete saddles on dowels set in concrete base. Anchor steel saddles to concrete base.
- G. Set storage container on concrete ballast base large enough to offset buoyancy of empty storage container immersed in water.
- H. Install tie-down straps over container anchored in ballast base and repair damaged coating.
- I. Backfill with a minimum coverage for underground or mounded storage containers according to NFPA 58.
- J. Backfill with pea gravel as required in Division 31 Section 312000 "Earth Moving."
- K. Install cathodic protection for storage container. Cathodic protection is specified in Division 26 Section "Cathodic Protection."

### 3.10 LABELING AND IDENTIFYING

- A. Comply with requirements in Division 23 Section 230553 "Identification for HVAC Piping and Equipment" 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.

### 3.11 FIELD QUALITY CONTROL

- A. Test, inspect, and purge LPG according to NFPA 58 and NFPA 54 and requirements of authorities having jurisdiction.
- B. LPG piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.12 OUTDOOR PIPING SCHEDULE

- A. Underground LPG liquid piping shall be one of the following:
  - 1. Schedule 40 steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
  - 2. Annealed-temper copper tube, Type L with wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.
- B. Aboveground LPG liquid piping shall be one of the following:
  - 1. NPS 2 and Smaller: Schedule 40 steel pipe, malleable-iron threaded fittings and threaded and seal welded joints. Coat pipe and fittings with protective coating for steel piping.
  - 2. Annealed-temper copper tube, Type L, with wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.
- C. Underground LPG vapor piping shall be one of the following:
  - 1. PE pipe and fittings joined by heat-fusion; service-line risers with tracer wire terminated in an accessible location.
  - 2. Schedule 40, steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
  - 3. Annealed-temper copper tube, Type L with wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.
- D. Aboveground LPG vapor piping shall be one of the following:
  - 1. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
  - 2. Schedule 40, steel pipe with wrought-steel fittings and welded joints.
  - 3. Annealed-temper copper tube, Type L, with wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.
- E. Branch Piping in Cast-in-Place Concrete to Single Appliance: Annealed-temper copper, with wrought-copper fittings and brazed joints. Install piping embedded in concrete with no joints in concrete.
- F. Containment Conduit: Schedule 40, steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

### 3.13 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

- A. Aboveground, branch piping NPS 1 and smaller shall be the following:
  - 1. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground, distribution piping shall be one of the following:
  - 1. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
  - 2. Schedule 40, steel pipe with wrought-steel fittings and welded joints.

- C. Underground, below building, piping shall be one of the following:
  1. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
  2. Schedule 40, steel pipe with wrought-steel fittings and welded joints.
- D. Containment Conduit: Schedule 40, steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
- E. Containment Conduit Vent Piping: Schedule 40, steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

### 3.14 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG AND LESS THAN 5 PSIG

- A. Aboveground, branch piping NPS 1 and smaller shall be the following:
  1. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground, distribution piping shall be one of the following:
  1. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
  2. Schedule 40, steel pipe with steel welding fittings and welded joints.
- C. Underground, below building, piping shall be one of the following:
  1. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
  2. Schedule 40, steel pipe with wrought-steel fittings and welded joints.
- D. Containment Conduit: Schedule 40, steel pipe with wrought-steel fittings and welded joints. Coat underground pipe and fittings with protective coating for steel piping.
- E. Containment Conduit Vent Piping: Schedule 40, steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

### 3.15 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Aboveground Liquid Piping:
  1. Two-piece, full-port, bronze ball valves with bronze trim.
- B. Valves for pipe NPS 2 and smaller at service meter shall be one of the following:
  1. One-piece, bronze ball valve with bronze trim.
  2. Two-piece, full-port, bronze ball valves with bronze trim.
  3. Bronze plug valve.
- C. Distribution piping valves for pipe NPS 2 and smaller shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

D. Valves in branch piping for single appliance shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

END OF SECTION 231126

## SECTION 232113 - HYDRONIC PIPING

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section includes pipe and fitting materials and joining methods for the following:

1. Hot-water heating piping.
2. Condensate-drain piping.
3. Air-vent piping.
4. Safety-valve-inlet and -outlet piping.

#### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Pressure-seal fittings.
2. Chemical treatment.

B. Delegated-Design Submittal:

1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
2. Locations of pipe anchors and alignment guides and expansion joints and loops.
3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
4. Locations of and details for penetration and firestopping for fire- and smoke-rated wall and floor and ceiling assemblies.

#### 1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

#### 1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.

#### 1.5 POLYPROPYLENE PIPING WARRANTY

A. Manufacturer : Warrant pipe and fittings to be free of manufacturing defects. Warranty period: 10 years.

1. Warranty : Cover labor and material costs of repairing or replacing defective products and repairing damage caused by failure of the piping system due to manufacturing defect.
2. Warranty : In effect only upon submission by the Contractor to the Manufacturer with a valid Pressure Test Form and documents confirming that the system was tested and passed the Manufacturer's Pressure Test.
3. Warranty : Effective only if the pipe and fittings are installed by an installer who has been certified and trained by Manufacturer or a Manufacturer's affiliate. Certification has to be current and specific to the type of fusion performed.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
  1. Hot-Water Heating Piping: at 200 deg F.
  2. Condensate-Drain Piping: 150 deg F.
  3. Air-Vent Piping: 200 deg F.
  4. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

### 2.2 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
- B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.
- C. Grooved, Mechanical-Joint, Wrought-Copper Fittings: ASME B16.22.
  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. Anvil International; a subsidiary of Mueller Water Products, Inc.
    - b. Star Pipe Products.
    - c. Victaulic Company.
  2. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting.
  3. Grooved-End-Tube Couplings: Rigid pattern unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, prelubricated EPDM gasket rated for minimum 230 deg F for use with housing, and steel bolts and nuts.
- D. Wrought-Copper Unions: ASME B16.22.
- E. Copper Pressure-Seal-Join Fittings (Acceptable manufacturers: Viega, Nibco):

1. Fittings for NPS 2 and Smaller: Wrought-Copper fitting with EPDM-rubber, O-ring seal in each end. Fittings and valves shall have non-shock working pressure of 200 psi between temperatures of negative 20°F and 250°F.
2. Fittings for NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end. Fittings and valves shall have non-shock working pressure of 200 psi between temperatures of negative 20°F and 250°F.

### 2.3 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.
- B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in "Piping Applications" Article.
- C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in "Piping Applications" Article.
- D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Applications" Article.
- E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in "Piping Applications" Article.
- F. 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.
- G. Grooved Mechanical-Joint Fittings and Couplings:
  1. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106/A 106M, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
  2. Couplings: Ductile- or malleable-iron housing and EPDM or nitrile gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

### 2.4 PLASTIC PIPE AND FITTINGS

- A. PEX Pipe and Fittings.
  1. Basis-of-Design Product: Subject to compliance with requirements, provide Viega LLC: or comparable product by one of the following:
    - a. Rehau

2. Pipe Material:
  - a. PEX tubing and fittings shall maintain a quality control program in accordance with ISO 9001 or NSF International in the manufacturing plant to assure that the tubing and fittings are continually being produced to the required standard.
  - b. Tubing: Silane cross-linked high density polyethylene as per ASTM F 876/F 877 and CSA B 137.5.
  - c. Tubing includes four layers.
    - 1) First Layer: Cross-linked, high density polyethylene.
    - 2) Second Layer: Adhesive.
    - 3) Third Layer: Ethylene vinyl alcohol layer (EVOH oxygen barrier).
    - 4) Fourth Layer: Polyethylene, to protect the EVOH layer from damage.
  - d. Certified to NSF 14 and 61.
  - e. Tubing will have 6 month UV protection.
3. Oxygen Barrier: Limit oxygen diffusion through the tube to maximum 0.10 mg per cu, m/day at 104 deg F according to DIN 4726.
4. Bronze Fittings: PEX Press Fittings manufactured from UNS C83600 copper alloy, meeting the requirements of ASTM F 877 tested as a system with PEX Barrier tubing.
  - a. PEX Press Sleeve: Manufactured out of a 304 grade or better stainless steel, and have one view hole (loose sleeve) or three view holes (attached sleeve) to ensure proper PEX tubing insertion.
  - b. Attached sleeve fitting will incorporate a tool locator ring that shall be in place while making a proper press connection.
  - c. PEX press connection shall be made with a Viega supplied ratcheting PEX Press hand tool or PEX Press power tool.
5. Pressure/Temperature Rating: PEX Barrier High-Density Cross-linked polyethylene tubing shall meet standard grade hydrostatic pressure ratings from Plastic Pipe Institute in accordance with TR-4/03. The following three standard grade ratings are required:
  - a. 200 degF at 80 psi .
  - b. 180 deg F at 100 psi .
  - c. 73.4 deg F at 160 psi .

B. Pipe : Polypropylene Mechanical Pipe and Fittings

1. Pipe Material:
  - a. Pipe: Manufactured from a PP-RCT or PP-R resin meeting the short-term properties and long-term strength requirements of ASTM F 2389 or CSA B137.11.
  - b. Rework or recycled materials are not permitted for pipe.
  - c. Pipe: Manufactured by a factory extrusion process.
  - d. Hot water pipe: Manufactured in a three layer extrusion process and contain a fiber middle layer to restrict thermal expansion.
  - e. Pipe: Comply with the rated pressure requirements of ASTM F 2389.

- f. Pipe : Certified as complying with NSF /ANSI 14, and ASTM F 2389 or CSA B137.11
2. Polypropylene Plastic Pipe Fittings
    - a. Fittings: Polypropylene fittings.
    - b. Fittings: Manufactured from a PP-RCT or PP-R resin meeting the short-term properties and long-term strength requirements of ASTM F 2389 or CSA B137.11.
    - c. Rework or recycled materials are not permitted for fittings.
    - d. Fittings :
      - 1) Certified as complying with NSF / ANSI 14, and ASTM F 2389 or CSA B137.11.
      - 2) For sizes 20 mm (1/2 inch nominal) to 125 mm (4 inches nominal) : Socket fusion type.
      - 3) For size 125 mm (4 inches nominal) pipe to pipe and pipe to flange adapter connections: Socket or Butt fusion type.
      - 4) For sizes 160 mm (6 inches nominal) and above: Butt fusion type.
      - 5) Outlets for all sizes: Saddle Fusion.
  3. Valves
    - a. Utilize standard metallic valves. Transition as needed for threaded 2" and smaller and flanged 2-1/2" and over. See separate valve specifications for requirements.
  4. UV protection
    - a. Protect pipe with UV resistant coating or with alternative UV protection recommended by Manufacturer, that will be exposed to direct UV light for more than 30 days.
  5. Thermal and vapor barrier
    - a. Provide piping with thermal (radiant, conductive, convective) and vapor barrier insulation ; where indicated on drawings that standard pipe insulation is required.
    - b. Pipe insulation: UV resistant, CFC-free, non-fibrous, and resistant to mold growth.

## 2.5 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 otherwise indicated.
    - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel 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/A5.8M, 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 D10.12M/D10.12 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.

## 2.6 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. 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. A.Y. McDonald Mfg. Co.
    - b. Capitol Manufacturing Company.
    - c. Central Plastics Company.
    - d. Hart Industries International, Inc.
    - e. Jomar Valve.
    - f. Matco-Norca.
    - g. Watts; a Watts Water Technologies company.
    - h. Wilkins.
    - i. Zurn Industries, LLC.
  - 2. Description:
    - a. Standard: ASSE 1079.
    - b. Pressure Rating: 125 psig minimum at 180 deg F.
    - c. End Connections: Solder-joint copper alloy and threaded ferrous.

## 2.7 BYPASS CHEMICAL FEEDER

- A. Description: Welded steel construction; 125-psig working pressure; 5-gal. capacity; with fill funnel and inlet, outlet, and drain valves.
  - 1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.

## PART 3 - EXECUTION

### 3.1 PIPING APPLICATIONS

- A. Hot-water heating piping, aboveground, NPS 3/4 and larger, may be one of the following:
  - 1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
  - 2. Type L, drawn-temper copper tubing, wrought-copper fittings, and pro-press joints.
- B. Radiant-floor heating system piping, aboveground, NPS 3/4 and larger, shall be the following:
  - 1. Polypropylene Piping: Manufactured from a PP-RCT or PP-R resin meeting the short-term properties and long-term strength requirements of ASTM F 2389 or CSA B137.11.  
NOTE: Plastic piping shall not be allowed in the return air plenum areas
  - 2. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
  - 3. Type L, drawn-temper copper tubing, wrought-copper fittings, and pro-press joints.
- C. Radiant-floor heating system piping installed below ground and within Slabs
  - 1. PEX plastic piping
- D. Condensate-Drain Piping: Schedule 40 PVC plastic pipe and fittings and solvent-welded joints.
- E. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.
- F. Air-Vent Piping:
  - 1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.
  - 2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.
- G. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.

### 3.2 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. 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 mechanically formed 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 Section 230523.12 "Ball Valves for HVAC Piping,"
- 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 shutoff valve immediately upstream of each dielectric fitting.
- T. Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.
- U. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.
- V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

- W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

### 3.3 FUSION WELDING OF JOINTS - POLYPROPYLENE PIPING

- A. Install fittings and joints using socket-fusion, electrofusion, or butt-fusion as applicable for the fitting or joint type. All fusion-weld joints shall be made in accordance with the pipe and fitting manufacturer's specifications and product standards.
- B. Fusion-weld tooling, welding machines, and electrofusion devices shall be as specified by the pipe and fittings manufacturer.
- C. Prior to joining, the pipe and fittings shall be prepared in accordance with ASTM F 2389 and the manufacturer's specifications.
- D. Joint preparation, setting and alignment, fusion process, cooling times and working pressure shall be in accordance with the pipe and fitting manufacturer's specifications.

### 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 unions.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flange kits.
- D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

### 3.5 HANGERS AND SUPPORTS

- A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.
- B. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.
- C. 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.
- D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
1. NPS 3/4: Maximum span, 7 feet.
  2. NPS 1: Maximum span, 7 feet.
  3. NPS 1-1/2: Maximum span, 9 feet.
  4. NPS 2: Maximum span, 10 feet.
  5. NPS 2-1/2: Maximum span, 11 feet.
  6. NPS 3 and Larger: Maximum span, 12 feet.
- E. 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 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
  4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
  5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
  6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
  7. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.
- F. Plastic 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.
- G. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

### 3.6 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. 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.
- D. 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/A5.8M.
- E. 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.
- 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. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
  2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
  3. PVC Pressure Piping: Join ASTM D 1785 schedule number, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule number PVC pipe and socket fittings according to ASTM D 2855.
  4. PVC Nonpressure Piping: Join according to ASTM D 2855.
- H. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.
- I. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.
- J. Polypropylene Fittings: Joined using in accordance with ASTM D 2657 and Manufacturer's specifications and the following:
1. For sizes 20 mm (1/2 inch nominal) to 125mm (4 inches nominal) : Use socket fusion.
  2. For size 125mm (4 inches nominal) pipe to pipe and pipe to flange adapter connections: Use socket or butt fusion.
  3. For sizes 160 mm (6 inches nominal) and above: Use butt fusion.
  4. Outlets for all sizes: Saddle Fusion.
- K. Install Polypropylene fittings and joints with electrofusion for repairs as applicable for the fitting or joint type. All electrofusion joints shall be made in accordance with the pipe and fitting manufacturer's specifications and product standards.
- L. Polypropylene Fusion machines, equipment and tools: Specified by the Pipe and Fittings Manufacturer.
- M. Polypropylene Joint preparation, setting, alignment, fusion process, cooling times and working pressures: In accordance with the Pipe and Fitting Manufacturer's specifications.

### 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. Comply with requirements in Section 230519 "Meters and Gages for HVAC Piping."

### 3.8 CHEMICAL TREATMENT

- A. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.
- B. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.
- C. Fill systems that have antifreeze or glycol solutions with the following concentrations:
  - 1. Hot-Water Heating Piping: Minimum of 35 percent propylene glycol.

### 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. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."

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 232113

## SECTION 232116 - HYDRONIC PIPING SPECIALTIES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes special-duty valves and specialties for the following:
  - 1. Hot-water heating piping.
  - 2. Condensate-drain piping.
  - 3. Blowdown-drain piping.
  - 4. Air-vent piping.
  - 5. Safety-valve-inlet and -outlet piping.
  
- B. This section specifies a system or part of a system being commissioned as defined in 01 9113 General Commissioning Requirements. Testing of these systems, as well as Operations & Maintenance (O&M) Manuals and Training of the Owner's personnel, is required in cooperation with the Owner, General Contractor, and the Commissioning Professional. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to 01 9113 General Commissioning Requirements for detailed commissioning requirements.

#### 1.2 ACTION 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. Air-control devices.
  - 3. Hydronic specialties.
  
- B. Refer to Section 01 9113 General Commissioning Requirements for commissioning-related submittals and submittal review processes.

#### 1.3 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

#### 1.4 QUALITY ASSURANCE

- A. ASME Compliance: 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 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
  - 1. Hot-Water Heating Piping: 125 psig at 200 deg F.
  - 2. Chilled-Water Piping: 125 psig at 200 deg F.
  - 3. Condenser-Water Piping: 125 psig at 150 deg F.
  - 4. Makeup-Water Piping: 80 psig at 150 deg F.
  - 5. Condensate-Drain Piping: 150 deg F.
  - 6. Blowdown-Drain Piping: 200 deg F.
  - 7. Air-Vent Piping: 200 deg F.
  - 8. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

### 2.2 VALVES

- A. Ball Valves: Comply with requirements specified in Section 230523.12 "Ball Valves for HVAC Piping,"
- B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Section 230923.11 "Control Valves "
- C. Bronze, Calibrated-Orifice, Balancing Valves:
  - 1. Manufacturers: Subject to compliance with requirements listed.
  - 2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
  - 3. Ball: Brass or stainless steel.
  - 4. Plug: Resin.
  - 5. Seat: PTFE.
  - 6. End Connections: Threaded or socket.
  - 7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
  - 8. Handle Style: Lever, with memory stop to retain set position.
  - 9. CWP Rating: Minimum 125 psig (860 kPa).
  - 10. Maximum Operating Temperature: 250 deg F (121 deg C).
- D. Diaphragm-Operated, Pressure-Reducing Valves: ASME labeled.
  - 1. Manufacturers: Subject to compliance with requirements listed.
  - 2. Body: Bronze or brass.
  - 3. Disc: Glass and carbon-filled PTFE.
  - 4. Seat: Brass.
  - 5. Stem Seals: EPDM O-rings.
  - 6. Diaphragm: EPT.
  - 7. Low inlet-pressure check valve.
  - 8. Inlet Strainer: removable without system shutdown.
  - 9. Valve Seat and Stem: Noncorrosive.
  - 10. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

- E. Diaphragm-Operated Safety Valves: ASME labeled.
  - 1. Manufacturers: Subject to compliance with requirements listed
  - 2. Body: Bronze or brass.
  - 3. Disc: Glass and carbon-filled PTFE.
  - 4. Seat: Brass.
  - 5. Stem Seals: EPDM O-rings.
  - 6. Diaphragm: EPT.
  - 7. Wetted, Internal Work Parts: Brass and rubber.
  - 8. Inlet Strainer: removable without system shutdown.
  - 9. Valve Seat and Stem: Noncorrosive.
  - 10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.
  
- F. Automatic Flow-Control Valves:
  - 1. Manufacturers: Subject to compliance with requirements listed
  - 2. Body: Brass or ferrous metal.
  - 3. Piston and Spring Assembly: Stainless steel, tamper proof, self-cleaning, and removable.
  - 4. Combination Assemblies: Include bronze or brass-alloy ball valve.
  - 5. Identification Tag: Marked with zone identification, valve number, and flow rate.
  - 6. Size: Same as pipe in which installed.
  - 7. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
  - 8. Minimum CWP Rating: 175 psig.
  - 9. Maximum Operating Temperature: 200 deg F.

## 2.3 AIR-CONTROL DEVICES

- A. Manual Air Vents:
  - 1. Manufacturers: Subject to compliance with requirements listed
  - 2. Body: Bronze.
  - 3. Internal Parts: Nonferrous.
  - 4. Operator: Screwdriver or thumbscrew.
  - 5. Inlet Connection: NPS 1/2 (DN 15).
  - 6. Discharge Connection: NPS 1/8 (DN 6).
  - 7. CWP Rating: 150 psig (1035 kPa).
  - 8. Maximum Operating Temperature: 225 deg F (107 deg C).
  
- B. Expansion Tanks:
  - 1. Manufacturers: Subject to compliance with requirements, provide products listed.
  - 2. Tank: Welded steel, rated for 125-psig (860-kPa) working pressure and 375 deg F (191 deg C) maximum operating temperature, with taps in bottom of tank for tank fitting and taps in end of tank for gage glass. Tanks shall be factory tested after taps are fabricated and shall be labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
  - 3. Air-Control Tank Fitting: Cast-iron body, copper-plated tube, brass vent tube plug, and stainless-steel ball check, 100-gal. (379-L) unit only; sized for compression-tank diameter. Provide tank fittings for 125-psig (860-kPa) working pressure and 250 deg F (121 deg C) maximum operating temperature.

4. Tank Drain Fitting: Brass body, nonferrous internal parts; 125-psig (860-kPa) working pressure and 240 deg F (116 deg C) maximum operating temperature; constructed to admit air to compression tank, drain water, and close off system.
  5. Gage Glass: Full height with dual manual shutoff valves, 3/4-inch-diameter gage glass, and slotted-metal glass guard.
- C. In-Line Air Separators:
1. Manufacturers: Subject to compliance with requirements, provide products listed.
  2. Air and dirt removal device shall be constructed of steel. It shall be designed, fabricated and stamped per ASME Section VIII Division 1 with a maximum working pressure of 125 psi at 240°F. Manufacturer shall be holder of ASME U stamp. Manufacturer to have optional 150,250 and 300psi ASME units available.
  3. Units up to three 3-inch in size shall be provided with threaded connections as standard. Units four 4-inch and larger shall be provided with flanged system connections as standard. Inlet and outlet connections to be inline with piping system. Both inlet and outlet to be in the same horizontal and vertical planes.
  4. Each air and dirt removal device shall be equipped with a brass conical shaped air venting chamber designed to minimize system fluid from fouling the venting assembly. The air vent shall be able to be closed to allow flushing and purging of dirt via side port without dirt passing through vent on initial system fill.
  5. A brass flushing cock shall be located on the side of each separator to facilitate system fast-fill and removal of the floating impurities from the air system interface within the separator.
  6. A blow down valve shall be provided by the unit manufacturer on the bottom of each unit to allow blow down and cleaning. On units 2 ½” and smaller the valve and all of its fittings shall be 1”. On units three 3” and larger the valve and all openings shall be 2”.
  7. The air and dirt removal device shall remove air down to 18 microns and shall remove dirt/debris down to 5 microns. The unit shall be 100% efficient at removing dirt down to 150 microns in 10 passes or less at 3.5ft/sec.
  8. The unit manufacturer shall provide the owner and design engineer third party independent test data certifying that their unit performs to the above standards. Suppliers not providing these independent performance test results will not be acceptable.

## 2.4 HYDRONIC PIPING SPECIALTIES

### A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
3. Strainer Screen: Stainless-steel, 40-mesh strainer, or perforated stainless-steel basket.
4. CWP Rating: 125 psig (860 kPa).

- B. Stainless-Steel Bellow, Flexible Connectors:
  - 1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
  - 2. End Connections: Threaded or flanged to match equipment connected.
  - 3. Performance: Capable of 3/4-inch (20-mm) misalignment.
  - 4. CWP Rating: 150 psig (1035 kPa).
  - 5. Maximum Operating Temperature: 250 deg F (121 deg C).
- C. Expansion Fittings: Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping.

## PART 3 - EXECUTION

### 3.1 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 throttling-duty valves at each branch connection to return main.
- C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.
- D. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; 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.
- F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

### 3.2 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 piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.
- C. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 (DN 50) and larger.
- D. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.

### 3.3 DEMONSTRATION AND TRAINING

- A. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner, General Contractor, and the Commissioning Professional. Provide competent, factory-authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, troubleshooting, routine servicing and maintenance of the installed systems. The instruction shall be scheduled in coordination with the Owner and the Commissioning Professional after submission and approval of formal training agendas. Refer to Sections 01 9113 General Commissioning Requirements.

### 3.4 FUNCTIONAL PERFORMANCE TESTING

- A. System functional performance testing is part of the Commissioning Process as detailed in Section 01 9113 General Commissioning Requirements. Functional performance testing shall be performed by the contractor and witnessed and documented by the Commissioning Professional. Installation checklists shall be successfully completed by the contractor and submitted to the Commissioning Professional prior to functional performance testing.

END OF SECTION 232116

## SECTION 232123 - HYDRONIC PUMPS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Close-coupled, in-line centrifugal pumps.
2. Separately coupled, base-mounted, end-suction centrifugal pumps.
3. Automatic condensate pump units.

#### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of pump.

B. Shop Drawings: For each pump.

1. Show pump layout and connections.
2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
3. Include diagrams for power, signal, and control wiring.

C. Refer to Section 01 9113 General Commissioning Requirements for commissioning-related submittals and submittal review processes.

#### 1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

### PART 2 - PRODUCTS

#### 2.1 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

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. TACO Incorporated.
2. Bell and Gossett
3. Armstrong
4. Wilo
5. Grundfos

- 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 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: Steel, with copper-alloy shaft sleeve.
  - 4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and EPT bellows and gasket. Include water slinger on shaft between motor and seal.
  - 5. Seal: Packing seal consisting of stuffing box with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
  - 6. 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 NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
    - a. Enclosure: Totally enclosed, fan cooled.
    - b. Enclosure Materials: Cast iron.
    - c. Motor Bearings: Permanently lubricated ball bearings.
    - d. Efficiency: Premium efficient.
- E. Capacities and Characteristics:
  - 1. See Schedule.

## 2.2 SEPARATELY COUPLED, VERTICALLY MOUNTED, IN-LINE CENTRIFUGAL PUMPS

- 1. TACO Incorporated.
- 2. Bell and Gossett
- 3. Armstrong
- 4. Wilo
- 5. Grundfos
- B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately 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 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 connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. 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 EPT bellows and gasket. Include water slinger on shaft between motor and seal.
5. Pump Bearings: Permanently lubricated ball bearings.

D. Shaft Coupling: Axially split spacer coupling.

E. Motor: Single speed and rigidly mounted to pump casing with lifting eyebolt and supporting lugs in motor enclosure.

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 230513 "Common Motor Requirements for HVAC Equipment."
  - a. Enclosure: Open, dripproof.
  - b. Enclosure Materials: Cast iron.
  - c. Motor Bearings: Grease-lubricated ball bearings.
  - d. Efficiency: Premium efficient.
  - e. Include shaft grounding rings.

F. Capacities and Characteristics:

- a. See Schedule on drawings.

## 2.3 PUMP SPECIALTY FITTINGS

A. Suction Diffuser:

1. Angle pattern.
2. 175-psig pressure rating, cast or ductile-iron body and end cap, pump-inlet fitting.
3. Bronze startup and bronze or stainless-steel permanent strainers.
4. Bronze or stainless-steel straightening vanes.
5. Drain plug.
6. Factory-fabricated support.

B. Triple-Duty Valve:

1. Angle or straight pattern.
2. 175-psig pressure rating, cast or ductile-iron body, pump-discharge fitting.

3. Drain plug and bronze-fitted shutoff, balancing, and check valve features.
4. Brass gage ports with integral check valve and orifice for flow measurement.

## PART 3 - EXECUTION

### 3.1 PUMP INSTALLATION

- A. Comply with HI 1.4.
- B. Install pumps to provide access for periodic maintenance including removing 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. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.
- E. Equipment Mounting:
  1. Install base-mounted pumps on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
  2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
- F. Equipment Mounting: Install in-line pumps with continuous-thread hanger rods and spring hangers of size required to support weight of in-line pumps.
  1. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

### 3.2 ALIGNMENT

- A. Perform alignment service.
- B. Comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.
- C. Comply with pump and coupling manufacturers' written instructions.
- 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.

### 3.3 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to pump, allow space for 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 triple-duty valve on discharge side of pumps.
- F. Install suction diffuser and shutoff valve on suction side of pumps.
- G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.
- H. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping, or install single gage with multiple-input selector valve.
- I. Install check valve and gate or ball valve on each condensate pump unit discharge.
- J. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- K. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

### 3.4 DEMONSTRATION AND TRAINING

- A. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner, General Contractor, and the Commissioning Professional. Provide competent, factory-authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, troubleshooting, routine servicing and maintenance of the installed systems. The instruction shall be scheduled in coordination with the Owner and the Commissioning Professional after submission and approval of formal training agendas. Refer to Sections 01 9113 General Commissioning Requirements.

### 3.5 FUNCTIONAL PERFORMANCE TESTING

- A. System functional performance testing is part of the Commissioning Process as detailed in Section 01 9113 General Commissioning Requirements. Functional performance testing shall be performed by the contractor and witnessed and documented by the Commissioning Professional. Installation checklists shall be successfully completed by the contractor and submitted to the Commissioning Professional prior to functional performance testing.

END OF SECTION 232123

## SECTION 232513 - WATER TREATMENT FOR CLOSED-LOOP HYDRONIC SYSTEMS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes the following water treatment for closed-loop hydronic systems:
  - 1. Manual and Automatic chemical-feed equipment.
  - 2. Chemicals.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for each type of product.
- B. Refer to Section 01 9113 General Commissioning Requirements for commissioning-related submittals and submittal review processes.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Ampion Corp.
  - 2. Anderson Chemical Company.
  - 3. Aqua-Chem, Inc.
  - 4. Barclay Water Management, Inc.
  - 5. Boland Trane Services.
  - 6. Cascade Water Services, Inc.
  - 7. Earthwise Environmental Inc.
  - 8. General Electric Company; GE Water & Process Technologies.
  - 9. H-O-H Water Technology, Inc.
  - 10. Metro Group, Inc. (The).

11. Nalco; an Ecolab company.
12. Sonitec-Vortisand inc.
13. Watcon, Inc.
14. Water Services Inc.

## 2.2 PERFORMANCE REQUIREMENTS

### A. Closed hydronic systems shall have the following water qualities:

1. pH: Maintain a value within 9.0 to 10.5.
2. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
3. Boron: Maintain a value within [100 to 200] ppm.
4. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
5. Soluble Copper: Maintain a maximum value of 0.20 ppm.
6. TSS: Maintain a maximum value of 10 ppm.
7. Ammonia: Maintain a maximum value of 20 ppm.
8. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
9. Microbiological Limits:
  - a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/mL.
  - b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/mL.
  - c. Nitrate Reducers: Maintain a maximum value of 100 organisms/mL.
  - d. Sulfate Reducers: Maintain a maximum value of zero organisms/mL.
  - e. Iron Bacteria: Maintain a maximum value of zero organisms/mL.

## 2.3 MANUAL CHEMICAL-FEED EQUIPMENT

### A. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.

1. Capacity: 2 gal..
2. Minimum Working Pressure: 125 psig.

## 2.4 AUTOMATIC CHEMICAL-FEED EQUIPMENT

### A. Chemical Solution Tanks:

1. Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with minimum 110 percent containment vessel.
2. Molded cover with recess for mounting pump.
3. Capacity: 50 gal..

### B. Chemical Solution Injection Pumps:

1. Self-priming, positive displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.

2. Adjustable flow rate.
  3. Metal and thermoplastic construction.
  4. Built-in relief valve.
  5. Fully enclosed, continuous-duty, single-phase motor. Comply with requirements in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."
  6. 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. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints except ASTM A 269, Type 304, stainless steel for steam boiler injection assemblies.
- D. Injection Assembly:
1. Quill: Minimum NPS 1/2 with insertion length sufficient to discharge into at least 25 percent of pipe diameter.
  2. Ball Valve: Two-piece, stainless steel; selected to fit quill.
  3. Packing Gland: Mechanical seal on quill of sufficient length to allow quill removal during system operation.
  4. Assembly Pressure/Temperature Rating: Minimum 600 psig at 200 deg F.

## 2.5 CHEMICALS

- A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment and that can attain water quality specified in "Performance Requirements" Article.

## 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 water testing equipment on wall near water chemical application equipment.
- C. Install interconnecting control wiring for chemical treatment controls and sensors.
- D. Mount sensors and injectors in piping circuits.
- E. Bypass Feeders: Install in closed hydronic systems, including hot-water heating, and equipped with the following:

1. Install bypass feeder in a bypass circuit around circulating pumps unless otherwise indicated on Drawings.
  2. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below the feeder inlet.
  3. Install a swing check on the inlet after the isolation valve.
- F. Where installing piping adjacent to equipment, allow space for service and maintenance.
- G. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Comply with requirements in Section 23 21 16 "Hydronic Piping Specialties"
- H. Install shutoff valves on HVAC water-treatment equipment inlet and outlet.
- I. Confirm applicable electrical requirements in electrical Sections for connecting electrical equipment.

### 3.3 FIELD QUALITY CONTROL

- A. Perform the following 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 hydronic 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.
- B. Equipment will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.4 DEMONSTRATION AND TRAINING

- A. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner, General Contractor, and the Commissioning Professional. Provide competent,

factory-authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, troubleshooting, routine servicing and maintenance of the installed systems. The instruction shall be scheduled in coordination with the Owner and the Commissioning Professional after submission and approval of formal training agendas. Refer to Sections 01 9113 General Commissioning Requirements.

### 3.5 FUNCTIONAL PERFORMANCE TESTING

- A. System functional performance testing is part of the Commissioning Process as detailed in Section 01 9113 General Commissioning Requirements. Functional performance testing shall be performed by the contractor and witnessed and documented by the Commissioning Professional. Installation checklists shall be successfully completed by the contractor and submitted to the Commissioning Professional prior to functional performance testing.

END OF SECTION 232513

## SECTION 233113 - METAL DUCTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Rectangular ducts and fittings.
2. Round ducts and fittings.
3. Sheet metal materials.
4. Sealants and gaskets.
5. Hangers and supports.

B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible 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. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

#### 1.3 ACTION SUBMITTALS

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

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, 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. Refer to Section 01 9113 General Commissioning Requirements for commissioning-related submittals and submittal review processes.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. 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.
- 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," for hangers and supports.
- 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 D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
  3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

## PART 2 - PRODUCTS

### 2.1 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 2-1, "Rectangular Duct/Transverse 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 2-2, "Rectangular Duct/Longitudinal Seams," 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 4, "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 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. Ductmate Industries, Inc.
    - b. Lewis and Lambert.

- c. Lindab Inc.
  - d. McGill AirFlow LLC.
  - e. SEMCO Incorporated.
  - f. Sheet Metal Connectors, Inc.
  - g. Spiral Tech.
  - h. Spiral Manufacturing Co., Inc.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse 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."
- 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 3-2, "Round Duct Longitudinal Seams," 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.
- D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "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: G90.
  - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.
- D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

- E. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- F. 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.
- G. 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: 4 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, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 11. Sealant 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. 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, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  7. Sealant 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."
- E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- F. Round Duct Joint O-Ring Seals:
1. Seal shall provide maximum 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 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- F. 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.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports:
1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
  2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.

3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

## 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. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.

### 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."
- B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
  - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  - 2. Outdoor, Supply-Air Ducts: Seal Class A.
  - 3. Outdoor, Exhaust Ducts: Seal Class C.
  - 4. Outdoor, Return-Air Ducts: Seal Class C.
  - 5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
  - 6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
  - 7. Unconditioned Space, Exhaust Ducts: Seal Class C.
  - 8. Unconditioned Space, Return-Air Ducts: Seal Class B.
  - 9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
  - 10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
  - 11. Conditioned Space, Exhaust Ducts: Seal Class B.
  - 12. Conditioned Space, Return-Air Ducts: Seal Class C.

### 3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
  - 1. Where practical, install concrete inserts before placing concrete.

2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
  3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
  4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
  5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "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 233300 "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

### 3.6 START UP

- A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

### 3.7 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
  1. Ductwork in office and other "finished areas" are to be Paint Lock for field painting.
  2. Underground Ducts: Blue Duct manufactured product or equivalent. Blue Duct to be installed per manufacturer's requirements. Correct joining methods, tools, gaskets, and any other components related to installation must meet manufacturer's requirements to maintain product warranty. Ductwork must be protected from dirt and moisture infiltration not to compromise indoor air quality.
- B. Supply Ducts:

1. Ducts Connected to Fan Coil Units and Terminal Units:
  - a. Pressure Class: Positive 2-inch wg.
  - b. Minimum SMACNA Seal Class: A.
  - c. SMACNA Leakage Class for Rectangular: 12.
  - d. SMACNA Leakage Class for Round and Flat Oval: 12.
  
2. Ducts Connected to Constant-Volume Air-Handling Units:
  - a. Pressure Class: Positive 2-inch wg.
  - b. Minimum SMACNA Seal Class: A.
  - c. SMACNA Leakage Class for Rectangular: 6.
  - d. SMACNA Leakage Class for Round and Flat Oval: 6.
  
3. Ducts Connected to Variable-Air-Volume Air-Handling Units:
  - a. Pressure Class: Positive 3-inch wg.
  - b. Minimum SMACNA Seal Class: A.
  - c. SMACNA Leakage Class for Rectangular: 3.
  - d. SMACNA Leakage Class for Round and Flat Oval: 3.
  
4. Ducts Connected to Equipment Not Listed Above:
  - a. Pressure Class: Positive 2-inch wg.
  - b. Minimum SMACNA Seal Class: A.
  - c. SMACNA Leakage Class for Rectangular: 3.
  - d. SMACNA Leakage Class for Round and Flat Oval: 3.
  
- C. Return Ducts:
  1. Ducts Connected to Fan Coil Units, and Terminal Units:
    - a. Pressure Class: Positive or negative 2-inch wg.
    - b. Minimum SMACNA Seal Class: A.
    - c. SMACNA Leakage Class for Rectangular: 12.
    - d. SMACNA Leakage Class for Round and Flat Oval: 12.
  
  2. Ducts Connected to Air-Handling Units:
    - a. Pressure Class: Positive or negative 2-inch wg.
    - b. Minimum SMACNA Seal Class: A.
    - c. SMACNA Leakage Class for Rectangular: 6.
    - d. SMACNA Leakage Class for Round and Flat Oval: 6.
  
  3. Ducts Connected to Equipment Not Listed Above:
    - a. Pressure Class: Positive or negative 2-inch wg.
    - b. Minimum SMACNA Seal Class: A.
    - c. SMACNA Leakage Class for Rectangular: 3.
    - d. SMACNA Leakage Class for Round and Flat Oval: 3.

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
  - a. Pressure Class: Negative 2-inch wg.
  - b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
  - c. SMACNA Leakage Class for Rectangular: 12.
  - d. SMACNA Leakage Class for Round and Flat Oval: 6.
2. Ducts Connected to Air-Handling Units:
  - a. Pressure Class: Positive or negative 2-inch wg.
  - b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
  - c. SMACNA Leakage Class for Rectangular: 6.
  - d. SMACNA Leakage Class for Round and Flat Oval: 3.
3. Ducts Connected to Equipment Not Listed Above:
  - a. Pressure Class: Positive or negative 2-inch wg.
  - b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
  - c. SMACNA Leakage Class for Rectangular: 6.
  - d. SMACNA Leakage Class for Round and Flat Oval: 3.

E. Outdoor-Air Ducts:

1. Ducts Connected to Fan Coil Units and Terminal Units:
  - a. Pressure Class: Positive or negative 2-inch wg.
  - b. Minimum SMACNA Seal Class: A.
  - c. SMACNA Leakage Class for Rectangular: 12.
  - d. SMACNA Leakage Class for Round and Flat Oval: 6.
2. Ducts Connected to Air-Handling Units:
  - a. Pressure Class: Positive or negative 2-inch wg.
  - b. Minimum SMACNA Seal Class: A.
  - c. SMACNA Leakage Class for Rectangular: 6.
  - d. SMACNA Leakage Class for Round and Flat Oval: 3.
3. Ducts Connected to Equipment Not Listed Above:
  - a. Pressure Class: Positive or negative 2-inch wg.
  - b. Minimum SMACNA Seal Class: A.
  - c. SMACNA Leakage Class for Rectangular: 3.
  - d. SMACNA Leakage Class for Round and Flat Oval: 3.

F. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.
  2. PVC-Coated Ducts:
    - a. Exposed to Airstream: Match duct material.
    - b. Not Exposed to Airstream: Galvanized.
  3. Stainless-Steel Ducts:
    - a. Exposed to Airstream: Match duct material.
    - b. Not Exposed to Airstream: Galvanized.
  4. Aluminum Ducts: Aluminum.
- G. Elbow Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
    - a. Velocity 1000 fpm or Lower:
      - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
      - 2) Mitered Type RE 4 without vanes.
    - b. Velocity 1000 to 1500 fpm:
      - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
      - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
      - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
    - c. Velocity 1500 fpm or Higher:
      - 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
      - 2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
      - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
  2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "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 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "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.
  - c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

H. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
  - a. Rectangular Main to Rectangular Branch: 45-degree entry.
  - b. Rectangular Main to Round Branch: Spin in.
2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
  - a. Velocity 1000 fpm or Lower: 90-degree tap.
  - b. Velocity 1000 to 1500 fpm: Conical tap.
  - c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

## SECTION 233300 - AIR DUCT ACCESSORIES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Horizontal, Drainable-Blade Louver
  - 2. Backdraft and pressure relief dampers.
  - 3. Manual volume dampers.
  - 4. Control dampers.
  - 5. Fire dampers.
  - 6. Smoke dampers.
  - 7. Flange connectors.
  - 8. Turning vanes.
  - 9. Duct-mounted access doors.
  - 10. Flexible connectors.
  - 11. Flexible ducts.
  - 12. Duct accessory hardware.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. 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 and smoke-damper installations, including sleeves; and duct-mounted access doors.
    - e. Wiring Diagrams: For power, signal, and control wiring.
- C. Refer to Section 01 9113 General Commissioning Requirements for commissioning-related submittals and submittal review processes.

#### 1.3 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

## PART 2 - PRODUCTS

### 2.1 ASSEMBLY DESCRIPTION

- 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 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.

### 2.2 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
  - 1. Galvanized Coating Designation: G60.
  - 2. Exposed-Surface Finish: Mill phosphatized.
- B. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and finish for exposed ducts.
- C. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- D. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.
- E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- 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.

### 2.3 HORIZONTAL, DRAINABLE-BLADE LOUVER:

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Cesco
  - b. Nailor.
  - c. Pottorff.
  - d. Ruskin Company.
- 2. Louver Depth: 6 inches.
- 3. Frame and Blade Nominal Thickness: Not less than 0.080 inch of extruded T6063T5 aluminum
- 4. Mullion Type: Exposed.
- 5. Louver Performance Ratings:

- a. Free Area: Not less than 9.08 sq. ft. for 48-inch- wide by 48-inch- high louver.
  - b. Point of Beginning Water Penetration: Not less than 1000 fpm.
  - c. Air Performance: Not more than 0.10-inch wg static pressure drop at 900-fpm free-area intake velocity.
- 6. AMCA Seal: Mark units with AMCA Certified Ratings Seal.
  - 7. Bird Screen: Provide bird screen at each exterior louver at the interior face.
  - 8. Finish: Kynar with custom color selected by architect.
- B. Louver Screen Frames: Same type and form of metal as indicated for louver to which screens are attached.
- C. Louver Screening for Aluminum Louvers:
    - 1. Bird Screening: Aluminum, 1/2-inch- square mesh, 0.063-inch wire.
    - 2. Bird Screening: Stainless steel, 1/2-inch- square mesh, 0.047-inch wire.
    - 3. Bird Screening: Flattened, expanded aluminum, 3/4 by 0.050 inch thick.

#### 2.4 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Cesco Products; a division of MESTEK, Inc.
  - 2. Nailor Industries Inc.
  - 3. Pottorff.
  - 4. Ruskin Company.
- B. Description: Gravity balanced.
- C. Maximum Air Velocity: 1250 fpm.
- D. Maximum System Pressure: 3-inch wg.
- E. Frame: Hat-shaped, 0.05-inch-thick, galvanized sheet steel, with welded corners or mechanically attached and mounting flange.
- F. Blades: Multiple single-piece blades, center pivoted, maximum 6-inch width, 0.025-inch-thick, roll-formed aluminum with sealed edges.
- G. Blade Action: Parallel.
- H. Blade Seals: Neoprene, mechanically locked.
- I. Blade Axles:
  - 1. Material: Galvanized steel or Aluminum.
  - 2. Diameter: 0.20 inch.
- J. Tie Bars and Brackets: Aluminum.

- K. Return Spring: Adjustable tension.
- L. Bearings: Steel ball.
- M. Accessories:
  - 1. Adjustment device to permit setting for varying differential static pressure.
  - 2. Counterweights and spring-assist kits for vertical airflow installations.
  - 3. Electric actuators.
  - 4. Chain pulls.
  - 5. Screen Mounting: Front mounted in sleeve.
    - a. Sleeve Thickness: 20 gage minimum.
    - b. Sleeve Length: 6 inches minimum.
  - 6. Screen Mounting: Rear mounted.
  - 7. Screen Material: Galvanized steel or Aluminum.
  - 8. Screen Type: Bird.
  - 9. 90-degree stops.

## 2.5 MANUAL VOLUME DAMPERS

- A. Standard, Steel, Manual Volume Dampers:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Nailor Industries Inc.
    - b. Pottorff.
    - c. Ruskin Company.
  - 2. Standard leakage rating, with linkage outside airstream.
  - 3. Suitable for horizontal or vertical applications.
  - 4. Dampers for low pressure rectangular ductwork
    - a. In ducts 12" in the larger dimension:
      - 1) Frames:
        - a) Frame: Hat-shaped, 0.064-inch-thick (16 gauge), galvanized sheet steel.
        - b) Mitered and welded corners.
        - c) Flanges for attaching to walls and flangeless frames for installing in ducts.
      - 2) Blades:
        - a) Single blade.
        - b) Galvanized-steel, 0.036 inch20 gauge thick.
    - b. In ducts over 12" in the larger dimension:

- 1) Frames:
    - a) Frame: Hat-shaped, 0.064-inch-thick (16 gauge), galvanized sheet steel.
    - b) Mitered and welded corners.
    - c) Flanges for attaching to walls and flangeless frames for installing in ducts.
  - 2) Blades:
    - a) Multiple blade.
    - b) Opposed-blade design.
    - c) Galvanized-steel, 0.064 inch thick (16 gauge).
5. Dampers for low pressure round ductwork
- a. In ducts 4"-12" in diameter:
    - 1) Frames:
      - a) Frame: Steel channel frame , 0.036-inch-thick (20 gauge), galvanized sheet steel.
      - b) Flanges for attaching to walls and flangeless frames for installing in ducts.
    - 2) Blades:
      - a) Single blade.
      - b) Galvanized-steel, 0.028 inch22 gauge thick.
  - b. In ducts 13"-18" in the larger dimension :
    - 1) Frames:
      - a) Frame: Steel channel frame , 0.036-inch-thick (20 gauge), galvanized sheet steel.
      - b) Flanges for attaching to walls and flangeless frames for installing in ducts.
    - 2) Blades:
      - a) Single blade.
      - b) Galvanized-steel, 0.036 inch20 gauge thick.
  - c. In ducts 19"-24" in the larger dimension :
    - 1) Frames:
      - a) Frame: Steel channel frame , 0.048-inch-thick (18 gauge), galvanized sheet steel.
      - b) Flanges for attaching to walls and flangeless frames for installing in ducts.

- 2) Blades:
    - a) Single blade.
    - b) Galvanized-steel, 0.064 inch 16 gauge thick.
  - 6. Blade Axles: Galvanized steel.
  - 7. Bearings:
    - a. Stainless-steel sleeve.
    - 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. Standard, Aluminum, Manual Volume Dampers:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Warming and Ventilating; a Mestek Architectural Group company.
    - b. McGill AirFlow LLC.
    - c. Nailor Industries Inc.
    - d. Pottorff.
    - e. Ruskin Company.
    - f. Trox USA Inc.
    - g. Vent Products Co., Inc.
  - 2. Standard leakage rating, with linkage outside airstream.
  - 3. Suitable for horizontal or vertical applications.
  - 4. Frames: Hat-shaped, 0.10-inch-thick, aluminum sheet channels; frames with 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. Roll-Formed Aluminum Blades: 0.10-inch-thick aluminum sheet.
    - e. Extruded-Aluminum Blades: 0.050-inch-thick extruded aluminum.
  - 6. Blade Axles: Galvanized steel.
  - 7. Bearings:
    - a. Stainless-steel sleeve.
    - 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: Aluminum.
- C. Jackshaft:
- 1. Size: 0.5-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.
- D. 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.

## 2.6 CONTROL DAMPERS

- A. Retain this article if motorized volume-control dampers are not specified in Section 230923.12 "Control Dampers."
- B. If multiple control-damper types are required, copy this article and re-edit for each type; assign each type a drawing designation and indicate each type on Drawings.
- C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cesco Products; a division of MESTEK, Inc.
  2. Nailor Industries Inc.
  3. Pottorff.
  4. Ruskin Company.
- D. Frames:
1. U shaped.
  2. 0.094-inch-thick, galvanized sheet steel.
  3. Mitered and welded corners.
- E. Blades:
1. Multiple blade with maximum blade width of 6 inches.
  2. Opposed-blade design.
  3. Galvanized-steel.
  4. 0.0747-inch-thick dual skin.
  5. Blade Edging: Closed-cell neoprene.
  6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.
- F. 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.
- G. Bearings:
1. Stainless-steel sleeve.

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.

## 2.7 FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Cesco Products; a division of MESTEK, Inc.
  2. Nailor Industries Inc.
  3. Pottorff.
  4. Ruskin Company.
- 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: 1 and 2 hours.
- E. Frame: Curtain type with blades inside airstream; 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, link and switch package, factory installed, 165 deg F rated.

## 2.8 SMOKE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Cesco Products; a division of MESTEK, Inc.
  2. Nailor Industries Inc.

3. Pottorff.
  4. Ruskin Company.
- B. General Requirements: Label according to UL 555S by an NRTL.
  - C. Smoke Detector: Integral, factory wired for single-point connection.
  - D. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel, with welded corners and mounting flange.
  - E. Blades: Roll-formed, horizontal, interlocking, 0.063-inch-thick, galvanized sheet steel.
  - F. Leakage: Class I.
  - G. Rated pressure and velocity to exceed design airflow conditions.
  - H. Mounting Sleeve: Factory-installed, 0.05-inch-thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone caulking.
  - I. Damper Motors: two-position action.
  - J. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
    1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
    2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 230923 "Direct Digital Control (DDC) System for HVAC"
    3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
    4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
    5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
    6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
    7. Electrical Connection: 115 V, single phase, 60 Hz.
  - K. Accessories:
    1. Auxiliary position switches for signaling fire alarm system.

## 2.9 FLANGE CONNECTORS

- A. If permitted by authorities having jurisdiction, flange connectors can substitute for slip-and-drive connections for smoke dampers.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. CL WARD & Family Inc.
  - 2. Ductmate Industries, Inc.
  - 3. Hardcast, Inc.
  - 4. Nexus PDQ.
  - 5. Ward Industries, Inc.
- C. Description: roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- D. Material: Galvanized steel.
- E. Gage and Shape: Match connecting ductwork.

## 2.10 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Aero-Dyne Sound Control Co.
  - 2. CL WARD & Family Inc.
  - 3. Ductmate Industries, Inc.
  - 4. Nailor Industries Inc.
  - 5. SEMCO Incorporated.
  - 6. Ward Industries, Inc.
- B. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; 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 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."
- D. Vane Construction: Double wall.

## 2.11 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Cesco Products; a division of MESTEK, Inc.
  - 2. Nailor Industries Inc.

3. Pottorff.
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
1. Door:
    - a. Double wall, rectangular.
    - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
    - c. Vision panel.
    - d. Hinges and Latches: 1-by-1-inchbutt or piano hinge and cam latches.
    - e. 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: Continuous and two compression latches with outside and inside handles.
    - d. Access Doors Larger Than 24 by 48 Inches: Continuous and two compression latches with outside and inside handles.
- C. Pressure Relief Access Door:
1. Door and Frame Material: Galvanized sheet steel.
  2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.
  3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
  4. Factory set at 3.0- to 8.0-inch wg.
  5. Doors close when pressures are within set-point range.
  6. Hinge: Continuous piano.
  7. Latches: Cam.
  8. Seal: Neoprene or foam rubber.
  9. Insulation Fill: 1-inch-thick, fibrous-glass or polystyrene-foam board.

## 2.12 DUCT ACCESS PANEL ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. 3M.
  2. Ductmate Industries, Inc.
  3. Flame Gard, Inc.
- B. Labeled according to UL 1978 by an NRTL.

- C. Panel and Frame: Minimum thickness 0.0428-inch stainless steel.
- D. Fasteners: Stainless steel. Panel fasteners shall not penetrate duct wall.
- E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.
- F. Minimum Pressure Rating: 10-inch wg, positive or negative.

## 2.13 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Ductmate Industries, Inc.
  - 2. Duro Dyne Inc.
  - 3. Elgen Manufacturing.
  - 4. Hardcast, Inc.
  - 5. JP Lamborn Co.
  - 6. Ventfabrics, Inc.
  - 7. Ward Industries, 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 5-3/4 inches wide attached to two 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. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
  - 1. Minimum Weight: 24 oz./sq. yd..
  - 2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
  - 3. Service Temperature: Minus 50 to plus 250 deg F.

## 2.14 FLEXIBLE DUCTS

- A. Insulated acoustical, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
  - 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.

2. Maximum Air Velocity: 4000 fpm.
  3. Temperature Range: Minus 20 to plus 210 deg F.
  4. Insulation R-value: Comply with ASHRAE/IESNA 90.1.
- B. 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. Non-Clamp Connectors: Liquid adhesive plus tape.
- C. Acceptable Manuf: Flexmaster Type 1M or 1B or equal.

## 2.15 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. 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 and to make a weathertight connection.
- C. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- D. Protect unpainted galvanized and nonferrous-metal surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.
- E. 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.
- F. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- G. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

- H. 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.
- I. Set dampers to fully open position before testing, adjusting, and balancing.
- J. Install test holes at fan inlets and outlets and elsewhere as indicated.
- K. Install fire and smoke dampers according to UL listing.
- L. 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 and downstream 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. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
  - 7. At each change in direction and at maximum 50-foot spacing.
  - 8. Upstream and downstream from turning vanes.
  - 9. Upstream or downstream from duct silencers.
  - 10. Control devices requiring inspection.
  - 11. Elsewhere as indicated.
- M. Install access doors with swing against duct static pressure.
- N. 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.
- O. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- P. Install flexible connectors to connect ducts to equipment.

- Q. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.
- R. Connect diffusers or light troffer boots to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- S. Connect flexible ducts to metal ducts with draw bands.
- T. Install duct test holes where required for testing and balancing purposes.

### 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. Operate fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.

### 3.3 DEMONSTRATION AND TRAINING

- A. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner, General Contractor, and the Commissioning Professional. Provide competent, factory-authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, troubleshooting, routine servicing and maintenance of the installed systems. The instruction shall be scheduled in coordination with the Owner and the Commissioning Professional after submission and approval of formal training agendas. Refer to Sections 01 9113 General Commissioning Requirements.

### 3.4 FUNCTIONAL PERFORMANCE TESTING

- A. System functional performance testing is part of the Commissioning Process as detailed in Section 01 9113 General Commissioning Requirements. Functional performance testing shall be performed by the contractor and witnessed and documented by the Commissioning Professional. Installation checklists shall be successfully completed by the contractor and submitted to the Commissioning Professional prior to functional performance testing.

END OF SECTION 233300

## SECTION 233346 - FLEXIBLE DUCTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Non-insulated flexible ducts.
  - 2. Insulated flexible ducts.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For flexible ducts.
  - 1. Include plans showing locations and mounting and attachment details.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, and coordinated with each other, using input from installers of the items involved.

### PART 2 - PRODUCTS

#### 2.1 ASSEMBLY DESCRIPTION

- 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 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.
- C. Comply with the Air Diffusion Council's "ADC Flexible Air Duct Test Code FD 72-R1."
- D. Comply with ASTM E96/E96M, "Test Methods for Water Vapor Transmission of Materials."

#### 2.2 NON-INSULATED FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Flexmaster U.S.A., Inc.
2. JP Lamborn Co.
3. McGill AirFlow LLC.
4. Thermaflex; a Flex-Tek Group company.
5. Ward Industries; a brand of Hart & Cooley, Inc.

B. Non-Insulated, Flexible Duct: UL 181, Class 1, two-ply vinyl film supported by helically wound, spring-steel wire.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 10 to plus 160 deg F.

## 2.3 INSULATED FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Flexmaster U.S.A., Inc.
2. JP Lamborn Co.
3. McGill AirFlow LLC.
4. Thermaflex; a Flex-Tek Group company.
5. Ward Industries; a brand of Hart & Cooley, LLC.

B. Insulated, Flexible Duct: UL 181, Class 1, two-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 10 to plus 160 deg F.
4. Insulation R-Value: R4.2.

## 2.4 FLEXIBLE DUCT CONNECTORS

A. Clamps: Nylon strap in sizes 3 through 18 inches, to suit duct size.

B. Non-Clamp Connectors: Adhesive plus sheet metal screws.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install flexible ducts 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 in indoor applications only. Flexible ductwork should not be exposed to UV lighting.

- C. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.
- D. Connect diffusers or light troffer boots to ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- E. Connect flexible ducts to metal ducts with draw bands.
- F. Install duct test holes where required for testing and balancing purposes.
- G. Installation:
  - 1. Install ducts fully extended.
  - 2. Do not bend ducts across sharp corners.
  - 3. Bends of flexible ducting shall not exceed a minimum of one duct diameter.
  - 4. Avoid contact with metal fixtures, water lines, pipes, or conduits.
  - 5. Install flexible ducts in a direct line, without sags, twists, or turns.
- H. Supporting Flexible Ducts:
  - 1. Suspend flexible ducts with bands 1-1/2 inches wide or wider and spaced a maximum of 48 inches apart. Maximum centerline sag between supports shall not exceed 1/2 inch per 12 inches.
  - 2. Install extra supports at bends placed approximately one duct diameter from center line of the bend.
  - 3. Ducts may rest on ceiling joists or truss supports. Spacing between supports shall not exceed the maximum spacing per manufacturer's written installation instructions.
  - 4. Vertically installed ducts shall be stabilized by support straps at a maximum of 72 inches o.c.

END OF SECTION 233346

## SECTION 233423 - HVAC POWER VENTILATORS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Centrifugal roof ventilators.
  - 2. Ceiling-mounted ventilators.
  - 3. In-line centrifugal fans.

#### 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 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.
  - 3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
  - 4. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
- C. Refer to Section 01 9113 General Commissioning Requirements for commissioning-related submittals and submittal review processes.

#### 1.3 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

#### 1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

## PART 2 - PRODUCTS

### 2.1 CENTRIFUGAL ROOF VENTILATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Acme Engineering & Manufacturing Corp.
  - 2. Aerovent; a division of Twin City Fan Companies, Ltd.
  - 3. Carnes.
  - 4. Loren Cook Company.
- B. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- C. 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.
- D. Accessories:
  - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
  - 2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
  - 3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
  - 4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
  - 5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
- E. 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: Self-flashing without a cant strip, with mounting flange.
  - 2. Overall Height: 12 inches or 16 inches.
  - 3. Sound Curb: Curb with sound-absorbing insulation.
  - 4. Pitch Mounting: Manufacture curb for roof slope.
  - 5. Metal Liner: Galvanized steel.
  - 6. Mounting Pedestal: Galvanized steel with removable access panel.
  - 7. Vented Curb: Unlined with louvered vents in vertical sides.
- F. Capacities and Characteristics:
  - 1. See Schedule.

## 2.2 CEILING-MOUNTED VENTILATORS

- A. These units are factory assembled with one or more centrifugal wheels up to 12 inches (300 mm) wide, directly connected to motor, enclosed in housing, with inlet grille and integral backdraft damper; AMCA rated.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Acme.
  - 2. Aerovent; a division of Twin City Fan Companies, Ltd.
  - 3. Carnes.
  - 4. Loren Cook Company.
  - 5. Panasonic
- C. Housing: Steel, lined with acoustical insulation.
- D. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.
- E. Grille: Plastic, louvered grille with flange on intake and thumbscrew attachment to fan housing.
- F. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.
- G. Accessories:
  - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
  - 2. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
  - 3. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
  - 4. Wall Switch: 120V by E.C.
  - 5. Ceiling Radiation Damper: Fire-rated assembly with ceramic blanket, stainless-steel springs, and fusible link.
  - 6. Filter: Washable aluminum to fit between fan and grille.
  - 7. Isolation: Rubber-in-shear vibration isolators.
  - 8. Manufacturer's standard roof jack or wall cap, and transition fittings.
- H. Capacities and Characteristics:
  - 1. See schedule.

## 2.3 IN-LINE CENTRIFUGAL FANS

- A. These fans are both belt driven and direct drive, usually with spun-aluminum housings, and are used for small ventilation requirements.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Acme Engineering & Manufacturing Corp.
  2. Aerovent; a division of Twin City Fan Companies, Ltd.
  3. Carnes.
  4. Loren Cook Company.
  5. Panasonic.
- C. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.
- D. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing; with wheel.
- E. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.
- F. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.
- G. Accessories:
1. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
  2. Companion Flanges: For inlet and outlet duct connections.
  3. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
  4. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.
- H. Capacities and Characteristics:
1. See schedule.

## 2.4 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- B. Enclosure Type: Totally enclosed, fan cooled.

## 2.5 SOURCE QUALITY CONTROL

- A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

- B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Equipment Mounting:
  - 1. Install power ventilators on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
  - 2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
- B. Secure roof-mounted fans to roof curbs with cadmium-plated hardware.
- C. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
- D. Support suspended units from structure using threaded steel rods and spring hangers having a static deflection of 1 inch. Vibration-control devices are specified in Section 230548.13 "Vibration Controls for HVAC."
- E. Install units with clearances for service and maintenance.
- F. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

### 3.2 CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."
- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

### 3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
1. Verify that shipping, blocking, and bracing are removed.
  2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
  3. Verify that cleaning and adjusting are complete.
  4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
  5. Adjust belt tension.
  6. Adjust damper linkages for proper damper operation.
  7. Verify lubrication for bearings and other moving parts.
  8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
  9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
  10. Shut unit down and reconnect automatic temperature-control operators.
  11. Remove and replace malfunctioning units and retest as specified above.
- C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Prepare test and inspection reports.

### 3.4 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Lubricate bearings.

### 3.5 DEMONSTRATION AND TRAINING

- A. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner, General Contractor, and the Commissioning Professional. Provide competent, factory-authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, troubleshooting, routine servicing and maintenance of the installed systems. The instruction shall be scheduled in coordination with the Owner and the

Commissioning Professional after submission and approval of formal training agendas. Refer to Sections 01 9113 General Commissioning Requirements.

### 3.6 FUNCTIONAL PERFORMANCE TESTING

- A. System functional performance testing is part of the Commissioning Process as detailed in Section 01 9113 General Commissioning Requirements. Functional performance testing shall be performed by the contractor and witnessed and documented by the Commissioning Professional. Installation checklists shall be successfully completed by the contractor and submitted to the Commissioning Professional prior to functional performance testing.

END OF SECTION 233423

## SECTION 233600 - AIR TERMINAL UNITS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Shutoff, single-duct air terminal units
2. Airflow Valves – Operating/Exam Room Airflow Controls Systems

#### 1.2 Performance requirements

- A. Structural Performance: Hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems".

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For air terminal units. Include plans, elevations, sections, details, and attachments to other work.
- C. Delegated-Design Submittal:
1. Materials, fabrication, assembly, and spacing of hangers and supports.
  2. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports and seismic restraints.
- D. Field quality-control reports.
- E. Operation and maintenance data.
- F. Refer to Section 01 9113 General Commissioning Requirements for commissioning-related submittals and submittal review processes.

#### 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: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

## PART 2 - PRODUCTS

### 2.1 SHUTOFF, SINGLE-DUCT AIR TERMINAL UNITS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. Carnes.
  - 2. Krueger.
  - 3. METALAIRE, Inc.
  - 4. Nailor Industries Inc.
  - 5. Phoenix Controls Corporation.
  - 6. Titus.
- B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.
- C. Casing: 0.034-inch steel, single wall.
  - 1. Casing Lining: Adhesive attached, 1/2-inch-thick, coated, fibrous-glass duct liner complying with ASTM C 1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
    - a. Cover liner with nonporous foil.
    - b. Cover liner with nonporous foil and perforated metal.
  - 2. Casing Lining: Adhesive attached, 1/2-inch-thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
  - 3. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
  - 4. Air Outlet: S-slip and drive connections, size matching inlet size.
  - 5. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
  - 6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
- D. Regulator Assembly: System-air-powered bellows section incorporating polypropylene bellows for volume regulation and thermostatic control. Bellows shall operate at temperatures from 0 to 140 deg F, shall be impervious to moisture and fungus, shall be suitable for 10-inch wg static pressure, and shall be factory tested for leaks.
- E. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
  - 1. Maximum Damper Leakage: ARI 880 rated, 3 percent of nominal airflow at 3-inch wg inlet static pressure.
  - 2. Damper Position: Normally open.

- F. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.

### PART 3 - EXECUTION

- A. The automatic temperature controls contractor shall install, monitors, control panels and sensors under the initial supervision of the operating room airflow control system supplier.
- B. The TC contractor shall install all control panels in designated location
- C. The TC shall install appropriately sized and fused 24VAC transformer suitable for NEC class II wiring
- D. All cable and wiring furnished and installed by the TC contractor. The TC contractor shall terminate and connect all cables as required.
- E. The mechanical contractor shall install all airflow control devices in the ductwork.
- F. The mechanical contractors shall provide and install all reheat coils and transitions.
- G. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
- H. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.
- I. Install wall-mounted thermostats.

### 3.2 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, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
  - 1. Where practical, install concrete inserts before placing concrete.
  - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
  - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches thick.
  - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches thick.
  - 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hangers Exposed to View: Threaded rod and angle or channel supports.
- D. 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.

### 3.3 CONNECTIONS

- A. Install piping adjacent to air terminal unit to allow service and maintenance.
- B. Hot-Water Piping: In addition to requirements in Division 23 Section 232113 "Hydronic Piping," connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.
- C. Connect ducts to air terminal units according to Division 23 Section 233113 "Metal Ducts."
- D. Make connections to air terminal units with flexible connectors complying with requirements in Division 23 Section 233300 "Air Duct Accessories."

### 3.4 IDENTIFICATION

- A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Division 23 230553 Section "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

### 3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
  - 1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
  - 2. Leak Test: After installation, fill water coils 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 motor rotation and unit operation.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Air terminal unit will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

### 3.6 STARTUP SERVICE

- A. Perform startup service.
  - 1. A factory representative shall complete installation and startup checks according to manufacturer's written instructions.

2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
3. Verify that controls and control enclosure are accessible.
4. Verify that control connections are complete.
5. Verify that nameplate and identification tag are visible.
6. Verify that controls respond to inputs as specified.

B. Airflow valves system startup shall be performed by a factory certified representative.

### 3.7 DEMONSTRATION AND TRAINING

- A. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner, General Contractor, and the Commissioning Professional. Provide competent, factory-authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, troubleshooting, routine servicing and maintenance of the installed systems. The instruction shall be scheduled in coordination with the Owner and the Commissioning Professional after submission and approval of formal training agendas. Refer to Sections 01 9113 General Commissioning Requirements.
- B. Train Owner's maintenance personnel to adjust, operate, and maintain air terminal units. A factory trained representative shall be on site for training.

### 3.8 FUNCTIONAL PERFORMANCE TESTING

- A. System functional performance testing is part of the Commissioning Process as detailed in Section 01 9113 General Commissioning Requirements. Functional performance testing shall be performed by the contractor and witnessed and documented by the Commissioning Professional. Installation checklists shall be successfully completed by the contractor and submitted to the Commissioning Professional prior to functional performance testing.

END OF SECTION 233600

## SECTION 233713.13 - AIR DIFFUSERS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Round ceiling diffusers.
2. Rectangular and square ceiling diffusers.
3. Perforated diffusers.
4. Louver face diffusers.
5. Linear bar diffusers.
6. Linear slot diffusers.

B. Related Requirements:

1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers.
2. Section 233713.23 "Air Registers and Grilles" for adjustable-bar register and grilles, fixed-face registers and grilles, and linear bar grilles.

#### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

### PART 2 - PRODUCTS

#### 2.1 ROUND CEILING DIFFUSERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Anemostat Products; a Mestek company.
2. Carnes Company.
3. Hart & Cooley Inc.
4. METALAIRE, Inc.
5. Nailor Industries Inc.
6. Price Industries.
7. Shoemaker Mfg. Co.
8. Titus; brand of Johnson Controls International plc, Global Products.
9. Tuttle & Bailey; brand of Johnson Controls International plc, Global Products.

B. Devices shall be specifically designed for variable-air-volume flows.

C. Material: Steel, or as indicated on the plans if different.

- D. Finish: Baked enamel, white, or color as specified on the G/R/D Schedule on the drawings.
- E. Face Style as specified on the G/R/D Schedule on the drawings.
- F. Mounting: Duct connection.
- G. Pattern: Fully adjustable.
- H. Dampers: as specified on the G/R/D Schedule on the drawings.
- I. Accessories: as specified on the G/R/D Schedule on the drawings.
  - 1. Equalizing grid.
  - 2. Plaster ring.
  - 3. Safety chain.
  - 4. Wire guard.
  - 5. Sectorizing baffles.
  - 6. Operating rod extension.

## 2.2 RECTANGULAR AND SQUARE CEILING DIFFUSERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Anemostat Products; a Mestek company.
  - 2. Carnes Company.
  - 3. Hart & Cooley Inc.
  - 4. Krueger-HVAC; brand of Johnson Controls International plc, Global Products.
  - 5. METALAIRE, Inc.
  - 6. Nailor Industries Inc.
  - 7. Price Industries.
  - 8. Titus; brand of Johnson Controls International plc, Global Products.
  - 9. Tuttle & Bailey; brand of Johnson Controls International plc, Global Products.
- B. Devices shall be specifically designed for variable-air-volume flows.
- C. Material: Steel or as specified on the G/R/D Schedule on the drawings..
- D. Finish: Baked enamel, white or color as specified on the G/R/D Schedule on the drawings.
- E. Face Size: as specified on the G/R/D Schedule on the drawings.
- F. Face Style: as specified on the G/R/D Schedule on the drawings.
- G. Mounting: as specified on the G/R/D Schedule on the drawings.
- H. Pattern: as specified on the G/R/D Schedule on the drawings.
- I. Dampers: as specified on the G/R/D Schedule on the drawings.
- J. Accessories: as specified on the G/R/D Schedule on the drawings.

## 2.3 LINEAR BAR DIFFUSERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Anemostat Products; a Mestek company.
  - 2. Carnes Company.
  - 3. Krueger-HVAC; brand of Johnson Controls International plc, Global Products.
  - 4. METALAIRE, Inc.
  - 5. Nailor Industries Inc.
  - 6. Price Industries.
  - 7. Titus; brand of Johnson Controls International plc, Global Products.
  - 8. Tuttle & Bailey; brand of Johnson Controls International plc, Global Products.
- B. Devices shall be specifically designed for variable-air-volume flows.
- C. Material: as specified on the G/R/D Schedule on the drawings.
- D. Finish: as specified on the G/R/D Schedule on the drawings.
- E. Core Spacing Arrangement: as specified on the G/R/D Schedule on the drawings.
- F. Deflection Vanes: as specified on the G/R/D Schedule on the drawings.
- G. Frame: as specified on the G/R/D Schedule on the drawings.
- H. Damper Type: as specified on the G/R/D Schedule on the drawings.
- I. Accessories: as specified on the G/R/D Schedule on the drawings.

## 2.4 LINEAR SLOT DIFFUSERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Anemostat Products; a Mestek company.
  - 2. Carnes Company.
  - 3. Krueger-HVAC; brand of Johnson Controls International plc, Global Products.
  - 4. METALAIRE, Inc.
  - 5. Nailor Industries Inc.
  - 6. Price Industries.
  - 7. Titus; brand of Johnson Controls International plc, Global Products.
  - 8. Tuttle & Bailey; brand of Johnson Controls International plc, Global Products.
- B. Devices shall be specifically designed for variable-air-volume flows.
- C. Material - Shell: Steel,.
- D. Material - Pattern Controller and Tees: Aluminum.
- E. Finish - Baked enamel.

- F. Slot Width: as specified on the G/R/D Schedule on the drawings.
- G. Number of Slots: as specified on the G/R/D Schedule on the drawings.
- H. Length: as specified on the G/R/D Schedule on the drawings.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install diffusers level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

### 3.2 ADJUSTING

- A. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713.13

## SECTION 233713.23 - REGISTERS AND GRILLES

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Adjustable blade face registers and grilles.
2. Fixed face registers and grilles.

##### B. Related Requirements:

1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to registers and grilles.
2. Section 233713.13 "Air Diffusers" for various types of air diffusers.

#### 1.2 ACTION SUBMITTALS

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

### PART 2 - PRODUCTS

#### 2.1 REGISTERS

##### A. Adjustable Blade Face Register:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. A-J Manufacturing Co., Inc.
  - b. Anemostat Products; a Mestek company.
  - c. Carnes Company.
  - d. Dayus Register & Grille Inc.
  - e. Hart & Cooley Inc.
  - f. Kees, Inc.
  - g. Krueger-HVAC; brand of Johnson Controls International plc, Global Products.
  - h. METALAIRE, Inc.
  - i. Nailor Industries Inc.
  - j. Price Industries.
  - k. Titus; brand of Johnson Controls International plc, Global Products.
  - l. Tuttle & Bailey; brand of Johnson Controls International plc, Global Products.
2. See plans for additional requirements

##### B. Fixed Face Register:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. A-J Manufacturing Co., Inc.
  - b. Anemostat Products; a Mestek company.
  - c. Carnes Company.
  - d. Dayus Register & Grille Inc.
  - e. Hart & Cooley Inc.
  - f. Kees, Inc.
  - g. Krueger-HVAC; brand of Johnson Controls International plc, Global Products.
  - h. Nailor Industries Inc.
  - i. Price Industries.
  - j. Shoemaker Mfg. Co.
  - k. Titus; brand of Johnson Controls International plc, Global Products.
  - l. Tuttle & Bailey; brand of Johnson Controls International plc, Global Products.
2. See plans for additional requirements.

## 2.2 GRILLES

### A. Adjustable Blade Face Grille:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. A-J Manufacturing Co., Inc.
  - b. Anemostat Products; a Mestek company.
  - c. Carnes Company.
  - d. Dayus Register & Grille Inc.
  - e. Hart & Cooley Inc.
  - f. Kees, Inc.
  - g. Krueger-HVAC; brand of Johnson Controls International plc, Global Products.
  - h. METALAIRE, Inc.
  - i. Nailor Industries Inc.
  - j. Price Industries.
  - k. Raymon-Donco.
  - l. Shoemaker Mfg. Co.
  - m. Titus; brand of Johnson Controls International plc, Global Products.
  - n. Tuttle & Bailey; brand of Johnson Controls International plc, Global Products.
2. See plans for additional requirements.

### B. Fixed Face Grille:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. A-J Manufacturing Co., Inc.
  - b. Anemostat Products; a Mestek company.
  - c. Carnes Company.
  - d. Dayus Register & Grille Inc.
  - e. Hart & Cooley Inc.

- f. Kees, Inc.
  - g. Krueger-HVAC; brand of Johnson Controls International plc, Global Products.
  - h. Nailor Industries Inc.
  - i. Price Industries.
  - j. Shoemaker Mfg. Co.
  - k. Titus; brand of Johnson Controls International plc, Global Products.
  - l. Tuttle & Bailey; brand of Johnson Controls International plc, Global Products.
2. See plans for additional requirements.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install registers and grilles level and plumb.
- B. Outlets and Inlets Locations: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

### 3.2 ADJUSTING

- A. After installation, adjust registers and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713.23

## SECTION 235216 - CONDENSING BOILERS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes packaged, factory-fabricated and -assembled, modulating, gas-fired, fire-tube condensing boilers, trim, and accessories for generating hot water.

#### 1.2 SUBMITTALS

- A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Source quality-control test reports.
- D. Field quality-control test reports.
- E. Operation and maintenance data.
- F. Warranty: Special warranty specified in this Section.
- G. Refer to Section 01 9113 General Commissioning Requirements for commissioning-related submittals and submittal review processes.

#### 1.3 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. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.
- C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
- D. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."

- E. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

#### 1.4 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period. This is a material only warranty.
  - 1. Warranty Period for Condensing Boiler: 10 years from date of Substantial Completion for heat exchanger tubes.
  - 2. Warranty Period for Condensing Boiler: 1 year, full boiler parts and labor warranty.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Subject to compliance with requirements presented below, provide the product indicated on Drawings or request prior approval for an equal:
  - 1. Lochinvar FTXL Series
- B. The following requirements must be met and proven in a prior approval submittal to be considered for bidding:
  - 1. Prove that the submitted alternate will fit, including all manufacturer's clearances, connections, piping, etc, in the space provided.
  - 2. Prove that the boiler will meet the following requirements:
    - a. Modulation of firing rate - minimum 10:1
    - b. Condensing boiler with 92% efficiency at 100°F entering water temperature at full fire.
    - c. On board boiler controller with sequencing capabilities.
    - d. Primary constant flow with secondary boiler pump required.

#### 2.2 MANUFACTURED UNITS

- A. Description: Factory-fabricated, -assembled, and -tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Water heating service only.
- B. Heat Exchanger: Individually removable 316L stainless steel heat exchanger tubes.
- C. Combustion Chamber: Stainless steel, sealed.
- D. Burner: Natural gas, forced draft drawing from gas premixing valve.

- E. Blower: Centrifugal fan to operate during each burner firing sequence and to prepurge and postpurge the combustion chamber.
  - 1. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
    - a. 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.
- F. Gas Train: Combination gas valve with manual shutoff and pressure regulator. Provide with ASME CSD-1 components.
- G. Casing:
  - 1. 16 ga. Jacket: Sheet metal, with snap-in or interlocking closures.
  - 2. Control Compartment Enclosures: NEMA 250, Type 1A.
  - 3. Finish: Heat resistant powder coating.
  - 4. Insulation: Minimum 1-inch-thick, mineral-fiber insulation surrounding the heat exchanger.
  - 5. Combustion-Air Connections: Inlet and vent duct collars.
  - 6. Mounting base to secure boiler.
  - 7. Access: Provide access panels to allow for cleaning of entire tube area.
- H. Characteristics and Capacities:
  - 1. See Schedule on Drawings for complete information.

### 2.3 TRIM

- A. Include devices sized to comply with ANSI B31.9, "Building Services Piping."
- B. Aquastat Controllers: Operating, firing rate, and high limit.
- C. Safety Relief Valve: ASME rated.
- D. Pressure and Temperature Gage: Minimum 3-1/2-inch-diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.
- E. Boiler Air Vent: Manual.
- F. Drain Valve: Minimum NPS 3/4 hose-end gate valve.
- G. Water flow switch.
- H. Condensate neutralization kit.

### 2.4 CONTROLS

- A. Refer to Division 23 Section "Direct Digital Control (DDC) System For HVAC."

- B. Boiler operating controls shall include the following devices and features:
  - 1. Control transformer.
  - 2. Set-Point Adjust: Set points shall be adjustable.
  - 3. Sequence of Operation: See Specification Section 230993.11.
  
- C. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
  - 1. High Cutoff: Manual reset stops burner if operating conditions rise above maximum boiler design temperature.
  - 2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manual-reset type.
  - 3. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
  - 4. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.
  
- D. Building Automation System Interface (BacNet): Factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms. See 230993 for points list and requirements.
  - 1. A communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building automation system.

## 2.5 ELECTRICAL POWER

- A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.
  
- B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
  - 1. House in NEMA 250, Type 1 enclosure.
  - 2. Wiring shall be numbered and color-coded to match wiring diagram.
  - 3. Install factory wiring outside of an enclosure in a raceway.
  - 4. Field power interface shall be to fused disconnect switch.
  - 5. Provide branch power circuit to each motor and to controls.
  - 6. Provide each motor with overcurrent protection.

## 2.6 VENTING KITS

- A. Kit: Complete system, ASTM A 959, Type 29-4C stainless steel, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap and dilution tank, and sealant.

- B. Combustion-Air Intake: Complete system, galvanized steel, pipe, vent terminal with screen, inlet air coupling, and sealant.

## 2.7 SOURCE QUALITY CONTROL

- A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
- B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

## PART 3 - EXECUTION

### 3.1 BOILER INSTALLATION

- A. Install boilers level on concrete base. Concrete base is specified in Division 23 Section "Common Work Results for HVAC," and concrete materials and installation requirements are specified in Division 03.
- B. Install gas-fired boilers according to NFPA 54 and ASME CSD-1.
- C. Assemble and install boiler trim.
- D. Install electrical devices furnished with boiler but not specified to be factory mounted.
- E. Install control wiring to field-mounted electrical devices.

### 3.2 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 boiler to allow service and maintenance.
- C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
- D. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service.
- E. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.
- F. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.
- G. Install piping from safety relief valves to nearest floor drain.

- H. Boiler Venting:
  - 1. Install flue venting kit and combustion-air intake.
  - 2. Connect full size to boiler connections. Comply with manufacturer's installation instructions.
- I. Ground equipment according to Division 26 Section 260526 "Grounding and Bonding for Electrical Systems."
- J. Connect wiring according to Division 26 Section 260529 "Low-Voltage Electrical Power Conductors and Cables."

### 3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.

Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

- B. Tests and Inspections:
  - 1. Perform installation and startup checks according to manufacturer's written instructions.
  - 2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
  - 3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
    - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and water temperature.
    - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. 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.

### 3.4 DEMONSTRATION AND TRAINING

- A. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner, General Contractor, and the Commissioning Professional. Provide competent, factory-authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, troubleshooting, routine servicing and maintenance of the installed systems. The instruction shall be scheduled in coordination with the Owner and the Commissioning Professional after submission and approval of formal training agendas. Refer to Sections 01 9113 General Commissioning Requirements.

- B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers.

### 3.1 FUNCTIONAL PERFORMANCE TESTING

- A. System functional performance testing is part of the Commissioning Process as detailed in Section 01 9113 General Commissioning Requirements. Functional performance testing shall be performed by the contractor and witnessed and documented by the Commissioning Professional. Installation checklists shall be successfully completed by the contractor and submitted to the Commissioning Professional prior to functional performance testing.

END OF SECTION 235216

## SECTION 237416.13 - PACKAGED, LARGE-CAPACITY, AIR-CONDITIONING UNITS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes packaged, large-capacity, air conditioning units (RTUs) with the following components:
  - 1. Casings.
  - 2. Fans, drives, and motors.
  - 3. Coils.
  - 4. Refrigerant circuit components.
  - 5. Air filtration.
  - 6. Gas furnaces.
  - 7. Dampers.
  - 8. Electrical power connections.
  - 9. Controls.
  - 10. Accessories.
  
- B. This section specifies a system or part of a system being commissioned as defined in 01 9113 General Commissioning Requirements. Testing of these systems, as well as Operations & Maintenance (O&M) Manuals and Training of the Owner's personnel, is required in cooperation with the Owner, General Contractor, and the Commissioning Professional. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to 01 9113 General Commissioning Requirements for detailed commissioning requirements.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of RTU.
  
- B. Shop Drawings: For each packaged, large-capacity, air-conditioning units.
  - 1. Include plans, elevations, sections, and mounting details.
  - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Include diagrams for power, signal, and control wiring.
  
- C. Refer to Section 01 9113 General Commissioning Requirements for commissioning-related submittals and submittal review processes.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

- B. Sample Warranty: For manufacturer's warranty.
- C. Source quality-control reports.
- D. System startup reports.
- E. Field quality-control reports.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

#### 1.5 WARRANTY

- A. Warranty: Manufacturer agrees to repair or replace components of outdoor, semi-custom, air-handling unit that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: 1 year(s) from date of Substantial Completion.
  - 2. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than five years from date of Substantial Completion

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of RTUs and components.
- C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- D. ASHRAE 15 Compliance: For refrigeration system safety.
- E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- F. UL Compliance: Comply with UL 1995.
- G. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design mounting and restraints for RTUs, including comprehensive engineering analysis.
  - 1. Design RTU supports to comply with seismic performance requirements.

H. Seismic Performance: RTUs shall withstand the effects of earthquake motions determined according to ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified".
2. Component Importance Factor: 1.0.

## 2.2 CAPACITIES AND CHARACTERISTICS

A. See Plans

## 2.3 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AAON.
2. Addison.
3. Allied Commercial.
4. Carrier Global Corporation.
5. Daikin Applied.
6. Engineered Air.
7. Lennox Industries, Inc.; Lennox International.
8. Rheem Manufacturing Company; Heating and Cooling Products.
9. Trane.
10. Valent.
11. YORK; brand of Johnson Controls International plc, Building Solutions North America.

## 2.4 UNIT CASINGS

A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.

B. Double-Wall Construction:

1. Outside Casing Wall: Galvanized steel, minimum 18 gauge thick with manufacturer's standard finish, with knockouts with grommet seals for electrical and piping connections and lifting lugs.
2. Inside Casing Wall: G90-coated galvanized steel, 0.034 inch thick.
3. Floor Plate: G90 galvanized steel, treadplate, minimum 18 gauge thick.
4. Casing Insulation:
  - a. Materials: Injected polyurethane foam insulation.
  - b. Casing Panel R-Value: Minimum R-13.
  - c. Insulation Thickness: 2 inches.
  - d. Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roof of unit.

- C. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.
- D. Static-Pressure Classifications:
  - 1. For Unit Sections Upstream of Fans: Minus 3.5-inch wg.
  - 2. For Unit Sections Downstream and Including Fans: 3.5-inch wg .
- E. Panels and Doors:
  - 1. Panels:
    - a. Fabrication: Formed and reinforced with same materials and insulation thickness as casing.
    - b. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
    - c. Gasket: Neoprene, applied around entire perimeters of panel frames.
    - d. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components. Dimensions to be at least 18 inches wide by full height of unit casing up to a maximum height of 60 inches.
  - 2. 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: Large enough to allow inspection and maintenance of air-handling unit's internal components. Dimensions to be at least 18 inches wide by full height of unit casing up to a maximum height of 60 inches.
  - 3. Locations and Applications:
    - a. Fan Section: Inspection and access panels.
    - b. Access Section: Doors.
    - c. Coil Section: Inspection and access panels.
    - d. Damper Section: Inspection and access panels.
    - e. Filter Section: Inspection and access panels large enough to allow periodic removal and installation of filters.
    - f. Mixing Section: Doors.
  - 4. Service Light: 100-W vaporproof fixture with switched junction box located outside adjacent to door.
    - a. Locations: Each section accessed with door.
- F. Condensate Drain Pans:
  - 1. Location: Each type of cooling coil.
  - 2. Construction:

- a. Single-wall, stainless steel sheet.
  - b. Double-wall, stainless steel sheet with space between walls filled with foam insulation and moisture-tight seal.
3. Drain Connection:
- a. Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on both ends of pan.
  - b. Minimum Connection Size: NPS 1.
4. Slope: Minimum 0.125-in./ft. slope, to comply with ASHRAE 62.1, 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.
5. Length: Extend drain pan downstream from leaving face for distance to comply with ASHRAE 62.1.
6. Width: Entire width of water producing device.
7. Depth: A minimum of 2 inches deep.
8. Pan-Top Surface Coating for Galvanized-Steel Drain Pans: Asphaltic waterproofing compound.
9. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

## 2.5 FANS, DRIVES, AND MOTORS

- A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
- B. Supply-Air Fans: Centrifugal, rated according to AMCA 210; galvanized or painted steel; mounted on solid-steel shaft.
- 1. Shafts: With field-adjustable alignment.
    - a. Turned, ground, and polished hot-rolled steel with keyway.
  - 2. Shaft Bearings:
    - a. Heavy-duty, self-aligning, pillow-block type with an L-50 rated life of minimum 100,000 hours according to ABMA 9.
  - 3. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.
    - a. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.
  - 4. Centrifugal Fan Wheels: Inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically fastened to flange and backplate; steel or aluminum hub swaged to backplate and fastened to shaft with setscrews.

5. Mounting: For internal vibration isolation and seismic control. Factory-mount fans with manufacturer's standard vibration isolation mounting devices having a minimum static deflection of 1 inch.
6. Shaft Lubrication Lines: Extended to a location outside the casing.
7. Flexible Connector: Factory fabricated with a fabric strip minimum 3-1/2 inches wide, attached to two strips of minimum 2-3/4-inch-wide by 0.028-inch-thick, galvanized-steel sheet.
  - a. Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.

C. Drives, Direct: Factory-mounted, direct drive.

D. Drives, Belt: Factory-mounted, V-belt drive, 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 the factory.
2. Belts: Oil resistant, non-sparking and nonstatic; in matched sets for multiple-belt drives.
3. Belt Guards: Comply with requirements specified by OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; 0.146-inch-thick, 3/4-inch diamond-mesh wire screen, welded to steel angle frame; prime coated.

E. Condenser-Coil Fan: Variable-speed propeller, mounted on shaft of permanently lubricated multispeed motors.

F. Relief-Air Fan: Backward inclined, shaft mounted on permanently lubricated motor.

G. Motors:

1. 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."
2. 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.
3. Enclosure Type: Open, dripproof.
4. Enclosure Materials: Cast iron.

## 2.6 COILS

A. General Requirements for Coils:

1. Comply with AHRI 410.
2. Fabricate coils 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.

B. Supply-Air Refrigerant Coil:

1. Tubes: Copper.

2. Fins:
  - a. Material: Aluminum.
  - b. Fin Spacing: Maximum 12 fins per inch.
3. Fin and Tube Joints: Mechanical bond.
4. Headers: Seamless-copper headers with brazed connections.
5. Frames: Stainless steel.
6. Ratings: Designed, tested, and rated according to ASHRAE 33 and AHRI 410.
  - a. Working Pressure: Minimum 300 psig.

## 2.7 REFRIGERANT CIRCUIT COMPONENTS

- A. Number of Refrigerant Circuits: Two.
- B. Compressor: Hermetic, variable speed scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater.
- C. Refrigeration Specialties:
  1. Refrigerant: R-410A.
  2. Expansion valve with replaceable thermostatic element.
  3. Refrigerant filter/dryer.
  4. Manual-reset high-pressure safety switch.
  5. Automatic-reset low-pressure safety switch.
  6. Minimum off-time relay.
  7. Automatic-reset compressor motor thermal overload.
  8. Brass service valves installed in compressor suction and liquid lines.
  9. Four-way reversing valve with a replaceable magnetic coil, thermostatic expansion valves with bypass check valves, and a suction line accumulator.

## 2.8 AIR FILTRATION

- A. Particulate air filtration is specified in Section 23 41 00 "Particulate Air Filtration."
- B. Panel Filters:
  1. Description: Flat, non-pleated factory-fabricated, self-supported, disposable air filters with holding frames.
  2. Filter Unit Class: UL 900.
  3. Media: Interlaced glass, synthetic or cotton fibers coated with nonflammable adhesive and antimicrobial coating.
  4. Filter-Media Frame: Beverage board with perforated metal retainer, or metal grid, on outlet side.
  5. Filters to be mounted with MERV 8 / MERV13 Arrangement.

## 2.9 GAS FURNACES

- A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47/CSA 2.3 and NFPA 54.
- B. CSA Approval: Designed and certified by and bearing label of CSA.
- C. Burners: Stainless steel.
  - 1. Rated Minimum Turndown Ratio: 9 to 1.
  - 2. Fuel: Natural gas.
  - 3. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.
  - 4. Gas Control Valve: Modulating.
  - 5. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.
  - 6. High-Altitude Model or Kit: For Project elevations more than 2000 feet above sea level.
- D. Heat-Exchanger and Drain Pan: Stainless steel.
- E. Venting, Gravity: Gravity vented.
- F. Venting, Power: Power vented, with integral, motorized centrifugal fan interlocked with gas valve.
- G. Safety Controls:
  - 1. Gas Manifold: Safety switches and controls complying with ANSI standards.

## 2.10 DAMPERS

- A. Outdoor- and Return-Air Dampers: Low-leakage, double-skin, airfoil-blade, galvanized-steel dampers with compressible jamb seals and extruded-vinyl blade edge seals in opposed-blade arrangement with zinc-plated steel operating rods rotating in sintered bronze or nylon bearings mounted in a single galvanized-steel frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 4 cfm/sq. ft. at 1-inch wg and 8 cfm/sq. ft. at 4-inch wg
- B. Barometric relief dampers.
- C. Electronic Damper Operators:
  - 1. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
  - 2. Electronic damper position indicator shall have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
  - 3. Operator Motors:
    - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors.
    - b. Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
    - c. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring

mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.

4. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
5. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.
6. Size dampers for running torque calculated as follows:
  - a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
  - b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
  - c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft. of damper.
  - d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
  - e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
  - f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.
7. Coupling: V-bolt and V-shaped, toothed cradle.
8. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
9. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
10. Power Requirements (Two-Position Spring Return): 24 V dc.
11. Power Requirements (Modulating): Maximum 10 VA at 24 V ac or 8 W at 24 V dc.
12. Proportional Signal: 2 to 10 V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
13. Temperature Rating: Minus 22 to plus 122 deg F.
14. Run Time: 12 seconds open, 5 seconds closed.

## 2.11 ELECTRICAL POWER CONNECTIONS

- A. RTU shall have a single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

## 2.12 CONTROLS

- A. DDC Controller:
  1. Controller shall have volatile-memory backup.
  2. Safety Control Operation:
    - a. Smoke Detectors: Stop fan and close outdoor-air damper if smoke is detected. Provide additional contacts for alarm interface to fire alarm control panel.
    - b. Firestats: Stop fan and close outdoor-air damper if air greater than 130 deg F enters unit. Provide additional contacts for alarm interface to fire alarm control panel.
    - c. Fire Alarm Control Panel Interface: Provide control interface to coordinate with operating sequence described in Section 28 46 21.11 "Addressable Fire-Alarm Systems."

- d. Low-Discharge Temperature: Stop fan and close outdoor-air damper if supply air temperature is less than 40 deg F.
  - e. Defrost Control for Condenser Coil: Pressure differential switch to initiate defrost sequence.
3. Terminal-Unit Relays:
- a. Provide heating- and cooling-mode changeover relays compatible with terminal control system required in Section 233600 "Air Terminal Units" and Section 230923 "Direct Digital Control (DDC) System for HVAC."
- B. Interface Requirements for HVAC Instrumentation and Control System:
- 1. Interface relay for scheduled operation.
  - 2. Interface relay to provide indication of fault at the central workstation and diagnostic code storage.
  - 3. Provide BACnet compatible interface for central HVAC control workstation for the following:
    - a. Adjusting set points.
    - b. Monitoring supply fan start, stop, and operation.
    - c. Inquiring data to include outdoor-air damper position, supply- and room-air temperature and humidity.
    - d. Monitoring occupied and unoccupied operations.
    - e. Monitoring constant and variable motor loads.
    - f. Monitoring variable-frequency drive operation.
    - g. Monitoring cooling load.
    - h. Monitoring economizer cycles.
    - i. Monitoring air-distribution static pressure and ventilation air volume.

## 2.13 ACCESSORIES

- A. Electric heater with integral thermostat maintains minimum 50 deg F temperature in gas burner compartment.
- B. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open.
- C. Filter differential pressure switch with sensor tubing on either side of filter bank. Set for final filter pressure loss.
- D. Remote potentiometer to adjust minimum economizer damper position.
- E. Return-air bypass damper.
- F. Safeties:
  - 1. Smoke detector.
  - 2. Condensate overflow switch.
  - 3. Phase-loss protection.

4. High pressure control.
  5. Gas furnace airflow-proving switch.
- G. Coil guards of painted, galvanized-steel wire.
- H. Hail guards of galvanized steel, painted to match casing.
- I. Concentric diffuser with white louvers and polished aluminum return grilles, insulated diffuser box with mounting flanges, and interior transition.
- J. Vertical vent extensions to increase the separation between the outdoor-air intake and the flue-gas outlet.
- K. Door switches to disable heating or reset set point when open.
- L. Outdoor air intake weather hood.
- M. Service Lights and Switch: Factory installed in fan and coil sections with weatherproof cover. Factory wire lights to a single-point field connection.
- N. UV Light Kit installed in DX coil section.

## 2.14 MATERIALS

- A. Steel:
1. ASTM A36/A36M for carbon structural steel.
  2. ASTM A568/A568M for steel sheet.
- B. Stainless Steel:
1. Manufacturer's standard grade for casing.
  2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.
- C. Galvanized Steel: ASTM A653/A653M.
- D. Aluminum: ASTM B209.
- E. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a 3000-hour salt-spray test according to ASTM B117.
1. Standards:
    - a. ASTM B117 for salt spray.
    - b. ASTM D2794 for minimum impact resistance of 100 in-lb.
    - c. ASTM B3359 for cross-hatch adhesion of 5B.
  2. Application: Immersion.
  3. Thickness: 1 mil.
  4. Gloss: Minimum gloss of 60 on a 60-degree meter.

## 2.15 SOURCE QUALITY CONTROL

### A. AHRI Compliance:

1. Comply with AHRI 340/360 for testing and rating energy efficiencies for RTUs.
2. Comply with AHRI 210/240 for testing and rating energy efficiencies for RTUs
3. Comply with AHRI 270 for testing and rating sound performance for RTUs.
4. Comply with AHRI 1060 for testing and rating performance for air-to-air exchanger.

### B. AMCA Compliance:

1. Comply with AMCA 11 and bear the AMCA-Certified Ratings Seal for air and sound performance according to AMCA 211 and AMCA 311.
2. Damper leakage tested in accordance with AMCA 500-D.
3. Operating Limits: Classify according to AMCA 99.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.
- B. Unit Support: Install unit level on concrete slab. Secure RTUs to slab support with anchor bolts.

### 3.2 PIPING CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to RTU, allow space for service and maintenance.
- C. Connect piping to unit mounted on vibration isolators with flexible connectors.
- D. Connect condensate drain pans using NPS 1-1/4, ASTM B88, Type M copper tubing. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
- E. Gas Piping: Comply with applicable requirements in Section 231126 "Facility Liquified-Petroleum Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.
- F. Refrigerant Piping: Comply with applicable requirements in Section 23 23 00 "Refrigerant Piping." Install shutoff valve and union or flange at each supply and return connection.

### 3.3 DUCT CONNECTIONS

- A. Comply with duct installation requirements specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

1. Connect supply ducts to RTUs with flexible duct connectors specified in Section 233300 "Air Duct Accessories."

### 3.4 ELECTRICAL CONNECTIONS

- A. Connect electrical wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
- D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
  1. Locate nameplate where easily visible.

### 3.5 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.

### 3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
  2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
  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.
- C. RTU will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

### 3.7 DEMONSTRATION AND TRAINING

- A. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner, General Contractor, and the Commissioning Professional. Provide competent, factory-authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, troubleshooting, routine servicing and maintenance of the

installed systems. The instruction shall be scheduled in coordination with the Owner and the Commissioning Professional after submission and approval of formal training agendas. Refer to Sections 01 9113 General Commissioning Requirements.

- B. Engage a factory-authorized service representative to train and Train Owner's maintenance personnel to adjust, operate, and maintain RTUs.

### 3.8 FUNCTIONAL PERFORMANCE TESTING

- A. System functional performance testing is part of the Commissioning Process as detailed in Section 01 9113 General Commissioning Requirements. Functional performance testing shall be performed by the contractor and witnessed and documented by the Commissioning Professional. Installation checklists shall be successfully completed by the contractor and submitted to the Commissioning Professional prior to functional performance testing.

END OF SECTION 237416.13

## SECTION 238239.13 - CABINET UNIT HEATERS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes cabinet unit heaters with centrifugal fans and hot-water coils.

#### 1.2 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.
- C. Samples: For each exposed product and for each color and texture specified.

#### 1.3 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 cabinet 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.

6. Perimeter moldings for exposed or partially exposed cabinets.
- B. Seismic Qualification Certificates: Submit certification that cabinet unit heaters, accessories, and components will withstand seismic forces defined in Section 23 05 48 "Vibration and Seismic Controls for HVAC."
- C. Field quality-control reports.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. JCI
  2. Rittling
  3. Sigma
  4. Vulcan.

#### 2.2 DESCRIPTION

- A. Factory-assembled and -tested unit complying with AHRI 440.
- 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.

#### 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: Cabinet 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."

## 2.4 COIL SECTION INSULATION

- A. Insulation Materials: ASTM C 1071; surfaces exposed to airstream shall have aluminum foil facing to prevent erosion of glass fibers.
  - 1. Thickness: 1 inch.
  - 2. Thermal Conductivity (k-Value): 0.26 Btu x in./h x sq. ft. at 75 deg F mean temperature.
  - 3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
  - 4. Adhesive: Comply with ASTM C 916 and with NFPA 90A or NFPA 90B.
  - 5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
  
- B. Insulation Materials: Comply with NFPA 90A or NFPA 90B. Unicellular polyethylene thermal plastic, preformed sheet insulation complying with ASTM C 534, Type II, except for density.
  - 1. Thickness: 1/2 inch.
  - 2. Thermal Conductivity (k-Value): 0.24 Btu x in./h x sq. ft. at 75 deg F mean temperature.
  - 3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM C 411.
  - 4. Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
  - 5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

## 2.5 CABINETS

- A. Material: Steel with baked-enamel finish with manufacturer's standard paint, in color selected by Architect.
  - 1. Vertical Unit, Exposed Front Panels: Minimum 0.0677-inch-thick sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.
  - 2. Horizontal Unit, Exposed Bottom Panels: Minimum 0.0677-inch-thick sheet steel, removable panels secured with tamperproof cam fasteners and safety chain.
  - 3. Recessed Flanges: Steel, finished to match cabinet.
  - 4. Control Access Door: Key operated.
  - 5. Base: Minimum 0.0528-inch-thick steel, finished to match cabinet, 4 inches high with leveling bolts.
  - 6. Extended Piping Compartment: 8-inch-wide piping end pocket.

## 2.6 FILTERS

- A. Minimum Arrestance: According to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
  - 1. Glass Fiber Treated with Adhesive: 80 percent arrestance and MERV 5.

## 2.7 COILS

- A. Hot-Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.

## 2.8 CONTROLS

- A. Fan and Motor Board: Removable.
  - 1. Fan: Forward curved, double width, centrifugal, directly connected to motor; thermoplastic or painted-steel wheels and aluminum, painted-steel, or galvanized-steel fan scrolls.
  - 2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."
  - 3. Wiring Terminations: Connect motor to chassis wiring with plug connection.
- B. Control devices and operational sequences are specified in Section 23 09 23 "Direct Digital Control (DDC) System for HVAC" and Section 23 09 93.11 "Sequence of Operations for HVAC DDC."
- C. Electrical Connection:
  - 1. Factory-wired motors and controls for a single field connection.
  - 2. Provide transformer as needed for 277V power supplied to unit.

## 2.9 CAPACITIES AND CHARACTERISTICS

- A. Cabinet: As scheduled.
  - 1. Vertical, Surface Mounted: Upflow.
    - a. Top: Sloped.
    - b. Air Inlet: Front, punched louver.
    - c. Air Outlet: Top.
  - 2. Vertical, Surface Mounted: Downflow.
    - a. Top: Flat.
    - b. Air Inlet: Front, .
    - c. Air Outlet: Front, punched louver.
  - 3. Horizontal, Fully Recessed:
    - a. Air Inlet: , punched louver.
    - b. Air Outlet: , punched louver.
- B. Fan:

- 1. As Scheduled.
- C. Heating Capacity:
  - 1. As Scheduled.
- D. Hot-Water Heating Coil:
  - 1. As Scheduled.
- E. Electrical Characteristics for Single-Point Connection:
  - 1. As Scheduled.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine areas to receive cabinet unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before unit-heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

- A. Install wall boxes in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Section 079200 "Joint Sealants."
- B. Install cabinet unit heaters to comply with NFPA 90A.
- C. Suspend cabinet unit heaters from structure with elastomeric hangers.
- 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.
- E. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

#### 3.3 CONNECTIONS

- A. Piping installation requirements are specified in Section 23 21 13 "Hydronic Piping," Section 23 21 16 Hydronic Piping Specialties," Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.

- C. Connect piping to cabinet unit heater's factory, hot-water piping package. Install the piping package if shipped loose.
- D. Connect supply and return ducts to cabinet unit heaters with flexible duct connectors specified in Section 23 33 00 "Air Duct Accessories."
- E. Comply with safety requirements in UL 1995.
- F. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of cabinet unit heater. Hydronic specialties are specified in Section 23 21 13 "Hydronic Piping" and Section 23 21 16 "Hydronic Piping Specialties."

#### 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. 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.

END OF SECTION 238239.13

## SECTION 238316 - RADIANT-HEATING HYDRONIC PIPING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes radiant-heating piping, including pipes, fittings, and piping specialties.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include data for piping, fittings, manifolds, specialties, and controls; include pressure and temperature ratings, oxygen-barrier performance, fire-performance characteristics, and water-flow and pressure-drop characteristics.
- B. Shop Drawings: Show radiant heating piping layout and details drawn to scale, including valves, manifolds, controls, and support assemblies, and their attachments to building structure.

#### 1.3 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

### PART 2 - PRODUCTS

#### 2.1 PEX PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. REHAU
  - 2. Watts
  - 3. Uponor
  - 4. Viegd
- B. Pipe Material: PEX plastic according to ASTM F 876.
- C. Oxygen Barrier: Limit oxygen diffusion through the tube to maximum 0.10 mg per cu. m/day at 104 deg F according to DIN 4726.
- D. Fittings: ASTM F 1807, metal insert and copper crimp rings.
- E. Pressure/Temperature Rating: Minimum 100 psig and 180 deg F.

## 2.2 PEX/AL/PEX PIPE AND FITTINGS

- 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. REHAU
  - 2. Watts
  - 3. Uponor
  - 4. Viegd
- B. Pipe Material: PEX plastic bonded to the inside and outside of a welded aluminum tube according to ASTM F 1281.
- C. Oxygen Barrier: Limit oxygen diffusion through the pipe to maximum 0.10 mg per cu. m/day at 104 deg F according to DIN 4726.
- D. Fittings: ASTM F 1974, metal insert fittings with split ring and compression nut (compression joint) or metal insert fittings with copper crimp rings (crimp joint).
- E. Flame-Spread and Smoke-Developed Indices: 25 and 50 or less, respectively, tested according to ASTM E 84.
- F. Pressure/Temperature Rating: Minimum 100 psig and 210 deg F.

## 2.3 DISTRIBUTION MANIFOLDS

- A. Manifold: Minimum NPS 1, brass or copper.
- B. Main Shutoff Valves:
  - 1. Factory installed on supply and return connections.
  - 2. Two-piece body.
  - 3. Body: Brass or bronze.
  - 4. Ball: Chrome-plated bronze.
  - 5. Seals: PTFE.
  - 6. CWP Rating: 150 psig.
  - 7. Maximum Operating Temperature: 225 deg F.
- C. Manual Air Vents:
  - 1. Body: Bronze.
  - 2. Internal Parts: Nonferrous.
  - 3. Operator: Key furnished with valve, or screwdriver bit.
  - 4. Inlet Connection: NPS 1/2.
  - 5. Discharge Connection: NPS 1/8.
  - 6. CWP Rating: 150 psig.
  - 7. Maximum Operating Temperature: 225 deg F.
- D. Balancing Valves:
  - 1. Body: Plastic or bronze, ball or plug, or globe cartridge type.

2. Ball or Plug: Brass or stainless steel.
3. Globe Cartridge and Washer: Brass with EPDM composition washer.
4. Seat: PTFE.
5. Visual Flow Indicator: Flowmeter with visible indication in a clear plastic cap at top of valve.
6. Differential Pressure Gage Connections: Integral seals for portable meter to measure loss across calibrated orifice.
7. Handle Style: Lever or knob, with memory stop to retain set position if used for shutoff.
8. CWP Rating: Minimum 125 psig.
9. Maximum Operating Temperature: 250 deg F.

E. Zone Control Valves:

1. Body: Plastic or bronze, ball or plug, or globe cartridge type.
2. Ball or Plug: Brass or stainless steel.
3. Globe Cartridge and Washer: Brass with EPDM composition washer.
4. Seat: PTFE.
5. Actuator: Replaceable electric motor.
6. CWP Rating: Minimum 125 psig.
7. Maximum Operating Temperature: 250 deg F.

F. Thermometers:

1. Mount on supply and return connections.
2. Case: Dry type, metal or plastic, 2-inch diameter.
3. Element: Bourdon tube or other type of pressure element.
4. Movement: Mechanical, connecting element and pointer.
5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
6. Pointer: Black metal.
7. Window: Plastic.
8. Connector: Rigid, back type.
9. Thermal System: Liquid- or mercury-filled bulb in copper-plated steel, aluminum, or brass stem.
10. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

G. Mounting Brackets: Copper, or plastic- or copper-clad steel, where in contact with manifold.

## 2.4 PIPING SPECIALTIES

A. Cable Ties:

1. Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.
2. Minimum Width: 1/8 inch.
3. Tensile Strength: 20 lb, minimum.
4. Temperature Range: Minus 40 to plus 185 deg F.

B. Floor Mounting Staples:

1. Steel, with corrosion-resistant coating and smooth finish without sharp edges.

2. Minimum Thickness: 3/32 inch.
3. Width: Minimum, wider than tubing.

C. Floor Mounting Clamps:

1. Two bolts, steel, with corrosion-resistant coating and smooth finish without sharp edges.
2. Minimum Thickness: 3/32 inch.
3. Width: Minimum, wider than tubing.

## 2.5 CONTROLS

- A. Controls are by the Temperature Control Contractor.

## PART 3 - EXECUTION

### 3.1 APPLICATIONS

- A. Install the following types of radiant-heating piping for the applications described:
1. Piping in Exterior Pavement: PEX.
  2. Piping in Interior Reinforced-Concrete Floors: PEX.
  3. Piping in Level Fill Concrete Floors (Not Reinforced): PEX.

### 3.2 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 Shop Drawings or coordination drawings.
- B. Install radiant-heating piping continuous from the manifold through the heated panel and back to the manifold without piping joints in heated panels.
- C. Connect radiant piping to manifold in a reverse-return arrangement.
- D. Do not bend pipes in radii smaller than manufacturer's minimum bend radius dimensions.
- E. Install manifolds in accessible locations, or install access panels to provide maintenance access.
- F. See Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties" for pipes and connections to hydronic systems and for glycol-solution fill requirements.
- G. Fire- and Smoke-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.
- H. Piping in Exterior Pavement:
1. Secure piping in concrete floors by attaching pipes to reinforcement using cable ties.

2. Space cable ties a maximum of 18 inches o.c. and at center of turns or bends.
  3. Maintain 3-inch minimum cover.
  4. Install a sleeve of 3/8-inch-thick, foam-type insulation or PE pipe around tubing and extending for a minimum of 10 inches on each side of slab joints to protect the tubing passing through expansion or control joints. Anchor sleeve to slab form at control joints to provide maximum clearance for saw cut.
  5. Maintain minimum 40-psig pressure in piping during concrete placement and continue for 24 hours after placement.
- I. Piping in Interior Reinforced-Concrete Floors:
1. Secure piping in concrete floors by attaching pipes to reinforcement using cable ties.
  2. Space cable ties a maximum of 18 inches o.c. and at center of turns or bends.
  3. Maintain 2-inch minimum cover.
  4. Install a sleeve of 3/8-inch-thick, foam-type insulation or PE pipe around tubing and extending for a minimum of 10 inches on each side of slab joints to protect the tubing passing through expansion or control joints. Anchor sleeve to slab form at control joints to provide maximum clearance for saw cut.
  5. Maintain minimum 40-psig pressure in piping during concrete placement and continue for 24 hours after placement.
- J. Piping in Level Fill Concrete Floors (Not Reinforced):
1. Secure piping in concrete floors by attaching pipes to subfloor using tracks, clamps, or staples.
  2. Space tracks, clamps, or staples a maximum of 18 inches o.c. and at center of turns or bends.
  3. Maintain 3/4-inch minimum cover.
  4. Install a sleeve of 3/8-inch-thick, foam-type insulation or PE pipe around tubing and extending for a minimum of 10 inches on each side of slab joints to protect the tubing passing through expansion or control joints. Anchor sleeve to slab form at control joints to provide maximum clearance for saw cut.
  5. Maintain minimum 40-psig pressure in piping during the concrete pour and continue for 24 hours during curing.
- K. Revise locations and elevations from those indicated as required to suit field conditions and ensure integrity of piping and as approved by Architect.
- L. After system balancing has been completed, mark balancing valves to permanently indicate final position.
- M. Perform the following adjustments before operating the system:
1. Open valves to fully open position.
  2. Check operation of automatic valves.
  3. Set temperature controls so all zones call for full flow.
  4. Purge air from piping.
- N. After concrete or plaster heating panel has cured as recommended by concrete or plaster supplier, operate radiant-heating system as follows:

1. Start system heating at a maximum of 10 deg F above the ambient radiant-panel temperature and increase 10 deg F each following day until design temperature is achieved.
2. For freeze protection, operate at a minimum of 60 deg F supply-water temperature.

### 3.3 FIELD QUALITY CONTROL

- A. Prepare radiant-heating piping for testing as follows:
  1. Open all isolation valves and close bypass valves.
  2. Open and verify operation of zone control valves.
  3. Flush with clean water and clean strainers.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  1. Leak Test: After installation, charge system and test for leaks. Subject piping to hydrostatic test pressure that is not less than 1.5 times the design pressure but not more than 100 psig. Repair leaks and retest until no leaks exist.
  2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Radiant-heating piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Protect hydronic piping system from damage during construction.

END OF SECTION 238316

## SECTION 260000 - ELECTRICAL GENERAL REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 ELECTRICAL REQUIREMENTS

- A. The electrical requirements are supplemental to the General and Supplementary Conditions and the General Requirements of these Specifications. The Electrical Sections shall apply to phases of the work specified, shown on the Drawings, or required to provide for the complete installation of Electrical Systems for this project.
- B. The work shall include all items, articles, materials, operations and methods listed, mentioned or scheduled in these specifications and the accompanying drawings. All material, equipment and labor shall be furnished together with all incidental items required by good practice to provide the complete systems described.
- C. Examine and refer to all Architectural, Structural, Landscape and Mechanical drawings and specifications for construction conditions which may affect the electrical work. Inspect the building site and existing facilities for verification of present conditions. Make proper provisions for these conditions in performance of the work and cost thereof.
- D. See general requirements for listed Alternate Bids. Note alternates listed and include any changes in work and price required to meet the requirements of the respective alternate.

#### 1.2 CODES AND STANDARDS

- A. Work shall meet the requirements of the plans and specifications and shall not be less than the minimum requirements of applicable sections of the latest Codes and Standards of the following organizations:
  - 1. American National Standards Institute (ANSI)
  - 2. Americans with Disabilities Act (ADA)
  - 3. Certified Ballast Manufacturers (CBM)
  - 4. Electrical Testing Laboratories (ETL)
  - 5. Independent Testing Laboratories (ITL)
  - 6. International Building Code (IBC)
  - 7. International Fire Code (IFC)
  - 8. National Electrical Code (NEC) Latest Edition
  - 9. National Electrical Manufacturers Association (NEMA)
  - 10. National Fire Protection Association (NFPA)
  - 11. Occupational Safety & Health Act (OSHA)
  - 12. Underwriters Laboratories (UL)
  - 13. Rules and Regulations of the State Fire Marshal
  - 14. Requirements of the Serving Utility Company
  - 15. Local and State Codes and Ordinances

### 1.3 FEES AND PERMITS

- A. The electrical contractor shall pay all fees and arrange for all permits required for work done under his contract and under his supervision by subcontract.
- B. Cost of primary work noted to be by Utility Company not to be included in Contractor's Bid. All charges made by the Utility Company for their part of the primary work will be billed directly to the Owner and paid for by the Owner.

### 1.4 MATERIALS AND EQUIPMENT

- A. Manufacturer's trade names and catalog numbers listed are intended to indicate the quality of equipment or materials desired. Manufacturers not listed must have prior approval. Written prior approval must be obtained from the Architect/Engineer ten (10) business days prior to bid opening. Requests are to be submitted sufficiently ahead of the deadline to give ample time for examination. The items approved will be listed in an addendum and only this list of equipment will be accepted in lieu of specified products. Submittals must indicate the specific item or items to be furnished in lieu of those specified, together with complete technical and comparative data on specified items and proposed items.
- B. Electrical equipment shall be installed with manufacturer's standard finish and color except where specific color, finish or choice is indicated. If the manufacturer has no standard finish, equipment shall have a prime coat and two finish coats of gray enamel.
- C. The electrical contractor shall be responsible for materials and equipment installed under this contract. Contractor shall also be responsible for the protection of materials and equipment of others from damage as a result of his work.
- D. Manufactured material and equipment shall be applied, installed, connected, erected, used, cleaned and conditioned as directed by the manufacturer unless herein specified to the contrary.
- E. The electrical contractor shall make the required arrangement with General Contractor for the introduction into the building of equipment too large to pass through finished openings.
- F. Materials and equipment shall be stored indoors at the job site or, if this is not possible, stored on raised platforms and protected from the weather by means of waterproof covers. Coverings shall permit circulation of air around the materials to prevent condensation of moisture. Screen or cap openings in equipment to prevent the entry of vermin.
- G. Lighting fixtures proposed as substitutes to those specified must have prior approval by Architect/Engineer as noted above. Approval will not be considered unless the request has all of the following information:
  - 1. Manufacturers data showing catalog number.
  - 2. Summary page on company letterhead with the following technical data: Lumens (LM), Watts (W), and Lumens/Watt (LPW) for each luminaire type.
  - 3. Construction details.
  - 4. Photometrics.
  - 5. Recommended maintenance factor.

## 1.5 INTENT OF DRAWINGS

- A. The drawings are partly diagrammatic and do not necessarily show exact location of conduit unless specifically dimensioned. Riser and other diagrams are schematic and do not necessarily show the physical arrangement of the equipment. They shall not be used for obtaining quantities or lineal runs of conduit. Discrepancies shown on different plans, or between plans and actual field conditions shall be brought to the attention of the Architect/Engineer for resolution.

## 1.6 RESPONSIBILITY

- A. The electrical contractor shall be responsible for the installation of satisfactory and complete systems in accordance with the intent of the drawings and specifications and shall provide, at no extra cost, all incidental items required for completion of the work even though they are not specifically mentioned or indicated on the drawings or in the specifications.
- B. The drawings do not attempt to show complete details of the building construction which affect the electrical installation; and reference is therefore required to the Architectural, Structural, Landscape and Mechanical drawings and specifications and to shop drawings of all trades for additional details which affect the installation of the work covered under this Division of the Contract.
- C. Location of electrical system components shall be checked for conflicts with openings, structural members and components of other systems having fixed locations. In the event of any conflicts, the Architect/Engineer shall be consulted and his decision shall govern. Necessary changes shall be made at no additional expense to the Architect/Engineer or Owner.
- D. The electrical contractor shall determine, and be responsible for, the proper location and character of inserts for hangers, chases, sleeves and other openings in the construction required for the work, and obtain this information well in advance of the construction progress so work will not be delayed. Roughing-in fixtures, etc., must be laid out accurately. Connections to equipment of the same class shall be equal heights, plumb, and at right angles to the wall, unless otherwise directed.
- E. Final location of inserts, hangers, etc., required for each installation, must be coordinated with facilities required for other installations to prevent interference.
- F. The electrical contractor shall take extreme caution not to install work that connects to equipment until such time as complete Shop Drawings of such equipment have been approved by the Architect/Engineer. Any work installed by the Contractor, prior to approval of Shop Drawings, will be at the Contractor's risk.
- G. At all times during the performance of this contract, the electrical contractor shall properly protect work from damage and protect the Owner's property from injury or loss. The contractor shall make good any damage, injury or loss, except such as may be directly due to errors in the Bidding Documents or caused by Agents or Employees of the Owner. The electrical contractor shall adequately protect adjacent property as provided by law and the Bidding Documents. The electrical contractor shall provide and maintain passageways, guard fences, lights and other facilities for protection required by Public Authority or Local conditions.

- H. Circuiting and switching shall be exactly as shown on drawings. Combining of home runs is acceptable but neutrals shall not be shared. Contractor shall refer to NEC Article 310-15 and adjust accordingly. Combining of wiring of various systems in conduit runs is not acceptable unless otherwise specified herein or noted on drawings.
- I. Neutrals shall not be shared to avoid the requirement of installing handle-ties on breakers.
- J. Contractor is responsible for providing UL-listed fire rated materials where required by applicable codes and other sections of this specification to seal fire-rated membrane penetrations. In particular this applies to requirements of IBC Section 712 as it pertains to:
  - 1. Electrical Boxes: Provide minimum 6 inch separation in non-rated walls. Provide minimum 24 inch horizontal separation in fire rated walls. In rated walls locate boxes so as to comply with IBC Section 712 separation and membrane penetration requirements. Apply fire-rated putty pads (SpecSeal Series SSP Intumescent Putty Pads, or equal) to all boxes where 24" box-to-box separation cannot be maintained or where openings exceed allowable limits under IBC section 712.
  - 2. Flush-Mounted Panels (panelboards, fire alarm panels and any other flush-mounted electrical enclosure exceeding 16 square inches of area): Coordinate with the general contractor for gypsum board lined framing pockets where any flush-mounted panelboards are located in 1 or 2-hour rated walls. Provide fire-rated putty pads on top and bottom of panelboards to seal around conduits.
  - 3. Conduit and Cable: Apply fire seal where conduit or cables penetrate fire-rated assemblies as required by NEC Article 300-21 and IBC section 712. Fire seal shall be equal to International Protective Coating Corp. #FSC or #FS series or Chase Technology Corp. #PR-855 Fire Stop.

## 1.7 INSPECTION

- A. All work and material is subject to inspection at any time by the Architect/Engineer or his representative. If the Architect/Engineer or his representative finds material that does not conform with these specifications or that is not properly installed or finished, correct the deficiencies in a manner satisfactory to the Architect/Engineer at no additional expense to the Owner.

## 1.8 WORKMANSHIP

### A. GENERAL

- 1. Work under this contract shall be performed by workmen skilled in the particular trade conducting all work necessary to properly complete the installation in a workmanlike manner to present a neat and finished appearance.

### B. EXCAVATION AND BACKFILL

- 1. Provide all excavating and backfilling as required, with backfilling only after approval of the Architect. Backfill to be free of all debris and decayable matter. See Excavation and Backfill requirements in DIVISION 1 -- GENERAL REQUIREMENTS.

## C. CUTTING, PATCHING AND FRAMING

1. Obtain Architect's/Engineer's approval before performing any cutting on structural members or patching of building surfaces. Any damage to the building or equipment by this Contractor shall be the responsibility of this Contractor and shall be repaired by skilled craftsmen of the trades involved at no additional expense to the Owner.
2. Chases, openings, sleeves, hangers, anchors, recesses, equipment pads, and framing for equipment are provided by others only if so noted on the drawings. Otherwise, they will be provided by this contractor for his work. Whether chases, etc., are provided by this contractor or others, this contractor is responsible for correct size and locations.

### 1.9 COORDINATION

- A. The electrical contractor shall plan his work to proceed with a minimum interference with other trades and it shall be his responsibility to inform the General Contractor of all openings required in the building structure for installation of work, and to provide sleeves as required. Dimensions of equipment installed and/or provided by others shall be checked in order that correct clearances and connections may be made.

### 1.10 CLEAN UP

- A. The electrical contractor shall keep the premises free from accumulation of waste material or rubbish caused by his work or employees.
- B. Upon completion of work, remove materials, scraps and debris relative to his work and leave the premises, including tunnels, crawl spaces, and pipe chases in clean and orderly condition. Remove all dirt and debris from the interior and exterior of all devices and equipment. After construction is completed, wash all light fixtures and lamps, remove all labels from fixture lenses.

### 1.11 DUST PROTECTION

- A. Contractor will provide suitable dust protection for all existing areas prior to beginning of cutting or demolition. Contractor will obtain approval of partition from Owner before proceeding with work involved in these rooms.

### 1.12 TEMPORARY FACILITIES

#### A. OFFICES

1. The electrical contractor shall provide temporary offices for himself including lights, heat and telephone, if required.

#### B. REMOVAL

1. The electrical contractor shall completely remove his temporary installations when no longer needed and the premises shall be completely clean, disinfected, patched, and refinished to match adjacent areas.

C. LADDERS AND SCAFFOLDS

1. The electrical contractor shall provide their own ladders, scaffolds, etc. of substantial construction for access to their work in various portions of the building as may be required. When no longer needed, they shall be removed by the contractor.

D. PROTECTION DEVICES

1. The electrical contractor shall provide and maintain his own necessary barricades, fences, signal lights, etc. required by all governing authorities or shown on the drawings. When no longer needed, they shall be removed by the contractor. The contractor shall assume all responsibility for which the owner may be held responsible because of lack of above items.

E. TEMPORARY WATER

1. The electrical contractor shall provide all water required by his trade for construction. Temporary drinking water shall be provided from a proven safe source dispensed by single service containers, until such time as the construction water outlet has been install, disinfected and approved for drinking purposes.

F. TEMPORARY FIRE PROTECTION

1. The electrical contractor shall provide all necessary first-aid hand fire extinguishers for Class A, B, C and special hazards as may exist in his own work area only in accordance with good and safe practice and as required by jurisdictional safety authority. The contractor shall provide general area fire extinguishers only.

1.13 TEMPORARY ELECTRICAL FACILITIES

A. ELECTRICAL POWER

1. The electrical contractor shall provide temporary construction power to the area to support construction activities of all trades. All temporary power shall be derived from a separate temporary construction service arranged and paid for by the contractor. No tie-ins or connections to the Owner's system shall be made without the Owner's consent. Construction power shall include the following unless otherwise agreed to by the General Contractor:
  - a. One temporary panel located as directed by the General Contractor with provision for 100A, 1-phase, 3-wire service at voltage available.
  - b. Power centers for miscellaneous tools and equipment used in the construction period, so that power can be secured at any desired point from temporary service panel within building proper.
  - c. Lighting for safe and adequate working conditions throughout the buildings, stairways, and crawl spaces. Provide at least 1/2 watt of incandescent lighting per square foot of floor area. Maintain a socket voltage of at least 110 volts. Use a minimum of 100 watt bulbs.
  - d. Power for construction site offices and for other temporary storage and construction buildings.

- e. Power to maintain continuous construction during changeover of electrical equipment.
- f. Power for testing and checking equipment.

#### 1.14 SHOP DRAWINGS

- A. Provide eight (8) copies of manufacturer's literature and/or certified prints as soon as possible but within thirty (30) days after awarding of Contract, for items of materials, equipment, or systems where called for in specifications. Shop drawings and literature complete showing item used, size, dimensions, capacity, rough-in, etc., as required for complete check and installation. Manufacturer's literature showing more than one item shall be clearly marked as to which item is being furnished or it will be rejected and returned without review.
- B. Each copy of each item submitted must be clearly marked as follows for purposes of identification and record. Submittals not marked (typewritten only) as described below will be rejected and returned without review.
  - Date:
  - Name of Project:
  - Branch of Work:
  - Submitted by:
  - Specification or Plan Reference:
- C. Prior to their submission, each submittal shall be thoroughly checked by the contractor for compliance with the Contract Document requirements, accuracy of dimensions, relationship to the work of other trades, and conformance with sound, safe practices as to erection and installation. Each submittal shall then bear a stamp evidencing such checking and shall show corrections made, if any. Submittals requiring extensive corrections shall be revised before submission. Each submittal not stamped and signed by the contractor evidencing such checking will be rejected and returned without review.
- D. All submittals will be examined when submitted in proper form for compliance. Such review shall not relieve the contractor of responsibility for errors, for deviation from the contract Documents, nor for violation of sound safety practices.
- E. The contractor shall keep in the field office one print of each submittal which has been reviewed and stamped by the Architect or Engineer.
- F. Submittals will be required for each item of material and equipment furnished as noted in specifications.
- G. All submittals shall be organized into a single binder and transmitted in one delivery. Transmittal of individual sections is not permitted. Exceptions will be considered upon request for exceptionally long-lead equipment or voluminous submittals that cannot reasonably fit into a single binder.
- H. Submittals which are incomplete relative to quality requirements, capacity, engineering data, dimensional data or detailed list of specialty or control equipment will be rejected. Lists shall include descriptive coding as specified or shown on drawings.

THE ENGINEER WILL PERFORM SHOP DRAWING REVIEW OF EACH ITEM, HOWEVER, SUBSEQUENT REVIEW OF ITEMS PREVIOUSLY REJECTED WILL BE BILLED TO THE CONTRACTOR AT A RATE OF \$75 PER HOUR.

I. Schedule of Shop Drawings.

ITEM	MFG LIT	SHOP DWG	WIRING DIAG.	O&M BOOK
RACEWAYS AND FITTINGS	X			X
WIRE AND CABLE	X			X
OUTLET BOXES	X			X
WIRING DEVICES	X			X
FIRE SEAL PRODUCTS (see specifications 260533)	X			X
SUPPORTING DEVICES	X			X
FUSES	X			X
DISCONNECT SWITCHES	X			X
PANELBOARDS	X	X		X
MOTOR CONTROLS	X			X
LIGHTING FIXTURES	X			X
VOICE AND DATA WIRING SYSTEM	X	X	X	X
INTRUSION DETECTION SYSTEM	X	X	X	X
FIRE ALARM SYSTEM	X	X	X	X

1.15 OPERATION AND MAINTENANCE MANUALS

- A. At the time orders are placed for any item of equipment requiring service or operating maintenance, the contractor shall request the manufacturer furnish three (3) copies of OPERATION AND MAINTENANCE INSTRUCTIONS for each piece of equipment. These shall be included in the brochure of equipment.

1.16 BROCHURE OF EQUIPMENT

- A. Upon completion of work, prepare a "Brochure of Equipment" containing data pertinent to equipment and systems on job. Binders containing materials shall be one or more three ring binders of sufficient number to hold all literature. Contained in binders shall be: Installation, maintenance, and operating instructions for each piece of equipment; parts lists; wiring diagrams; one copy of each shop drawing and literature submittal; record drawings, etc.

- B. All literature shall be clean, unused and filed under divider headings corresponding to the specifications.
- C. These brochures shall be submitted to the Architect/Engineer and approved by him before authorization of final payment.

#### 1.17 "AS-BUILT" DRAWINGS

- A. The electrical contractor shall furnish to the Owner and Architect/Engineer a red line marked print set of drawings, each sheet stamped as the "As-Built" drawing and bearing the contractor's name, date and signature. The As-Built drawing shall show the location of all concealed or underground conduit runs and other equipment, devices, outlets, etc., installed other than as shown on the drawings. Dimension underground lines from established building lines. As-Built drawings to be developed from a job site record drawing set and shall be clean, neat and all changes legible and shown in the same format and symbols used on the contract drawings. The As-Built drawing set shall be submitted to the architect/engineer for approval, and any deficiencies noted by the architect/engineer corrected and resubmitted until approved by the architect/engineer at no cost to architect/engineer or owner.

#### 1.18 PLACING SYSTEMS IN OPERATION

- A. At the completion of the work and at such time as the Owner shall direct, prior to final acceptance, the electrical contractor performing this work shall put into satisfactory operation the various systems installed under the specifications. At no additional cost to the Owner, furnish the services of a person completely familiar with the installations performed under this specification, to instruct the Owners operating personnel in the proper operation and servicing of the equipment and systems. These services shall be available for a period of no less than one (1) day.
- B. Upon placing systems in operation the contractor shall measure phase currents at each main and branch panel within the facility and balance the phase currents to within 20% of each other by moving circuit breakers to different phases.

#### 1.19 GUARANTEE-WARRANTY

- A. The electrical contractor shall and hereby does warrant and guarantee that all work executed under this Division will be free from defects of materials and workmanship for a period of one year from the date of final acceptance of this work and that he will, at his own expense, repair and/or replace all such defective materials and work and all other work damaged thereby which becomes defective during the term of warranty, except that lamps and tubes shall be his responsibility only for normal lamp life or one year, whichever occurs first.

END OF SECTION 260000

## SECTION 260045 - TRENCHING FOR SITE UTILITIES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Backfilling and compacting for utilities outside the building to utility main connections and any other site work done by this Contractor.

#### 1.2 RELATED SECTIONS

- A. Section 260519 - Low-Voltage Power Conductors and Cables.
- B. Section 260534 - Conduit.

#### 1.3 DEFINITIONS

- A. Finish Grade Elevations: Indicated on Civil/Architectural drawings.
- B. Subgrade Elevations: Indicated on Civil/Architectural drawings.

#### 1.4 PROJECT CONDITIONS

- A. Provide sufficient quantities of fill to match existing grade.
- B. Prior to any excavation, effort shall be made to determine whether underground installations (i.e., sewer, telephone, water, fuel, electric lines, etc.) will be encountered and where. Utility companies shall be contacted and advised of proposed work prior to the start of actual excavation.
- C. Protect plants, lawns, rock outcroppings, and other features to remain.
- D. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

### PART 2 - PRODUCTS

#### 2.1 FILL MATERIALS

- A. General Fill: Subsoil excavated on-site or conform to the requirements outlined in Section 312000.
- B. Bedding Material: Sand: Natural river or bank sand; washed; free of silt, clay, loam, friable or soluble materials, and organic matter.

1. For bedding of conduit with a coverage of 1" above and below the conduit.
- C. Topsoil: See Sections 312000.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Identify required lines, levels, contours, and datum locations.
- B. Locate, identify, and protect utilities that remain and protect from damage.

#### 3.2 TRENCHING

- A. Notify Engineer of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.
- B. Do not interfere with 45 degree bearing splay of foundations.
- C. Cut trenches wide enough to allow inspection of installed utilities.
- D. Hand trim excavations. Remove loose matter.
- E. This Contractor shall be responsible for the replacement of existing street pavement, curbs, sidewalks, etc., removed or damaged by them in the course of the work unless such pavement, curbs, and sidewalks are to be reconstructed under the General Contract. This Contractor shall make necessary arrangements to perform such repairs and shall pay all costs in connection therewith and include it in his bid.
- F. Remove excavated material that is unsuitable for re-use from site.
- G. Remove excess excavated material from site.

#### 3.3 PREPARATION FOR UTILITY PLACEMENT

- A. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.
- B. Compact subgrade to density equal to or greater than requirements for subsequent fill material.
- C. Until ready to backfill, maintain excavations and prevent loose soil from falling into excavation.

#### 3.4 BACKFILLING

- A. Backfill materials shall be as required by utility company when work is being installed for utility. Other backfill material shall be in accordance with Section 312000.
- B. Backfill to contours and elevations indicated using unfrozen materials with 6" lifts.

- C. Employ a placement method that does not disturb or damage other work.
- D. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.
- E. Maintain optimum moisture content of fill materials to attain required compaction density.
- F. Slope grade away from building minimum 2 inches in 10 ft (50 mm in 3 m), unless noted otherwise. Make gradual grade changes. Blend slope into level areas.
- G. Correct areas that are over-excavated.
- H. Provide top soil and landscape finishes that match existing areas. Refer to Section 329200 Turf and Grasses regarding additional information related to reclaiming disturbed areas.
- I. Compaction Density Unless Otherwise Specified or Indicated:
  - 1. Under paving, slabs-on-grade, and similar construction: 97 percent of maximum dry density.
  - 2. At other locations: 95 percent of maximum dry density.
- J. Reshape and re-compact fills subjected to vehicular traffic.

### 3.5 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for general requirements for field inspection and testing.
- B. Perform compaction density testing on compacted fill in accordance with ASTM D1556, ASTM D2167, ASTM D2922, or ASTM D3017.
- C. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D 698 ("standard Proctor"), ASTM D 1557 ("modified Proctor"), or AASHTO T 180.
- D. If tests indicate work does not meet specified requirements, remove work, replace and retest.
- E. Frequency of Tests: 1 per 200 feet of trench.

### 3.6 CLEAN-UP

- A. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

END OF SECTION 260045

## SECTION 260050 - FIRE STOPPING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Firestopping materials.
- B. Firestopping of all penetrations and interruptions to fire rated assemblies, whether indicated on drawings or not, and other openings indicated.

#### 1.2 RELATED SECTIONS

- A. Section 260000 – Electrical General Requirements.
- B. Section 260519 - Low-Voltage Power Conductors and Cables.
- C. Section 260534 - Conduit.

#### 1.3 REFERENCES

- A. ASTM E 119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 1995a.
- B. ASTM E 814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops; 1994b.
- C. ITS (DIR) - Directory of Listed Products; Intertek Testing Services NA, Inc.; current edition.
- D. FM P7825 - Approval Guide; Factory Mutual Research Corporation; current edition.
- E. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.; current edition.

#### 1.4 SUBMITTALS

- A. No submittals are required for this section.

#### 1.5 QUALITY ASSURANCE

- A. Fire Testing: Provide firestopping assemblies of designs which provide the specified fire ratings when tested in accordance with ASTM E 814 and ASTM E 119.

#### 1.6 ENVIRONMENTAL REQUIREMENTS

- A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation. Maintain minimum temperature before, during, and for 3 days after installation of materials.
- B. Provide ventilation in areas where solvent-cured materials are being installed.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Elastomeric Silicone Firestopping: Single component silicone elastomeric compound and compatible silicone sealant; conforming to the following:
  - 1. Durability and Longevity: Permanent.
  - 2. Color: Per Manufacturer.
  - 3. Manufacturers:
    - a. 3M Product CP25WB+.
- B. Foam Firestopping: Single component foam compound; conforming to the following:
  - 1. Durability and Longevity: Permanent.
  - 2. Color: Per Manufacturer.
- C. Fibered Compound Firestopping: Formulated compound mixed with incombustible non-asbestos fibers; conforming to the following:
  - 1. Durability and Longevity: Permanent.
  - 2. Color: Per Manufacturer.
- D. Fiber Packing Material: Mineral fiber packing insulation; conforming to the following:
  - 1. Durability and Longevity: Permanent.
- E. Firestop Devices: Mechanical device with incombustible filler and sheet stainless steel jacket; conforming to the following:
  - 1. Durability and Longevity: Permanent .
  - 2. Manufacturers:
    - a. EZ Pathway Products; Product EZ Path.
- F. Intumescent Putty: Compound which expands on exposure to surface heat gain; conforming to the following:
  - 1. Potential Expansion: Minimum 1000 percent.
  - 2. Durability and Longevity: Permanent.
  - 3. Color: Per Manufacturer.
  - 4. Manufacturers:
    - a. 3M Product MPS+.
    - b. 3M Product MPP+.
- G. Firestop Pillows: Formed mineral fiber pillows; conforming to the following:
  - 1. Durability and Longevity: Permanent.
  - 2. Manufacturers:
    - a. 3M Product FB249.
    - b. 3M Product FB269.

c. 3M Product FB369.

H. Primers, Sleeves, Forms, and Accessories: Type required for tested assembly design.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

A. Verify openings are ready to receive the work of this section.

#### 3.2 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter which may affect bond of firestopping material.

B. Remove incompatible materials which may affect bond.

#### 3.3 INSTALLATION

A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.

B. Do not cover installed firestopping until inspected by authority having jurisdiction.

#### 3.4 CLEANING AND PROTECTION

A. Clean adjacent surfaces of firestopping materials.

END OF SECTION 260050

## SECTION 260519 - LOW-VOLTAGE POWER CONDUCTORS AND CABLES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Wire and cable for 600 volts and less.
- B. Wiring connectors.
- C. Electrical tape.
- D. Wire pulling lubricant.
- E. Cable ties.

#### 1.2 RELATED REQUIREMENTS

- A. Section 260045 - Trenching for Site Utilities: Excavating, bedding, and backfilling.
- B. Section 260534 - Conduit.
- C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 283111 – Addressable Fire Alarm System: Fire alarm system conductors and cables.

#### 1.3 REFERENCE STANDARDS

- A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013.
- B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2011.
- C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010 (Reapproved 2014).
- D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2014).
- E. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape; 2010.
- F. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- G. NEMA WC 70 - Nonshielded Power Cable 2000 V or Less for the Distribution of Electrical Energy; 2009.

- H. NEMA WC5 - Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
- I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- J. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.
- K. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.
- L. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.
- M. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.
- N. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.

#### 1.4 SUBMITTALS

- A. There are no shop drawing submittals required for this section.
- B. Project Record Documents: Record actual locations of components and circuits.

#### 1.5 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Products: Furnish products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

#### 1.7 FIELD CONDITIONS

- A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F (-10 degrees C), unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Engineer and obtain direction before proceeding with work.

### PART 2 - PRODUCTS

#### 2.1 WIRING REQUIREMENTS

- A. Dry Interior Locations: Use only building wire with Type THWN/THHN insulation in raceway.
- B. Wet or Damp Interior Locations: Use only building wire with Type THWN insulation in raceway.
- C. Exterior Locations: Use only building wire with Type THHN/THWN insulation in raceway, unless specifically noted otherwise.
- D. Underground Installations: Use only building wire with Type THHN/THWN insulation in raceway.
- E. Use solid conductor for feeders and branch circuits No.10 AWG and smaller, and stranded conductor for feeders and branch circuits No. 8 AWG and larger.
- F. Use stranded conductors for control circuits.
- G. Use conductor not smaller than 12 AWG for power and lighting circuits.
- H. Use conductor not smaller than 14 AWG for control circuits.
- I. Use 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 75 feet (25 m).
- J. Aluminum cable is not allowed.
- K. This contractor shall derate conductor ampacity in areas of high ambient temperature per the NEC.
- L. All branch circuits served by a single pole breaker shall be provided with a separate, dedicated neutral conductor throughout. Shared neutrals on these circuits will not be allowed.
- M. No more than three (3) branch circuits will be allowed in conduit homeruns.
- N. All branch circuits serving non-linear loads (i.e. personal computer, mainframe computers, computer terminals, fax machines, electronic ballasts, receptacles adjacent to data outlets, etc.) shall have a minimum neutral conductor size of #10 Cu. This includes all receptacles in offices, open office areas, reception areas, copy rooms, communications/server closets, etc.

## 2.2 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose indicated.
- C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- D. Comply with NEMA WC 70.
- E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.

- F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
- G. Conductor Material:
  - 1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
  - 2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B 787M unless otherwise indicated.
  - 3. Tinned Copper Conductors: Comply with ASTM B33.
- H. Conductor Color Coding:
  - 1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
  - 2. Color Coding Method: Integrally colored insulation.
  - 3. Color Code:
    - a. 208Y/120V, 3 Phase, 4 Wire System:
      - 1) Phase A: Black.
      - 2) Phase B: Red.
      - 3) Phase C: Blue.
      - 4) Neutral/Grounded: White.
    - b. Equipment Ground, All Systems: Green.
    - c. Travelers for 3-Way and 4-Way Switching: Purple.
    - d. For control circuits, comply with manufacturer's recommended color code.

## 2.3 SINGLE CONDUCTOR BUILDING WIRE

- A. Manufacturers: Anaconda, Cyprus Wire and Cable Company (Rome), General Electric Company, General Cable Company, Pirelli or approved equivalent.
- B. Description: Single conductor insulated wire.
- C. Conductor Stranding:
  - 1. Feeders and Branch Circuits:
    - a. Size 10 AWG and Smaller: Solid.
    - b. Size 8 AWG and Larger: Stranded.
- D. Insulation Voltage Rating: 600V.
- E. Insulation:
  - 1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2.

## 2.4 WIRING CONNECTORS

- A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.
- B. Solderless Pressure Connectors:

1. Product: 3M Scotchlok Brand, Type Y, R, G, and B, or Ideal Model 451, 452, 453, and 455 or equivalent.
- C. Splices and taps for conductor sizes No. 8 and larger, use approved gutter taps similar to O.Z. type PMX combination parallel gutter taps and covers.
- D. Where tapping of conductors is required, use minimum of two layers wrapped half lapped. Tape shall be a minimum of 150% of thickness of insulation. Tape shall be U.L. Listed 3M Scotch Brand 33+.

## 2.5 WIRING ACCESSORIES

- A. Electrical Tape:
  1. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil (0.18 mm); resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F (-18 degrees C) and suitable for continuous temperature environment up to 221 degrees F (105 degrees C).
- B. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.
- C. Cable Ties: Material and tensile strength rating suitable for application.
- D. Solderless Pressure Connectors:
  1. Product: 3M Scotchlok Brand, Type Y, R, G, and B, or Ideal Model 451, 452, 453, and 455 or equivalent.
- E. Splices and taps for conductor sizes No. 8 and larger, use approved gutter taps similar to O.Z. type PMX combination parallel gutter taps and covers.
- F. Where tapping of conductors is required, use minimum of two layers wrapped half lapped. Tape shall be a minimum of 150% of thickness of insulation. Tape shall be UL Listed 3M Scotch Brand 33+.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that work likely to damage wire and cable has been completed.
- C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
- D. Verify that raceway installation is complete and supported.
- E. Protect conductors from paint.

- F. Verify that conditions are satisfactory for installation prior to starting work.

### 3.2 PREPARATION

- A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

### 3.3 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install conductors and cable in a neat and workmanlike manner in accordance with NECA 1.
- C. Installation in Raceway:
  - 1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
  - 2. Pull all conductors and cables together into raceway at same time.
  - 3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
  - 4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.
- D. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
- E. Install conductors with a minimum of 12 inches (300 mm) of slack at each outlet.
- F. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
- G. Make wiring connections using specified wiring connectors.
  - 1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
  - 2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
  - 3. Do not remove conductor strands to facilitate insertion into connector.
  - 4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
- H. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
- I. Insulate ends of spare conductors using vinyl insulating electrical tape.
- J. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.
- K. All wire and cable shall be installed with within conduit or other raceway system.
- L. Conduits shall have a maximum fill in accordance with NEC requirements and wire and cable shall be installed within conduits as outlined in Section 260534 Conduit.

- M. Route wire and cable as required to meet NEC and project conditions.
  - 1. Wire and cable routing indicated is approximate unless dimensioned.
  - 2. Where wire and cable destination is indicated and routing is not shown, determine exact routing and lengths required.
  - 3. Include wire and cable of lengths required to install connected devices within 10 ft (3000 mm) of location shown.
- N. Use wiring methods indicated.
- O. Clean conductor surfaces before installing lugs and connectors.
- P. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
- Q. Use split bolt connectors for copper conductor splices and taps, 6 AWG and larger. Tape uninsulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor.
- R. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and larger.
- S. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.
- T. Identify and color code wire and cable under provisions of Section 260553. Identify each conductor with its circuit number or other designation indicated.

#### 3.4 FIELD QUALITY CONTROL

- A. Perform inspection, testing, and adjusting in accordance with Section 014000.
- B. Correct deficiencies and replace damaged or defective conductors and cables. Retain and revise applicable piping applications in this article. Coordinate with materials specified.

END OF SECTION 260519

## SECTION 260529 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Grounding and bonding components, including grounding electrodes and conductors, equipment grounding conductors, and bonding to complete grounding system consisting of:
- B. Metal underground water pipe electrode.
- C. Metal frame of the building.
- D. Rod electrodes.
- E. Concrete-encased electrode.

#### 1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete.
- B. Section 260519 - Low-Voltage Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
- C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

#### 1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- B. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Grounding System Resistance: 5 ohms maximum.

#### 1.5 SUBMITTALS

- A. See Division 01 for submittals procedures.

- B. Test Reports: Indicate overall resistance to ground.
- C. Project Record Documents: Record actual locations of components and grounding electrodes.

#### 1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- D. Installer Qualifications for Signal Reference Grids: Company with minimum five years documented experience with high frequency grounding systems.

### PART 2 - PRODUCTS

#### 2.1 GROUNDING AND BONDING REQUIREMENTS

- A. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- C. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

#### 2.2 GROUNDING AND BONDING COMPONENTS

- A. General Requirements:
  - 1. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated.
  - 2. Provide products listed and labeled as complying with UL 467 where applicable.
- B. Conductors for Grounding and Bonding, in addition to requirements of Section 260519:
  - 1. Use insulated copper conductors unless otherwise indicated.
    - a. Exceptions:
      - 1) Use bare copper conductors where installed underground in direct contact with earth.
      - 2) Use bare copper conductors where directly encased in concrete (not in raceway).
- C. Connectors for Grounding and Bonding:

1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.

## 2.3 ELECTRODES

- A. Provide new grounding electrodes at new service as detailed on the drawings and/or as required by NEC.
- B. Rod Electrodes: Copper.
  1. Diameter: 3/4 inch (19 mm).
  2. Length: 10 feet (3000 mm).
  3. Shape: Straight.
- C. Metallic water pipe electrodes: 3/0 AWG.
- D. Foundation Electrodes: 3/0 AWG.

## 2.4 CONNECTORS AND ACCESSORIES

- A. Mechanical Connectors (for indoor locations only): Bronze.
  1. Product: by O.Z. Gedney or equivalent.
- B. Exothermic Connections:
  1. Product: by Cadweld or equivalent.
- C. Wire: Stranded copper.
- D. Grounding Electrode Conductor: Size to meet NFPA 70 requirements. Minimum #3/0 bare copper interconnecting ground conductors.
- E. Motor shaft grounding:
  1. Provide field installed shaft grounding for all motors served by VFD's.
  2. Provide Aegis SGR or approved equivalent.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that work likely to damage grounding and bonding system components has been completed.
- B. Verify that conditions are satisfactory for installation prior to starting work.
- C. Verify that final backfill and compaction has been completed before driving rod electrodes.

### 3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install grounding and bonding system components in a neat and workmanlike manner in accordance with NECA 1.
- C. Make grounding and bonding connections using specified connectors.
  - 1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
  - 2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
  - 3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
  - 4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
  - 5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- D. Identify grounding and bonding system components in accordance with Section 260553.
- E. Provide electrical service and distribution grounding system as indicated in drawings and outlined in this specification and as required by NEC.
- F. Install ground electrodes at locations as required. Install additional rod electrodes as required to achieve specified resistance to ground.
- G. Provide grounding electrode conductor and connect to reinforcing steel in foundation footing.
- H. Provide bonding to meet requirements described in Quality Assurance.
- I. Bond together each metallic raceway (2" and larger), pipe, duct and other metal object entering equipment enclosures. Use bare copper conductor, sized per NEC or as shown on plans (whichever is the most stringent).
- J. Equipment Grounding Conductor: Provide separate, insulated copper equipment grounding conductor in all of the following runs listed below. Terminate each end on suitable lug, bus, or bushing. Where ground conductors are specified or required, conduit sizes shall be increased as necessary to meet the NEC conduit fill requirements.
  - 1. All new feeders.
  - 2. All raceways for receptacle circuits, including special power receptacles.
  - 3. All feeds to light fixtures.
  - 4. All motor feeders and branch circuits.
  - 5. All flexible metal conduit.
  - 6. All non-metallic raceways containing power conductors.
- K. Terminate each end of equipment ground conductors in an approved lug or bus or bushing.

- L. In general, equipment ground conductors are not indicated on the plans. Where ground conductors are required, conduit sizes shall be increased as required to comply with NEC conduit fill requirements.
- M. Where a pad mounted transformer is installed, the ground network shall consist of four (4) ground rods, one at each corner of the transformer pad, and interconnect with #1/0 bare copper conductor. Extend separate ground conductors to the primary and secondary side of the transformer. All ground connections below grade shall be of the exothermic weld type. Ground all conduits in the transformer enclosure using grounding bushings. Ground stress cones, lightning arrestors, transformer housings, and all non current carrying metal parts to the ground network. Provide a grounding jumper, provided by the manufacturer, between the grounding network and the transformer neutral.

### 3.3 FIELD QUALITY CONTROL

- A. Perform inspections listed in NETA STD ATS, Section 7.13.
- B. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
- C. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

END OF SECTION 260529

## SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

### 1.1 SECTION INCLUDES

- A. Support and attachment components for equipment, conduit, cable, boxes, and other electrical work.
- B. Anchors and fasteners.
- C. For communications cabling, see also specific sections.

### 1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 260534 - Conduit: Additional support and attachment requirements for conduits.
- C. Section 260537 - Boxes: Additional support and attachment requirements for boxes.
- D. Section 265100 - Interior Lighting: Additional support and attachment requirements for interior luminaires.
- E. Section 265600 - Exterior Lighting: Additional support and attachment requirements for exterior luminaires.
- F. Section 271021 - Voice/Data Systems - Cat 6.

### 1.3 REFERENCE STANDARDS

- A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.
- B. MFMA-4 - Metal Framing Standards Publication; 2004.
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

### 1.4 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Comply with applicable building code.
- C. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

## PART 2 - PRODUCTS

### 2.1 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
  2. Provide products listed, classified, and labeled by Underwriters Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated, where applicable.
  3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of 2. Include consideration for vibration, equipment operation, and shock loads where applicable.
  4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
  5. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
    - a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
    - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
    - c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
    - d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
  2. Conduit Clamps: Bolted type unless otherwise indicated.
- C. Steel Spring Clips:
1. Product: Caddy, or equivalent.
  2. Use only in concealed locations (i.e. above ceilings, within walls, etc).
- D. Supports: Fabricated of structural steel or formed steel members; galvanized or painted, as required.
- E. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.
- F. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
1. Comply with MFMA-4.
  2. Channel Material:
    - a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
    - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
- G. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
- H. Anchors and Fasteners:

1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
2. Do not use powder-actuated anchors.
3. Concrete Structural Elements: Use preset concrete inserts, expansion anchors, or screw anchors.
4. Steel Structural Elements: Use beam clamps, steel ramset fasteners, or welded fasteners.
5. Concrete Surfaces: Use self-drilling anchors or expansion anchors.
6. Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts or hollow wall fasteners.
7. Solid Masonry Walls: Use expansion anchors or preset inserts.
8. Sheet Metal: Use sheet metal screws.
9. Wood Elements: Use wood screws.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install hangers and supports as required to adequately and securely support electrical system components, in a neat and workmanlike manner, in accordance with NECA 1.
  1. Do not drill or cut structural members, unless specifically approved in writing by Structural Engineer.
- C. Rigidly weld support members or use hexagon-head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.
- D. Install surface-mounted cabinets and panelboards with minimum of four anchors.
- E. In wet and damp locations use steel channel supports to stand cabinets and panelboards 1 inch (25 mm) off wall.
- F. All supports shall be securely positioned to the structure, not equipment or ceiling tile supports. Coordinate structure load capabilities with General Contractor.
- G. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.
- H. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- I. Equipment Support and Attachment:
  1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
  2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
  3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.

4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

J. Interior Luminaire Support and Attachment: Also comply with Section 265100.

K. Secure fasteners according to manufacturer's recommended torque settings.

L. Remove temporary supports.

### 3.2 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Inspect support and attachment components for damage and defects.

C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

D. Correct deficiencies and replace damaged or defective support and attachment components.

E. Install hangers and supports as required to adequately and securely support electrical system components, in a neat and workmanlike manner, as specified in NECA 1.

END OF SECTION 260529

## SECTION 260534 - CONDUIT

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Galvanized steel rigid metal conduit (RMC).
- B. Intermediate metal conduit (IMC).
- C. PVC-coated galvanized steel rigid metal conduit (RMC).
- D. Flexible metal conduit (FMC).
- E. Liquid tight flexible metal conduit (LFMC).
- F. Electrical metallic tubing (EMT).
- G. Rigid polyvinyl chloride (PVC) conduit.
- H. Conduit fittings.
- I. Accessories.

#### 1.2 RELATED REQUIREMENTS

- A. Section 260526 - Grounding and Bonding for Electrical Systems.
- B. Section 260529 - Hangers and Supports for Electrical Systems.
- C. Section 260537 - Boxes.
- D. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

#### 1.3 REFERENCE STANDARDS

- A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2005.
- B. ANSI C80.3 - American National Standard for Steel Electrical Metallic Tubing (EMT); 2005.
- C. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit (EIMC); 2005.
- D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- E. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2013.

- F. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); 2003.
- G. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2012.
- H. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit; 2005.
- I. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; 2013.
- J. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; 2015.
- K. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- L. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.
- M. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.
- N. UL 360 - Liquid-Tight Flexible Steel Conduit; Current Edition, Including All Revisions.
- O. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.
- P. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.
- Q. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.
- R. UL 1242 - Electrical Intermediate Metal Conduit-Steel; Current Edition, Including All Revisions.

#### 1.4 SUBMITTALS

- A. There are no shop drawing submittals required for this section.
- B. Shop Drawings:
  - 1. Indicate proposed arrangement for conduits to be installed within structural concrete slabs, where permitted.
- C. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2 inch (51 mm) trade size and larger.

#### 1.5 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for purpose specified and shown.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.
- B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- C. Protect PVC conduit from sunlight.

## PART 2 - PRODUCTS

### 2.1 CONDUIT REQUIREMENTS

- A. Conduit Size: Comply with NFPA 70.
  - 1. Minimum Size: 3/4 inch (19 mm) for circuit homeruns, and for runs with more than the equivalent of three single circuits served with single pole breakers and #12 AWG conductors. 1/2" conduit may be used for all other runs with the equivalent of 7 #12 AWG conductors or less.
- B. Underground Installations:
  - 1. More than 5 Feet (1.5 Meters) from Foundation Wall: Use thickwall non-metallic conduit.
  - 2. Through foundation walls and five feet either side: Use plastic coated rigid steel conduit.
  - 3. Where conduits turn up from under slab or from underground: Use plastic coated rigid steel conduit until above slab or grade.
  - 4. Under Slab on Grade: Use thickwall non-metallic conduit.
  - 5. Minimum Size: 3/4 inch (19 mm).
  - 6. Other locations shall be Schedule 80 PVC.
- C. Outdoor Locations Exposed Above Grade: Use rigid steel conduit or intermediate metal conduit.
- D. In Slab Above Grade: Conduits shall not be routed in concrete floor topping.
  - 1. Use rigid steel conduit or intermediate metal conduit with appropriate protective coating.
- E. Wet and Damp Locations: Use rigid steel conduit or intermediate metal conduit.
  - 1. Liquid tight conduit with liquid tight fittings shall be used for final connection to equipment in kitchens, wells, sump pits, transformer connections, underfloor in computer/server rooms and other areas of moisture content.
- F. Dry Locations:
  - 1. Concealed: Use electrical metallic tubing.
  - 2. Exposed: Use electrical metallic tubing.
  - 3. Flexible metal conduit shall be used for connections to motors, fixed appliances, equipment subject to vibration, and recessed luminaires where required.
- G. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.

- H. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated.
- I. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

## 2.2 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Manufacturers: Republic Conduit, Youngstown, Triangle, Allied Tube & Conduit, Wheatland Tube Company, or approved equal.
- B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.
- C. Fittings:
  - 1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
  - 2. Material: Use steel.
  - 3. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.
  - 4. All connectors shall have insulated throats.

## 2.3 INTERMEDIATE METAL CONDUIT (IMC)

- A. Manufacturers: Republic Conduit, Youngstown, Triangle, Allied Tube & Conduit, Wheatland Tube Company, or approved equal.
- B. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.
- C. Fittings:
  - 1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
  - 2. Material: Use steel.
  - 3. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

## 2.4 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Manufacturers: Allied, Robroy Industries, or approved equal.
- B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6.
- C. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil (1.02 mm).
- D. PVC-Coated Fittings:
  - 1. Manufacturer: Same as manufacturer of PVC-coated conduit to be installed.

2. Non-Hazardous Locations: Use fittings listed and labeled as complying with UL 514B.
3. Material: Use steel.
4. Exterior Coating: Polyvinyl chloride (PVC), minimum thickness of 40 mil (1.02 mm).
5. All connectors shall have insulated throats.

E. PVC-Coated Supports: Furnish with exterior coating of polyvinyl chloride (PVC), minimum thickness of 15 mil (0.38 mm).

## 2.5 FLEXIBLE METAL CONDUIT (FMC)

- A. Manufacturers: AFC Cable Systems, Inc, Electri-Flex Company, International Metal Hose, or approved equal.
- B. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.
- C. Fittings:
  1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
  2. Material: Use steel.
  3. All connectors shall have insulated throats.

## 2.6 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Manufacturers: AFC Cable Systems, Inc, Electri-Flex Company, International Metal Hose, Anamet Electrical, Inc, or approved equal.
- B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.
- C. Fittings:
  1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
  2. Material: Use steel.
  3. All connectors shall have insulated throats.

## 2.7 ELECTRICAL METALLIC TUBING (EMT)

- A. Manufacturers: Republic Conduit, Youngstown, Triangle, Allied Tube & Conduit, Wheatland Tube Company, or approved equal.
- B. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
- C. Fittings:
  1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
  2. Material: Use steel.
    - a. Do not use die cast zinc fittings.

3. Connectors and Couplings: Use set-screw type.
  - a. Do not use indenter type connectors and couplings.
4. Embedded Within Concrete (where permitted): Use fittings listed as concrete-tight. Fittings that require taping to be concrete-tight are acceptable.
5. All connectors shall have insulated throats.

## 2.8 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

- A. Manufacturers: Carlon, Triangle, Johns-Manville or approved equal.
- B. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.
- C. Fittings:
  1. Manufacturer: Same as manufacturer of conduit to be connected.
  2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

## 2.9 ACCESSORIES

- A. Any paints or coatings used on this project need to be in compliance with LEED requirements. VOC emissions from these materials must not exceed the VOC and chemical component limits of Green Seal's Standard GS-11 requirements.
- B. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.
- C. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.
- D. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force (890 N).

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that field measurements are as shown on drawings.
- B. Verify that mounting surfaces are ready to receive conduits.
- C. Verify that conditions are satisfactory for installation prior to starting work.
- D. Verify routing and termination locations of conduit prior to rough-in.

- E. Conduit routing is shown on drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

### 3.2 INSTALLATION

- A. At contractor's option, existing conduit in remodeled areas may be reused for new branch circuits and feeders where practical, and as noted on the plans. Existing conduits shall meet all requirements for new conduit as specified herein, and shall be warranted as new by the contractor.
- B. Install products in accordance with manufacturer's instructions.
- C. Install conduit in a neat and workmanlike manner in accordance with NECA 1.
- D. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.
- E. Install intermediate metal conduit (IMC) in accordance with NECA 101.
- F. Install PVC-coated galvanized steel rigid metal conduit (RMC) using only tools approved by the manufacturer.
- G. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.
- H. Install nonmetallic conduit in accordance with manufacturer's instructions.
  - 1. For all nonmetallic conduit runs 2 inch trade size and larger, all sweeps shall be of galvanized rigid construction. If sweeps are underground, sweeps shall be coated with two coats of tar prior to installation or shall be PVC coated.
- I. Cut conduit square using saw or pipecutter; de-burr cut ends.
- J. Bring conduit to shoulder of fittings; fasten securely.
- K. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.
- L. Use conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations.
- M. Install no more than equivalent of three 90 degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use hydraulic one shot bender to fabricate bends in metal conduit larger than 2 inch (50 mm) size. Runs that require more than three 90 degree bends shall be brought to the attention of the Engineer.
- N. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.
- O. Provide suitable pull string in each empty conduit except sleeves and nipples.
- P. Use suitable caps to protect installed conduit against entrance of dirt and moisture.
- Q. Conduit Routing:

1. Unless dimensioned, conduit routing indicated is diagrammatic.
2. When conduit destination is indicated and routing is not shown, determine exact routing required.
3. Conceal all conduits unless specifically indicated to be exposed.
4. Arrange conduit to maintain headroom and present neat appearance.
5. Route exposed conduit parallel and perpendicular to walls.
6. Route conduit installed above accessible ceilings parallel and perpendicular to walls.
7. Route conduit under slab, and underground from point-to-point.
8. No conduit shall be run within concrete slabs unless specifically noted otherwise.
9. Maintain adequate clearance between conduit and piping.
10. Maintain 12 inch (300 mm) clearance between conduit and surfaces with temperatures exceeding 104 degrees F (40 degrees C).
11. Conduits installed underground or embedded in concrete may be routed in the shortest possible manner unless otherwise indicated. Route all other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.

R. Conduit Support:

1. Secure and support conduits in accordance with NFPA 70 and Section 260529 using suitable supports and methods approved by the authority having jurisdiction.
2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
3. Group related conduits; support using conduit rack. Construct rack using steel channel ; provide space on each for 25 percent additional conduits.
4. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports.
5. Arrange supports to prevent misalignment during wiring installation.

S. Connections and Terminations:

1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
3. Use suitable adapters where required to transition from one type of conduit to another.
4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
6. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
7. Secure joints and connections to provide maximum mechanical strength and electrical continuity.

T. Penetrations:

1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
2. Make penetrations perpendicular to surfaces unless otherwise indicated.
3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
4. Conceal bends for conduit risers emerging above ground.

5. Provide conduit seals where raceway enters the building from underground. Seal in accordance with NEC requirements.
  6. Where conduits pass through exterior walls or roofs, Contractor shall seal penetrations with materials outlined in Section 079200.
  7. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
  8. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty. Include proposed locations of penetrations and methods for sealing with submittals.
  9. Where conduits pass through smoke or fire rated walls Contractor shall seal penetrations with appropriate smoke and/or fire rated materials as outlined in Section 078400 and/or 260050.
- U. Concrete Encasement: Where conduits not otherwise embedded within concrete are indicated to be concrete-encased, provide concrete in accordance with Section 033000 with minimum concrete cover of 3 inches (76 mm) on all sides unless otherwise indicated.
- V. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
  2. Where conduits are subject to earth movement by settlement or frost.
- W. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:
1. Where conduits pass from outdoors into conditioned interior spaces.
  2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
- X. Provide grounding and bonding in accordance with Section 260526.
- Y. Provide conduit seals where raceway enters the building from underground. Seal in accordance with NEC requirements.
- Z. Identify conduits in accordance with Section 260553.

### 3.3 PROTECTION

- A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

### 3.4 INTERFACE WITH OTHER PRODUCTS

- A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 260050.

- B. Route conduit through roof openings for piping and ductwork wherever possible. Where separate roofing penetration is required, coordinate location and installation method with roofing installation.

END OF SECTION 260534

## SECTION 260537 - BOXES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Outlet and device boxes up to 100 cubic inches (1,650 cu cm), including those used as junction and pull boxes.
- B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches (1,650 cu cm).
- C. Wall and ceiling outlet boxes.
- D. Pull and junction boxes.

#### 1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete.
- B. Section 260000 – Electrical General Requirements.
- C. Section 260526 - Grounding and Bonding for Electrical Systems.
- D. Section 260529 - Hangers and Supports for Electrical Systems.
- E. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- F. Section 260050 - Firestopping.
- G. Section 260526 - Grounding and Bonding for Electrical Systems.
- H. Section 260529 - Hangers and Supports for Electrical Systems.
- I. Section 260534 - Conduit: Conduit bodies and other fittings.
- J. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- K. Section 262726 - Wiring Devices:
  - 1. Wall plates.
  - 2. Additional requirements for locating boxes for wiring devices.
- L. Section 270507 - Communications Raceway System.

#### 1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.

- B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.
- C. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2012.
- D. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; 2013.
- E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. SCTE 77 - Specification for Underground Enclosure Integrity; 2013.
- H. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- I. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- J. UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.
- K. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.
- L. UL 1203 - Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.

#### 1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
  1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
  2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
  3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
  4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
  5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
  6. Coordinate the work with other trades to preserve insulation integrity.
  7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
  8. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

#### 1.5 SUBMITTALS

- A. See Division 01 and Section 260000 for submittal procedures.

- B. Provide product data on floor boxes and handholes.
- C. Project Record Documents: Record actual locations and mounting heights of outlet, pull, and junction boxes on project record documents. Also record actual locations of floor boxes on project record documents.

## 1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.
- C. Products: Provide products listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

## PART 2 - PRODUCTS

### 2.1 BOXES

- A. General Requirements:
  - 1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
  - 2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
  - 3. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated.
  - 4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
  - 5. Provide grounding terminals within boxes where equipment grounding conductors terminate.
- B. Outlet and Device Boxes Up to 100 cubic inches (1,650 cu cm), Including Those Used as Junction and Pull Boxes:
  - 1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
  - 2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
  - 3. Use suitable concrete type boxes where flush-mounted in concrete.
  - 4. Use suitable masonry type boxes where flush-mounted in masonry walls.
  - 5. Use raised covers suitable for the type of wall construction and device configuration where required.
  - 6. Use shallow boxes where required by the type of wall construction.
  - 7. Do not use "through-wall" boxes designed for access from both sides of wall.
  - 8. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.

9. Cast Boxes: NEMA FB 1, Type FD, aluminum. Provide gasketed cover by box manufacturer. Provide threaded hubs.
  10. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
  11. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
  12. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes.
  13. Wall Plates: Comply with Section 262726.
- C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches (1,650 cu cm):
1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
  2. NEMA 250 Environment Type, Unless Otherwise Indicated:
  3. Junction and Pull Boxes Larger Than 100 cubic inches (1,650 cu cm):
    - a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.

## 2.2 PULL AND JUNCTION BOXES

- A. Sheet Metal Boxes: NEMA OS 1, galvanized steel.
- B. Hinged Enclosures: As specified in Section 262716.
  1. Material: Galvanized cast iron.
  2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.
  3. Material: Galvanized cast iron.
  4. Cover: Smooth cover with neoprene gasket and stainless steel cover screws.
  5. Cover Legend: Shall represent the system served.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that field measurements are as shown on drawings.
- B. Verify that mounting surfaces are ready to receive boxes.
- C. Verify that conditions are satisfactory for installation prior to starting work.
- D. Verify locations of floor boxes and outlets prior to rough-in.

### 3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.

- B. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Box Supports:
  - 1. Secure and support boxes in accordance with NFPA 70 and Section 260529 using suitable supports and methods approved by the authority having jurisdiction.
  - 2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
- E. Install boxes plumb and level.
- F. Flush-Mounted Boxes:
  - 1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch (6 mm) or does not project beyond finished surface.
  - 2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
  - 3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch (3 mm) at the edge of the box.
- G. Install boxes as required to preserve insulation integrity.
- H. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- I. Close unused box openings.
- J. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
- K. Provide grounding and bonding in accordance with Section 260526.
- L. Identify boxes in accordance with Section 260553.
- M. Install boxes securely, in a neat and workmanlike manner, as specified in NECA 1.
- N. Install in locations as shown on Drawings and approved by owner, and as required for splices, taps, wire pulling, equipment connections, and as required by NFPA 70.
- O. Coordinate installation of outlet boxes for equipment connected under Section 262717.
- P. Set wall mounted boxes at elevations to accommodate mounting heights indicated.
- Q. Electrical boxes are shown on Drawings in approximate locations unless dimensioned.

1. Adjust box locations up to 10 feet (3 m) if required to accommodate intended purpose, without adjustment in contract amount.
- R. Orient boxes to accommodate wiring devices oriented as specified in Section 262726.
  - S. Maintain headroom and present neat mechanical appearance.
  - T. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
  - U. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 12 inches (305 mm) from ceiling access panel or from removable recessed luminaire.
  - V. Install boxes to preserve fire resistance rating of partitions and other elements.
  - W. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.
  - X. Locate outlet boxes to allow luminaires positioned as shown on reflected ceiling plan.
  - Y. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.
  - Z. Use flush mounting outlet boxes in finished areas.
  - AA. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening at nearest mortar joint.
  - BB. Do not install flush mounting box back-to-back in walls; provide minimum 12 inches (300 mm) horizontal separation. Provide minimum 24 inches (600 mm) horizontal separation in acoustic rated walls.
  - CC. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
  - DD. Properly support boxes with approved methods.
  - EE. Install flush mounting box without damaging wall insulation or reducing its effectiveness. AF. Use properly supported, adjustable steel channel fasteners for hung ceiling outlet box.
  - FF. Do not fasten boxes to ceiling support wires.
  - GG. Support boxes independently of conduit, except cast box that is connected to two rigid metal conduits both supported within 12 inches (305 mm) of box.
  - HH. Use gang box where more than one device is mounted together. Do not use sectional boxes.
  - II. Use 4" square box with plaster ring for single device outlets.
  - JJ. Use cast outlet box, FS type, in exterior locations and wet locations. AL. Set floor boxes level.
  - KK. Large Pull Boxes: Use hinged enclosure in interior dry locations, surface-mounted cast metal box in other locations.

LL. Handholes shall be installed per detail on drawings.

### 3.3 ADJUSTING

- A. Adjust flush-mounting outlets to make front flush with finished wall material.
- B. Install knockout closures in unused box openings.

### 3.4 CLEANING

- A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

### 3.5 PROTECTION

- A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.
- B. Clean exposed surfaces and restore finish.

END OF SECTION 260537

## SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Electrical identification requirements.
- B. Identification nameplates and labels.
- C. Wire and cable markers.
- D. Underground warning tape.
- E. Field-painted identification of conduit.

#### 1.2 RELATED REQUIREMENTS

- A. Section 260519 - Low-Voltage Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.
- B. Section 260534 - Conduit.
- C. Section 262416 - Panelboards.
- D. Section 262717 - Equipment Wiring.
- E. Section 262726 – Wiring Devices: Device and wallplate finishes; factory pre-marked wallplates.
- F. Section 262913 - Enclosed Controllers.

#### 1.3 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- B. NFPA 70E - Standard for Electrical Safety in the Workplace; 2021.

#### 1.4 QUALITY ASSURANCE

- A. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for purpose specified and shown.
- B. Conform to requirements of NFPA 70 and NFPA 70E.

#### 1.5 FIELD CONDITIONS

- A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

## PART 2 - PRODUCTS

### 2.1 IDENTIFICATION REQUIREMENTS

- A. Identification for Equipment:
  - 1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
  - 2. Arc Flash Hazard Warning Labels: Use warning labels to identify arc flash hazards for electrical equipment, such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers that are likely to require examination, adjustment, servicing, or maintenance while energized.
  - 3. Use warning signs to identify electrical hazards for entrances to all rooms and other guarded locations that contain exposed live parts operating at 600 V nominal or less with the word message "DANGER; Electrical hazard; Authorized personnel only" or approved equivalent.
- B. Identification for Conductors and Cables:
  - 1. Color Coding for Power Conductors 600 V and Less: Comply with Section 260519.
  - 2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
- C. JUNCTION BOX COVERPLATE COLOR CODING:
  - 1. Junction box coverplates shall be color-coded to indicate function.
    - a. Emergency circuit homerun coverplates - WHITE.
    - b. Fire Alarm system coverplates - RED.
    - c. Telephone and Data system coverplates - BLUE.
  - 2. External surface of coverplate may be painted in unfinished spaces, and above accessible ceilings. The inside surface of the coverplate shall be painted for boxes located in finished spaces.
  - 3. In addition to color coding, the voltage of the homerun circuits shall be stenciled on to the box cover, indicating 208Y/120V.

### 2.2 IDENTIFICATION NAMEPLATES AND LABELS

- A. Identification Nameplates:
  - 1. Manufacturers:
    - a. Brimar Industries, Inc: [www.brimar.com/#sle](http://www.brimar.com/#sle).
    - b. Kolbi Pipe Marker Co: [www.kolbipipemarkers.com/#sle](http://www.kolbipipemarkers.com/#sle).
    - c. Seton Identification Products: [www.seton.com/#sle](http://www.seton.com/#sle).
    - d. Substitutions: See Division 01 and Section 260000 for Product Requirements.
  - 2. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch (25 mm) high; Four, located at corners for larger sizes.
- B. Identification Labels:

1. Manufacturers:
    - a. Brady Corporation: [www.bradyid.com/#sle](http://www.bradyid.com/#sle).
    - b. Brother International Corporation: [www.brother-usa.com/#sle](http://www.brother-usa.com/#sle).
    - c. Panduit Corp: [www.panduit.com/#sle](http://www.panduit.com/#sle).
    - d. Substitutions: See Division 01 and Section 260000 for Product Requirements.
  2. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
  3. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.
- C. Contractor MUST coordinate faceplate/block labeling scheme with Owner. Owner will provide additional labeling information to contractor after contract is awarded.
- D. Faceplates and punchdown blocks must be machine labeled.
- E. Nameplates: Engraved three-layer laminated plastic, white letters on black background. Use white letters on red background for equipment on Standby power.
- F. Equipment to have Nameplates include:
  1. Panelboards, distribution panels, special system control panels, motors, motor starters, and, pushbutton stations.
  2. Normal use light switches will not require identification unless specifically noted otherwise.
  3. All receptacles shall be labeled with panel name and circuit number.
- G. Letter Size:
  1. Use 1/8 inch (3 mm) letters for identifying individual equipment and loads.
  2. Use 1/4 inch (6 mm) letters for identifying grouped equipment.
- H. Identification Labels:
  1. Equipment to have Identification Labels include:
    - a. All receptacles, pilot lights, special lighting or control switches, communication system pull boxes and junction boxes, and empty conduits provided for future use.
- I. Identification Label format for receptacles, pilot lights, special lighting or control switches:
  1. Minimum Size: 3/8 inch (10 mm) by 1.5 inches (38 mm).
  2. Legend: Power source and circuit number or other designation indicated.
  3. Text: All capitalized unless otherwise indicated.
  4. Minimum Text Height: 3/16 inch (5 mm).
  5. Color: Black text on clear background.
- J. Identification Label format for communication system pull boxes and junction boxes, and empty conduits provided for future use:
  1. Minimum Size: 1/2 inch (13 mm) by 1.5 inches (38 mm).
  2. Legend: Source for Communications and Power source and circuit number for power circuits.
    - a. Include voltage and phase for other than 120V, single phase circuits.
  3. Text: All capitalized unless otherwise indicated.
  4. Minimum Text Height: 1/4 inch (6 mm).
  5. Color: Black text on clear background.

## 2.3 WIRE AND CABLE MARKERS

- A. Manufacturers:
  - 1. Brady Corporation: [www.bradyid.com/#sle](http://www.bradyid.com/#sle).
  - 2. HellermannTyton: [www.hellermannntyton.com/#sle](http://www.hellermannntyton.com/#sle).
  - 3. Panduit Corp: [www.panduit.com/#sle](http://www.panduit.com/#sle).
  - 4. Substitutions: See Division 01 and Section 260000 for Product Requirements.
- B. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.
- C. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.
- D. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
- E. Minimum Text Height: 1/8 inch (3 mm).
- F. Color: Black text on white background unless otherwise indicated.
- G. Locations: Each conductor at panelboard gutters, pull boxes, and junction boxes for each load connection. Identify with branch circuit or feeder number for power and lighting circuits, and with control wire number as indicated on schematic and interconnection diagrams.
- H. Communication cable shall be provided with indelible, permanent identification labels on both ends. Coordinate with Owner to verify proper identification scheme.

## 2.4 UNDERGROUND WARNING TAPE

- A. Manufacturers:
  - 1. Brady Corporation: [www.bradyid.com/#sle](http://www.bradyid.com/#sle).
  - 2. Brimar Industries, Inc: [www.brimar.com/#sle](http://www.brimar.com/#sle).
  - 3. Seton Identification Products: [www.seton.com/#sle](http://www.seton.com/#sle).
  - 4. Substitutions: See Division 01 and Section 260000 for Product Requirements.
- B. Materials: Use 4-inch wide foil-backed detectable type polyethylene tape suitable for direct burial, unless otherwise noted.
- C. Legend: Type of service, continuously repeated over full length of tape.
- D. Color:
  - 1. Tape for Buried Power Lines: Black text on red background.
  - 2. Tape for Buried Communication, Alarm, and Signal Lines: Black text on orange background.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

- B. Degrease and clean surfaces to receive nameplates and labels.

### 3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
  - 1. Surface-Mounted Equipment: Enclosure front.
  - 2. Flush-Mounted Equipment: Inside of equipment door when located in finished areas. Mount on outside of door when installed in electrical, mechanical, custodial or similar rooms.
  - 3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
  - 4. Elevated Equipment: Legible from the floor or working platform.
  - 5. Interior Components: Legible from the point of access.
  - 6. Boxes: Outside face of cover.
  - 7. Conductors and Cables: Legible from the point of access.
- C. Install identification products centered, level, and parallel with lines of item being identified.
- D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
- E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
- F. Install underground warning tape above buried lines with one tape per trench at 3 inches (75 mm) below finished grade.
- G. All junction boxes shall be legibly and permanently marked to indicate the circuit numbers associated with the conductors in the junction box.
- H. Each new panelboard or existing panelboard with circuits provided under this project shall be provided with a neatly typed circuit directory with plastic protector.

### 3.3 FIELD QUALITY CONTROL

- A. See Section 014000 – Quality Requirements, for additional requirements.
- B. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION 260553

## SECTION 260919 – ENCLOSED CONTACTORS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. General purpose contactors.
- B. Lighting control contactors.

#### 1.2 RELATED REQUIREMENTS

- A. Section 260526 - Grounding and Bonding.
- B. Section 260529 - Hangers and Supports for Electrical Systems.
- C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 262813 - Fuses.
- E. Section 265100 - Interior Lighting
- F. Section 265600 - Exterior Lighting

#### 1.3 REFERENCE STANDARDS

- A. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2000 (R2005), with errata, 2008.
- B. NEMA ICS 6 - Industrial Control and Systems: Enclosures; 1993 (R2011).
- C. General purpose contactors.

#### 1.4 SUBMITTALS

- A. See Division 01 and Section 260000 for submittal procedures.
- B. Product Data: Provide dimensions, size, voltage ratings and current ratings.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- D. Maintenance Data: Include instructions for replacing and maintaining coil and contacts.

## 1.5 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Allen-Bradley/Rockwell Automation: [www.ab.com/#sle](http://www.ab.com/#sle).
- B. Eaton Corporation: [www.eaton.com/#sle](http://www.eaton.com/#sle).
- C. Schneider Electric; Square D Products: [www.schneider-electric.us/#sle](http://www.schneider-electric.us/#sle).
- D. Tork.
- E. Intermatic.
- F. Paragon.
- G. Substitutions: See Section 016000 - Product Requirements.

### 2.2 GENERAL PURPOSE CONTACTORS

- A. Description: NEMA ICS 2, AC general purpose magnetic contactor.
- B. Coil operating voltage: 120 volts, 60 Hertz, voltage as scheduled or as needed.
- C. Poles: As required to match circuit configuration and control function.
- D. Enclosure: NEMA ICS 6, Type 1.
- E. Accessories:
  - 1. Selector Switch: ON/OFF/AUTOMATIC.
  - 2. Indicating Light: RED.
  - 3. Auxiliary Contacts: Two, field convertible.

### 2.3 LIGHTING CONTACTORS

- A. Lighting contactors shall be equal to GE CR460 series for up to 30A or CR360 series for amperages over 30A.
- B. Description: NEMA ICS 2, magnetic lighting contactor.
- C. Configuration: Electrically held.

- D. Coil operating voltage: 120 volts, 60 Hertz, voltage as scheduled or needed.
- E. Poles: As required to match circuit configuration and control function.
- F. Contact Rating: 600VAC, 30A current rating.
- G. Enclosure: NEMA ICS 6, Type 1.
- H. Accessories:
  - 1. Selector Switch: ON/OFF/AUTOMATIC.
  - 2. Indicating Light: RED.
  - 3. Auxiliary Contacts: Two, field convertible.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install enclosed contactors where indicated, in accordance with manufacturer's instructions.
- B. Install enclosed contactors plumb. Provide supports in accordance with Section 260529.
- C. Provide engraved plastic nameplates; refer to Section 260553 for product requirements and location.

#### 3.2 FIELD QUALITY CONTROL

- A. Perform field inspection and testing in accordance with Section 014000.

END OF SECTION 260919

## SECTION 262416 - PANELBOARDS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Distribution panelboards (power panelboards).
- B. Lighting and appliance panelboards.

#### 1.2 RELATED REQUIREMENTS

- A. Section 260519 - Low-Voltage Power Conductors and Cables (600V and Less).
- B. Section 260526 - Grounding and Bonding for Electrical Systems.
- C. Section 260529 - Hangers and Supports for Electrical Systems.
- D. Section 260534 - Conduit.
- E. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- F. Section 264300 - Surge Protective Devices.

#### 1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- B. NECA 407 - Standard for Installing and Maintaining Panelboards; 2009.
- C. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches; National Electrical Manufacturers Association; 1993.
- D. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013.
- E. NEMA PB 1 - Panelboards; 2011.
- F. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; 2013.
- G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. NFPA 70E - Standard for Electrical Safety in the Workplace; 2021.
- I. UL 67 - Panelboards; Current Edition, Including All Revisions.

#### 1.4 ADMINISTRATIVE REQUIREMENTS

##### A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
4. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

#### 1.5 SUBMITTALS

- A. See Division 01 and Section 260000 for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.
- C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories. Dimensions of Equipment.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.
- F. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

#### 1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.
- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

- C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

## 1.8 MAINTENANCE MATERIALS

- A. See Section 260000 Electrical General Requirements, for additional provisions.
- B. Furnish two of each panelboard key.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. ABB/GE : [www.geindustrial.com/](http://www.geindustrial.com/) .
- B. Eaton Corporation : [www.eaton.com/](http://www.eaton.com/) .
- C. Schneider Electric; Square D Products : [www.schneider-electric.us/](http://www.schneider-electric.us/) .
- D. Siemens Industry, Inc: [www.usa.siemens.com/](http://www.usa.siemens.com/) .
- E. Source Limitations: Furnish panelboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

### 2.2 ALL PANELBOARDS - GENERAL REQUIREMENTS

- A. Provide products listed, classified, and labeled by Underwriter Laboratories Inc. or other NTRL as suitable for the purpose intended.
- B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
  - 1. Altitude: Less than 6,600 feet (2,000 m).
  - 2. Ambient Temperature:
    - a. Panelboards Containing Circuit Breakers: Between 23 degrees F (-5 degrees C) and 104 degrees F (40 degrees C).
- C. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.
- D. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.
- E. Bussing: Sized in accordance with UL 67 temperature rise requirements.
  - 1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
  - 2. Provide 200 percent rated neutral bus and lugs where oversized neutral conductors are provided.

3. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
- F. Conductor Terminations: Suitable for use with the conductors to be installed.
  - G. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.
  - H. Surge Protective Devices: Where factory-installed, internally mounted surge protective devices are provided in accordance with Section 264300, list and label panelboards as a complete assembly including surge protective device.
  - I. Load centers are not acceptable.

### 2.3 POWER DISTRIBUTION PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Shall be Square D I-Line Panelboard or equal.
- C. Bussing:
  1. Phase and Neutral Bus Material: Copper.
  2. Ground Bus Material: Copper.
  3. Provide 200% neutral bus in panels as scheduled or when fed by K rated transformers.
- D. Minimum integrated short circuit rating unless specifically noted on schedules:
  1. 208Y/120 Volt Panelboards: Minimum 22,000 amperes rms symmetrical.
- E. Molded Case Circuit Breakers: With integral thermal and instantaneous magnetic trip in each pole, bolt-on type, with common trip handle for all poles; UL listed. For air conditioning equipment branch circuits provide circuit breakers UL listed as Type HACR. For branch circuits to HID lighting fixtures provide circuit breakers UL listed for HID use.
- F. Enclosures:
  1. NEMA PB 1, Type 1, [12] inches ([153] mm) deep maximum, [48] inches ([508] mm) wide maximum cabinet box.
  2. Cabinet Front: Surface type, fastened with concealed trim clamps, hinged door with flush lock, metal directory frame, finished in manufacturer's standard gray enamel.

### 2.4 LIGHTING AND APPLIANCE PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Manufacturer/Product: Square D Type NQ or equal depending on voltage or equal.
- C. Bussing:

1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.
  2. Phase and Neutral Bus Material: Copper.
  3. Ground Bus Material: Copper.
  4. Provide 200% neutral bus in panels as scheduled or when fed by K rated transformers.
- D. Minimum Integrated Short Circuit Rating unless specifically noted on schedules:
1. 208Y/120 Volt Panelboards: Minimum 22,000 amperes rms symmetrical.
- E. Molded Case Circuit Breakers: Thermal magnetic trip circuit breakers, bolt-on type, with common trip handle for all poles; UL listed.
1. Type SWD for lighting circuits.
  2. Type HID for HID lighting circuits.
  3. Type HACR for air conditioning equipment circuits.
  4. Class A ground fault interrupter circuit breakers where scheduled.
  5. Do not use tandem circuit breakers.
  6. Provide shunt trip breakers as shown on drawings.
- F. Enclosures:
1. Enclosure: NEMA PB 1, Type 1.
  2. Provide surface-mounted or flush-mounted enclosures as indicated.
  3. Cabinet Box: 6 inches (153 mm) deep, 20 inches (508 mm) wide for all panelboards.
  4. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
  5. Provide clear plastic circuit directory holder mounted on inside of door.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive panelboards.
- D. Verify that conditions are satisfactory for installation prior to starting work.

### 3.2 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.
- C. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.

- D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- E. Provide required support and attachment in accordance with Section 260529.
- F. Install panelboards plumb.
- G. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.
- H. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches (2000 mm) above the floor or working platform.
- I. Provide grounding and bonding in accordance with Section 260526.
- J. Install all field-installed branch devices, components, and accessories.
- K. Provide filler plates to cover unused spaces in panelboards.
- L. Provide typed circuit directory for each lighting and appliance panelboard and each power distribution panelboard provided with a door, clearly and specifically indicating the loads served. Identify spares and spaces.
- M. Provide identification nameplate for each power distribution panelboard branch device in accordance with Section 260553, clearly and specifically indicating the loads served.
- N. Provide identification nameplate for each panelboard in accordance with Section 260553.
- O. Provide spare conduits out of each recessed panelboard to an accessible location above ceiling. Quantity of spare conduits shall be one (1) 3/4" conduit for every three (3) spares/spaces, or fraction thereof. Identify each as SPARE.
- P. Minimum spare conduits: 4 empty 3/4 inch (19mm).
- Q. Ground and bond panelboard enclosure according to Section 260526.
- R. For all panelboards, provide NFPA 70 Art 110.24 Available Fault Current markings. The Available Fault Current markings may be either field or factory applied.
- S. For all panelboards, provide NFPA 70 Art 110.21(B) compliant hazard markings (Arc Flash and Shock Hazard). The hazard markings may be either field or factory applied.

### 3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.
- C. Test GFCI circuit breakers to verify proper operation.

- D. Test shunt trips to verify proper operation.
- E. Correct deficiencies and replace damaged or defective panelboards or associated components.

#### 3.4 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- B. Adjust alignment of panelboard fronts.
- C. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

#### 3.5 CLEANING

- A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 262416

## SECTION 262716 - CABINETS AND ENCLOSURES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Hinged cover enclosures.
- B. Cabinets.
- C. Terminal blocks.

#### 1.2 RELATED REQUIREMENTS

- A. Section 260526 - Grounding and Bonding.
- B. Section 260529 - Hangers and Supports for Electrical Systems.

#### 1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- B. PART 1 GENERAL
- C. NEMA ICS 4 - Application Guideline for Terminal Blocks; 2015.

#### 1.4 SUBMITTALS

- A. See Division 01 and Section 260000 for submittal procedures.
- B. Product Data: Provide manufacturer's standard data for enclosures and cabinets.
- C. Cabinet Keys: Deliver to Owner in accordance with Section 260000 for maintenance materials.

#### 1.5 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

### PART 2 - PRODUCTS

## 2.1 HINGED COVER ENCLOSURES

- A. Construction: NEMA 250, Type 1 (3R where installed outdoors or exposed to moisture) steel enclosure.
- B. Covers: Continuous hinge, held closed by flush latch operable by screwdriver.
- C. Provide interior plywood panel for mounting terminal blocks and electrical components; finish with white enamel.
- D. Enclosure Finish: Manufacturer's standard enamel.
- E. Keys: Provide two of each different key.

## 2.2 CABINETS

- A. Boxes: Galvanized steel.
- B. Backboard: Provide 3/4 inch (19 mm) thick plywood backboard for mounting terminal blocks and electrical components. Paint matte white.
- C. Fronts: Steel, surface type with screw cover front, door with concealed hinge, and flush lock . Finish with gray baked enamel.
- D. Provide metal barriers to form separate compartments wiring of different systems and voltages.
- E. Keys: Provide two of each different key.

## 2.3 TERMINAL BLOCKS

- A. Terminal Blocks: NEMA ICS 4.
- B. Power Terminals: Unit construction type with closed back and tubular pressure screw connectors, rated 600 volts.
- C. Provide ground bus terminal block, with each connector bonded to enclosure.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install securely, in a neat and workmanlike manner, as specified in NECA 1.
- B. Install enclosures and boxes plumb. Anchor securely to wall and structural supports at each corner under the provisions of Section 260529.
- C. Install cabinet fronts plumb.

3.2 CLEANING

- A. Clean electrical parts to remove conductive and harmful materials.
- B. Remove dirt and debris from enclosure.
- C. Clean finishes and touch up damage.

END OF SECTION 262716

## SECTION 262717 - EQUIPMENT WIRING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Electrical connections to equipment.

#### 1.2 RELATED REQUIREMENTS

- A. Section 260519 - Low-Voltage Electrical Power Conductors and Cables (600 V and Less).
- B. Section 260526 - Grounding and Bonding.
- C. Section 260534 - Conduit.
- D. Section 260537 - Boxes.
- E. Section 260553 - Identification for Electrical Systems.

#### 1.3 REFERENCE STANDARDS

- A. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (R 2010).
- B. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2012.
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

#### 1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
  - 1. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
  - 2. Determine connection locations and requirements.
- B. Sequencing:
  - 1. Install rough-in of electrical connections before installation of equipment is required.
  - 2. Make electrical connections before required start-up of equipment.

#### 1.5 SUBMITTALS

- A. See Division 01 for submittal procedures.

- B. Product Data: Provide wiring device manufacturer's catalog information showing dimensions, configurations, and construction.

#### 1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

#### 1.7 COORDINATION

- A. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
- B. Determine connection locations and requirements.
- C. Sequence rough-in of electrical connections to coordinate with installation of equipment.
- D. Sequence electrical connections to coordinate with start-up of equipment.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
  - 1. Colors: Conform to NEMA WD 1.
  - 2. Cord Construction: NFPA 70, Type SO, multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
  - 3. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.
- B. Flexible Conduit: As specified in Section 260534.
- C. Wire and Cable: As specified in Section 260519.
- D. Boxes: As specified in Section 260537.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Verify that equipment is ready for electrical connection, wiring, and energization.

### 3.2 ELECTRICAL CONNECTIONS

- A. Make electrical connections in accordance with equipment manufacturer's instructions.
- B. Make conduit connections to equipment using flexible conduit. Use liquid tight flexible conduit with watertight connectors in damp or wet locations.
- C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
- D. Provide receptacle outlet to accommodate connection with attachment plug.
- E. Provide cord and cap where field-supplied attachment plug is required.
- F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.
- H. Install terminal block jumpers to complete equipment wiring requirements.
- I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

END OF SECTION 262717

## SECTION 262726 - WIRING DEVICES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Wall switches.
- B. Wall dimmers.
- C. Occupancy sensors.
- D. Receptacles.
- E. Wall plates.
- F. Cord and plugs for plug connected equipment.
- G. Floor box service fittings

#### 1.2 RELATED REQUIREMENTS

- A. Section 260519 - Low-Voltage Electrical Power Conductors and Cables (600 V and Less).
- B. Section 260526 - Grounding and Bonding.
- C. Section 260534 - Conduit.
- D. Section 260537 - Boxes.
- E. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- F. Section 262717 - Equipment Wiring: Cords and plugs for equipment.
- G. This section specifies a system or part of a system being commissioned as defined in 01 9113 General Commissioning Requirements. Testing of these systems, as well as Operations & Maintenance (O&M) Manuals and Training of the Owner's personnel, is required in cooperation with the Owner, General Contractor, and the Commissioning Professional. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to 01 9113 General Commissioning Requirements for detailed commissioning requirements.

#### 1.3 REFERENCE STANDARDS

- A. FS W-C-596 - Connector, Electrical, Power, General Specification for; Federal Specification; Revision G, 2001.

- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- C. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.
- D. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (R 2010).
- E. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2012.
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. UL 498 - Attachment Plugs and Receptacles; Current Edition, Including All Revisions.
- H. UL 514D - Cover Plates for Flush-Mounted Wiring Devices; Current Edition, Including All Revisions.
- I. UL 943 - Ground-Fault Circuit-Interruption; Current Edition, Including All Revisions.
- J. UL 1472 - Solid-State Dimming Controls; Current Edition, Including All Revisions.

#### 1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
  1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
  2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
  3. Coordinate the placement of outlet boxes for wall switches with actual installed door swings.
  4. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
  5. Notify Engineer of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.
- B. Sequencing:
  1. Do not install wiring devices until final surface finishes and painting are complete.

#### 1.5 SUBMITTALS

- A. See Division 01 and Section 260000 for submittal procedures.
- B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.
- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- D. Operation and Maintenance Data:
  1. Wall Dimmers: Include information on operation and setting of presets.

2. Occupancy Sensors: Include information on operation and setting of presets.
  3. GFCI Receptacles: Include information on status indicators and testing procedures and intervals.
- E. Project Record Documents: Record actual installed locations of wiring devices.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Section 016000 - Product Requirements, for additional provisions.
  2. Screwdrivers for Tamper-Resistant Screws: Two for each type of screw.
  3. Extra Wall Plates: 20 of each style, size, and finish.
- G. Refer to Section 01 9113 General Commissioning Requirements for commissioning-related submittals and submittal review processes.

## 1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Products: Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

## 1.7 DELIVERY, STORAGE, AND PROTECTION

- A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

## PART 2 - PRODUCTS

### 2.1 ALL WIRING DEVICES

- A. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- B. Finishes:
1. Wiring Devices Installed in Finished Spaces: Light Almond with Light Almond nylon wall plate unless otherwise indicated.
  2. Wiring Devices Installed in Unfinished Spaces: Gray with galvanized steel wall plate unless otherwise indicated.
  3. Wiring Devices Installed in Wet or Damp Locations: Gray with specified weatherproof cover unless otherwise indicated.
  4. Wiring Devices Connected to Emergency Power: Red with red nylon wall plate.
  5. All ceiling mounted occupancy sensors shall be White.

### 2.2 WALL SWITCHES

- A. Manufacturers:
1. Hubbell Incorporated: [www.hubbell.com/#sle](http://www.hubbell.com/#sle).

2. Leviton Manufacturing Company, Inc: [www.leviton.com/#sle](http://www.leviton.com/#sle).
  3. Pass & Seymour, a brand of Legrand North America, Inc: [www.legrand.us/#sle](http://www.legrand.us/#sle).
  4. Arrow Hart, a brand of Eaton.
  5. Sensor Switch, a brand of Acuity Brands Lighting, Inc: [www.acuitybrands.com](http://www.acuitybrands.com).
- B. Wall Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.
- C. Standard Wall Switches: Industrial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three-way, or four-way as indicated on the drawings.
1. Product: Hubbell No. HBL1221GY Series or equal.
- D. Occupancy Sensor Wall Switch Style:
1. Product: Sensor Switch #WSD-V-AL, or equal. Switch will require manual on and will provide automatic (predictive) off.
- E. Occupancy Sensor Ceiling Mounted:
1. Product: Sensor Switch #CMR-PDT-9 or equal.
  2. Large Areas Requiring multiple sensors: Product: Sensor Switch #CM-PDT-10 with
  3. #PP-20 power pack, or equal.

## 2.3 WALL DIMMERS

- A. Manufacturers:
1. Leviton Manufacturing Company, Inc: [www.leviton.com/#sle](http://www.leviton.com/#sle).
  2. Lutron Electronics Company, Inc; Diva Series: [www.lutron.com/#sle](http://www.lutron.com/#sle).
  3. Pass & Seymour, a brand of Legrand North America, Inc: [www.legrand.us/#sle](http://www.legrand.us/#sle).
  4. Hubbell Incorporated: [www.hubbell.com/#sle](http://www.hubbell.com/#sle).
- B. Wall Dimmers - General Requirements: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 1472; types and ratings suitable for load controlled as indicated on the drawings.
- C. Wall Dimmers: NEMA WD 1; Semiconductor dimmer for LED lamps, Type as indicated on drawings, or as required to be compatible with LED driver and device boards.
1. Voltage: 120 or 277 volts, as required.
  2. Product: Diva series by Lutron Corporation, or approved equivalent. MUST be compatible with lamps and ballasts.

## 2.4 RECEPTACLES

- A. Manufacturers:
1. Hubbell Incorporated: [www.hubbell.com/#sle](http://www.hubbell.com/#sle).
  2. Leviton Manufacturing Company, Inc: [www.leviton.com/#sle](http://www.leviton.com/#sle).
  3. Pass & Seymour, a brand of Legrand North America, Inc: [www.legrand.us/#sle](http://www.legrand.us/#sle).

4. Arrow Hart, a brand of Eaton.
- B. All Receptacles: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
  2. NEMA configurations specified are according to NEMA WD 6.
  3. Provide labeling of receptacles as outlined in Section 260553.
- C. Convenience Receptacles:
1. Standard Convenience Receptacles: Commercial specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.
    - a. Hubbell #5362LA or equal.
  2. Tamper-Resistant Convenience Receptacles: Commercial specification grade, 20A, 125V, NEMA 5-20R, , listed and labeled as tamper-resistant type; single or duplex as indicated on the drawings.
    - a. Hubbell #BR20LATR or equal.
- D. GFCI Receptacles:
1. All GFCI Receptacles: Provide with feed-through protection, light to indicate ground fault tripped condition and loss of protection, and list as complying with UL 943, class A.
    - a. Provide test and reset buttons of same color as device.
  2. Standard GFCI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.
    - a. Hubbell #GF20LALA or equal.
  3. Tamper-Resistant GFCI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper-resistant type.
    - a. Pass & Seymour #2095TRSLA or equal.
  4. Tamper-Resistant and Weather-Resistant GFCI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper-resistant type and as weather-resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.
    - a. At all outdoor receptacle locations: Hubbell #GFTR20GY or equal.
- E. Special purpose receptacles, as noted or shown on the drawings.

## 2.5 WALL PLATES

- A. Manufacturers:
1. Hubbell Incorporated: [www.hubbell-wiring.com/#sle](http://www.hubbell-wiring.com/#sle).
  2. Leviton Manufacturing Company, Inc: [www.leviton.com/#sle](http://www.leviton.com/#sle).
  3. Lutron Electronics Company, Inc: [www.lutron.com/#sle](http://www.lutron.com/#sle).
  4. Pass & Seymour, a brand of Legrand North America, Inc: [www.legrand.us/#sle](http://www.legrand.us/#sle).
  5. Arrow Hart, a brand of Eaton.
  6. Sensor Switch, a brand of Acuity Brands Lighting, Inc: [www.acuitybrands.com](http://www.acuitybrands.com).
  7. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wallplates by the same manufacturer in locations indicated.

- B. All Wall Plates: Comply with UL 514D.
  - 1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
  - 2. Size: Standard.
  - 3. Screws: Metal with slotted heads finished to match wall plate finish.
- C. Nylon Wall Plates: Smooth finish, high-impact thermoplastic.
- D. Galvanized Steel Wall Plates: Rounded corners and edges, with corrosion resistant screws.
- E. Weatherproof While-In-Use Covers: Single gang, vertical mount. Self-closing and weatherproof (gasketed) with cord and plug inserted into the device. Extra Duty, commercial quality die-cast aluminum cover with factory powered coated finish. Integral cord catch and hole to accept a standard size padlock, 302 Stainless Steel mounting screws. Product: Hubbell Bell 5881-0 or approved equivalent.

## 2.6 FLOOR BOX SERVICE FITTINGS

- A. Flush Floor Convenience Receptacles and Communication Outlet Boxes:
  - 1. All Locations except Conference Room: Floor boxes where indicating a duplex receptacle shall be a two gang box for a duplex receptacle and data outlets. Floor boxes indicating a double-duplex receptacle and data outlets shall be a three-gang box. Provide a 1" conduit stubbed up to an accessible location above the ceiling from one gang for data wiring. Conduit shall extend to nearest corridor above ceiling.
    - a. Material: Stamped Steel.
    - b. Product: Hubbell #3SFBS with 3SFBRP face plate for each duplex receptacle and the data face plate shall be compatible with data outlets supplied by Communications Cabling Contractor. Coordinate requirements.
    - c. Provide matching floor covering inside recess of cover to help conceal floor box.
  - 2. Conference Room Only: Floor boxes where indicated shall be a four gang box for a double duplex receptacle, data outlets and other communications outlets as noted on drawings. Provide a dedicated 1" conduit from two of the four gangs for data and other communication outlet needs. Conduit from these two gangs shall be stubbed up to an accessible location above the ceiling. One of these three conduits from shall extend to nearest corridor above ceiling.
    - a. Material: Stamped Steel.
    - b. Product: Hubbell #HBLCFB401CB four gang box with LCFBCALC Cover & Flange assembly; two HBLST302SGY modular face plates; and two HBLDE301SGY modular face plates or approved equivalents.
    - c. Provide matching floor covering inside recess of cover to help conceal floor box.

## 2.7 CORD AND PLUGS

- A. Provide cord and plugs for all plug connected equipment as required. Provide cord sets for new cord & plug connected equipment in the Kitchen and Laundry areas, per manufacturer's recommendations, as shown and scheduled on the plans. Cord and plug connected equipment includes garbage disposals, ranges, washers, dryers, dishwashers and other equipment noted on the plans.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C. Verify that wall openings are neatly cut and will be completely covered by wall plates.
- D. Verify that final surface finishes are complete, including painting.
- E. Verify that floor boxes are adjusted properly.
- F. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- G. Verify that conditions are satisfactory for installation prior to starting work.

### 3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

### 3.3 INSTALLATION

- A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Coordinate locations of outlet boxes provided under Section 260537 as required for installation of wiring devices provided under this section.
- C. Install wiring devices in accordance with manufacturer's instructions.
- D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300V.
- E. Where required, connect wiring devices using pigtails not less than 6 inches (150 mm) long. Do not connect more than one conductor to wiring device terminals.
- F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.
- G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

- H. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.
- I. Install securely, in a neat and workmanlike manner, as specified in NECA 1.
- J. Install wiring devices plumb and level with mounting yoke held rigidly in place.
- K. Install wall switches with OFF position down.
- L. Do not share neutral conductor on branch circuits utilizing wall dimmers.
- M. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.
- N. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- O. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.
- P. Identify wiring devices in accordance with Section 260553.
- Q. Install receptacles with grounding pole oriented to the top.
- R. Connect wiring device grounding terminal to outlet box with bonding jumper, except where equipment grounding conductor is present.
- S. Connect wiring devices by wrapping conductor around screw terminal.
- T. Use jumbo size plates for outlets installed in masonry walls.
- U. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.
- V. Install protective rings on active flush cover service fittings.

### 3.4 INTERFACE WITH OTHER PRODUCTS

- A. Coordinate locations of outlet boxes provided under Section 260537 to obtain mounting heights specified or indicated on drawings.
- B. Install wall switch 46 inches (1.17 m) above finished floor.
- C. Install convenience receptacle 18 inches (450 mm) above finished floor or as indicated on plans.
- D. Install convenience receptacle 6 inches (150 mm) above counter.
- E. Install wall dimmers 46 inches (1.17 m) above finished floor.

- F. Install telephone and data jacks 18 inches (450 mm) above finished floor or as indicated on plans.
- G. Install telephone jack for all wall telephone and intercom outlets at 46 inches (1.17 m) above finished floor.
- H. All electrical devices in warehouse area shall be installed a minimum of 24 inches (.61m) above finished floor or as indicated on plans.
- I. Heights above are to the center of the box.

### 3.5 FIELD QUALITY CONTROL

- A. Perform field inspection, testing, and adjusting in accordance with Section 014000.
- B. Inspect each wiring device for damage and defects.
- C. Operate each wall switch with circuit energized to verify proper operation.
- D. Operate each wall switch with circuit energized and verify proper operation.
- E. Verify that each receptacle device is energized.
- F. Test each receptacle to verify operation and proper polarity.
- G. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.
- H. Correct wiring deficiencies and replace damaged or defective wiring devices.

### 3.6 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.
- B. Adjust devices and boxes as required to assure that device coverplates seat firmly to wall surface.

### 3.7 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

### 3.8 DEMONSTRATION AND TRAINING

- A. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner, General Contractor, and the Commissioning Professional. Provide competent, factory-authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, troubleshooting, routine servicing and maintenance of the installed

systems. The instruction shall be scheduled in coordination with the Owner and the Commissioning Professional after submission and approval of formal training agendas. Refer to Sections 01 9113 General Commissioning Requirements.

### 3.9 FUNCTIONAL PERFORMANCE TESTING

- A. System functional performance testing is part of the Commissioning Process as detailed in Section 01 9113 General Commissioning Requirements. Functional performance testing shall be performed by the contractor and witnessed and documented by the Commissioning Professional. Installation checklists shall be successfully completed by the contractor and submitted to the Commissioning Professional prior to functional performance testing.

END OF SECTION 262726

## SECTION 262813 - FUSES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Fuses.
- B. Fuse cabinet and spare fuses.

#### 1.2 RELATED REQUIREMENTS

- A. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- B. Section 262818 - Enclosed Switches: Fusible switches.

#### 1.3 REFERENCE STANDARDS

- A. NEMA FU 1 - Low Voltage Cartridge Fuses; 2012.
- B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. UL 248-1 - Low-Voltage Fuses - Part 1: General Requirements; Current Edition, Including All Revisions.
- D. UL 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses; Current Edition, Including All Revisions.

#### 1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
  - 1. Coordinate fuse clips furnished in equipment provided under other sections for compatibility with indicated fuses.
    - a. Fusible Enclosed Switches: See Section 262818.
  - 2. Coordinate fuse requirements according to manufacturer's recommendations and nameplate data for actual equipment to be installed.
  - 3. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

#### 1.5 SUBMITTALS

- A. See Section 013330 and Section 260000 for submittal procedures.
- B. Product Data: Provide manufacturer's standard data sheets including voltage and current ratings, interrupting ratings, time-current curves, and current limitation curves.
  - 1. Spare Fuse Cabinet: Include dimensions

#### 1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

#### 1.7 MAINTENANCE MATERIALS

- A. See Section 260000 – Electrical General Requirements, for additional provisions.
- B. Furnish one fuse puller for each type of fuse.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Bussmann, a division of Eaton Corporation: [www.cooperindustries.com/#sle](http://www.cooperindustries.com/#sle).
- B. Littelfuse, Inc: [www.littelfuse.com/#sle](http://www.littelfuse.com/#sle).
- C. Mersen: [ep-us.mersen.com/#sle](http://ep-us.mersen.com/#sle).
- D. Substitutions: See Division 01 and Section 260000.

#### 2.2 APPLICATIONS

- A. Individual Motor Branch Circuits: Class RK1, time-delay.

#### 2.3 FUSES

- A. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose indicated.
- B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.
- C. Provide fuses of the same type, rating, and manufacturer within the same switch.

- D. Comply with UL 248-1.
- E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, Class and ratings as indicated.
- F. Voltage Rating: Suitable for circuit voltage.
- G. Class R Fuses: Comply with UL 248-12.

#### 2.4 FUSE CABINET AND SPARE FUSES

- A. Provide one spare fuse cabinet Bussman "SPC" or equivalent. The cabinet shall contain fuse puller and all applicable spare fuses with labels identifying type and size. Cabinet shall be provided with hinged door and latch.
- B. Provide one spare fuse for each three fuses of each amp rating installed with a minimum of three spares for each amp rating used.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Verify that fuse ratings are consistent with circuit voltage and manufacturer's recommendations and nameplate data for equipment.
- B. Verify that conditions are satisfactory for installation prior to starting work.

#### 3.2 INSTALLATION

- A. Do not install fuses until circuits are ready to be energized.
- B. Install fuses with label oriented such that manufacturer, type, and size are easily read.
- C. Install spare fuse cabinet where directed by Owner.

END OF SECTION 262813

## SECTION 262818 - ENCLOSED SWITCHES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Enclosed safety switches.
- B. Fusible switches.
- C. Nonfusible switches.

#### 1.2 RELATED REQUIREMENTS

- A. Section 260526 - Grounding and Bonding for Electrical Systems.
- B. Section 260529 - Hangers and Supports for Electrical Systems.
- C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 262813 - Fuses.

#### 1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- C. NECA (INST) - NECA Standard of Installation; National Electrical Contractors Association; 1993.
- D. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- H. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.
- I. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.

#### 1.4 SUBMITTALS

- A. See Section 013330 and Section 260000 for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.
- C. Project Record Documents: Record actual locations of enclosed switches.

#### 1.5 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed switch internal components, enclosure, and finish.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Source Limitations: Furnish enclosed switches and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

#### 2.2 ENCLOSED SAFETY SWITCHES

- A. Description: Quick-make, quick-break enclosed safety switches listed and labeled as complying with UL 98; heavy duty; ratings, configurations, and features as indicated on the drawings.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
  - 1. Altitude: Less than 6,600 feet (2,000 m).
  - 2. Ambient Temperature: Between -22 degrees F (-30 degrees C) and 104 degrees F (40 degrees C).
- D. Horsepower Rating: Suitable for connected load.

- E. Voltage Rating: Suitable for circuit voltage.
- F. Short Circuit Current Rating:
  - 1. Provide enclosed safety switches, when protected by the fuses or supply side overcurrent protective devices to be installed, with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
- G. Enclosed Safety Switches Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.
- H. Provide with switch blade contact position that is visible when the cover is open.
- I. Fuse Clips for Fusible Switches: As required to accept fuses indicated.
- J. Conductor Terminations: Suitable for use with the conductors to be installed.
- K. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.
- L. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
- M. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.
- N. Heavy Duty Switches:
  - 1. Comply with NEMA KS 1.
  - 2. Conductor Terminations:
    - a. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
  - 3. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.

## 2.3 COMPONENTS

- A. Fusible Switch Assemblies: NEMA KS 1, Type HD (heavy-duty) enclosed load interrupter knife switch.
  - 1. Externally operable handle interlocked to prevent opening front cover with switch in ON position.
  - 2. Handle lockable in OFF position.
  - 3. Fuse clips for Main Disconnect Switches: Designed to accommodate NEMA FU1, Class L fuses.
  - 4. Fuse clips: Designed to accommodate NEMA FU1, Class R fuses.
- B. Nonfusible Switch Assemblies: NEMA KS 1, Type HD (heavy-duty) enclosed load interrupter knife switch.
  - 1. Externally operable handle interlocked to prevent opening front cover with switch in ON position.
  - 2. Handle lockable in OFF position.
- C. Enclosures: NEMA KS 1.

1. Interior Dry Locations: Type 1.
2. Exterior or Wet Locations: Type.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that the ratings of the enclosed switches are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive enclosed safety switches.
- D. Verify that conditions are satisfactory for installation prior to starting work.

### 3.2 INSTALLATION

- A. All disconnect switches shown on drawings shall be considered fused unless specifically noted as non-fused.
- B. Install enclosed switches in accordance with manufacturer's instructions.
- C. Install enclosed switches securely, in a neat and workmanlike manner in accordance with NECA 1.
- D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- E. Provide required supports in accordance with Section 260529.
- F. Install enclosed switches plumb.
- G. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches (2000 mm) above the floor or working platform.
- H. Provide grounding and bonding in accordance with Section 260526.
- I. Provide fuses complying with Section 262813 for fusible switches as indicated or as required by equipment manufacturer's recommendations.
- J. Provide identification nameplate for each enclosed switch in accordance with Section 260553.
- K. Provide arc flash warning labels in accordance with NFPA 70.
- L. Install fuses in fusible disconnect switches, with fuse nameplates visible from the front.
- M. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

3.3 FIELD QUALITY CONTROL

- A. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.

3.4 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.5 CLEANING

- A. Clean dirt and debris from switch enclosures and components according to manufacturer's instructions.

END OF SECTION 262818

## SECTION 262913 - ENCLOSED CONTROLLERS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Combination magnetic motor controllers and disconnects.
- B. Variable Frequency Drives
- C. Disconnect Switch.

#### 1.2 RELATED REQUIREMENTS

- A. Section 260526 - Grounding and Bonding.
- B. Section 260529 - Hangers and Supports for Electrical Systems.
- C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

#### 1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- B. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches; National Electrical Manufacturers Association; 1993.
- C. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2000 (R2005), with errata, 2008.
- D. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices; 2000 (R2010).
- E. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013.
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

#### 1.4 SUBMITTALS

- A. See Section 013330 and Section 260000 for submittal procedures.
- B. Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.
- C. Maintenance Data: Replacement parts list for controllers.

## 1.5 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 150 miles (241 km) of Project.
- C. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Same as panelboards or Allen-Bradley.

### 2.2 VARIABLE FREQUENCY DRIVES

- A. Variable frequency drives (VFD's) are being provided as indicated on Motor and Starter schedule. Coordinate requirements with Mechanical Contractor.
  - 1. Where VFD's are noted to be supplied by the Mechanical Contractor with equipment the Electrical Contractor shall ensure they are installed and wired properly.
  - 2. Provide motor shaft grounding of all motors served by VFD's in accordance with Section 260526 Grounding and Bonding. This is required of all VFD's whether supplied by the Electrical Contractor or not.

### 2.3 ACCESSORIES FOR ALL AUTOMATIC CONTROLLERS

- A. Auxiliary Contacts: NEMA ICS 2, 2 field convertible contacts in addition to seal-in contact.
- B. Cover Mounted Pilot Devices: NEMA ICS 5, heavy duty oiltight type. Provide red RUN and green OFF LED lights.
- C. Pilot Device Contacts: NEMA ICS 5, Form Z, rated A150.
- D. Pushbuttons: Recessed type.
- E. Indicating Lights: Transformer, LED type.
- F. Selector Switches: Rotary type. Cover mounted HOA.
- G. Control Power Transformers: 24 volt secondary, 120V primary or as needed. Provide fused primary, secondary, and bond unfused leg of secondary to enclosure.

### 2.4 DISCONNECTS

- A. Combination Controllers: Combine motor controllers with over-current protective device and disconnect in common enclosure. Obtain IEC Class 2 coordinated component protection.

- B. Motor Circuit Protector: Circuit breakers with integral instantaneous magnetic trip in each pole; UL listed. Shall be provided in all combination controllers.
- C. Nonfusible Switch Assemblies: NEMA KS 1, enclosed knife switch with externally operable handle.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install enclosed controllers where indicated, in accordance with manufacturer's instructions.
- B. Install securely, in a neat and workmanlike manner, as specified in NECA 1.
- C. Provide supports in accordance with Section 260529.
- D. Height: 5 ft (1500 mm) to operating handle.
- E. Select and install overload heater elements in motor controllers to match installed motor characteristics.
- F. Provide engraved plastic nameplates; refer to Section 260553 for identification requirements and location. Shall identify motor served, horsepower of motor, and voltage/phase rating.

### 3.2 FIELD QUALITY CONTROL

- A. Correct deficiencies and replace damaged or defective enclosed controllers or associated components.

### 3.3 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

### 3.4 CLEANING

- A. Clean dirt and debris from controller enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 262913

## SECTION 263213 - ENGINE GENERATORS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Packaged engine generator system and associated components and accessories:
  - 1. Engine and engine accessory equipment.
  - 2. Alternator (generator).
  - 3. Generator set control system.
  - 4. Generator set enclosure (Level 2 Acoustic Enclosure).
- B. Exhaust silencer and fittings.
- C. Fuel fittings.
- D. Unit mounted control panel.
- E. Battery and charger.

#### 1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 260526 - Grounding and Bonding for Electrical Systems.
- C. Section 231126 - Facility Liquefied-Petroleum Gas Piping.
- D. Section 260529 - Hangers and Supports for Electrical Systems.
- E. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- F. Section 263600 – Transfer Switches.

#### 1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- B. NECA/EGSA 404 - Standard for Installing Generator Sets; National Electrical Contractors Association; 2007.
- C. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2011.
- D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2008.

- E. NFPA 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines; 2021.
- F. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. NFPA 101 - Code for Safety to Life from Fire in Buildings and Structures; National Fire Protection Association; 2021.
- H. NFPA 110 - Standard for Emergency and Standby Power Systems; National Fire Protection Association; 2022.
- I. UL 1236 - Battery Chargers for Charging Engine-Starter Batteries; Current Edition, Including All Revisions.
- J. UL 2200 - Stationary Engine Generator Assemblies; Current Edition, Including All Revisions.

#### 1.4 SUBMITTALS

- A. See Section 013330 and Section 260000 for submittal procedures.
- B. Manufacturer's factory emissions certification.
- C. Provide NFPA 110 required documentation from manufacturer where requested by authorities having jurisdiction, including but not limited to:
  - 1. Certified prototype tests.
  - 2. Torsional vibration compatibility certification.
  - 3. NFPA 110 compliance certification.
  - 4. Certified rated load test at rated power factor.
- D. Shop Drawings: Indicate electrical characteristics and connection requirements. Show plan and elevation views with overall and interconnection point dimensions, fuel consumption rate curves at various loads, ventilation and combustion air requirements, electrical diagrams including schematic and interconnection diagrams.
- E. Product Data: Provide data showing dimensions, weights, ratings, interconnection points, and internal wiring diagrams for engine, generator, control panel, battery, battery rack, battery charger, remote radiator, exhaust silencer and vibration isolators.
- F. Test Reports: Indicate results of performance testing.
- G. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- H. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- I. Operation Data: Include instructions for normal operation.

- J. Maintenance Data: Include instructions for routine maintenance requirements, service manuals for engine, oil sampling and analysis for engine wear, and emergency maintenance procedures.

## 1.5 QUALITY ASSURANCE

- A. Comply with the following:
  - 1. NFPA 70 (National Electrical Code).
  - 2. NFPA 110 (Standard for Emergency and Standby Power Systems); meet requirements for Level 2 system.
  - 3. NFPA 37 (Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines).
  - 4. NFPA 30 (Flammable and Combustible Liquids Code)
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with engine generator systems of similar size, type, and complexity; manufacturer's authorized installer.
- D. Products: Listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authorities having jurisdiction as suitable for the purpose indicated.
- E. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience with service facilities within 300 miles of Project. Also refer to requirements of SECTION 014000 Quality Requirements Paragraph 1.6.
- F. Supplier Qualifications: Authorized distributor of specified manufacturer with minimum three years documented experience.
- G. Products: Furnish products listed and classified by testing firm acceptable to authority having jurisdiction as suitable for purpose specified and indicated.

## 1.6 WARRANTY

- A. Engine-generator package, including transfer switch, shall be provided with an extended 5-year warranty against defects in material and workmanship. The 5-year warranty begins at substantial completion and is applicable to all emergency power supply system (EPSS) equipment.
- B. See Section 017700 Closeout Procedures and Section 260000 for additional warranty requirements.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store generator sets in accordance with manufacturer's instructions and NECA/EGSA 404.

- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle carefully in accordance with manufacturer's instructions to avoid damage to generator set components, enclosure, and finish.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Packaged Engine Generator Set - Basis of Design: Generac Power Systems as indicated under product description below: [www.generac.com/industrial](http://www.generac.com/industrial).
- B. Packaged Engine Generator Set - Other Acceptable Manufacturers:
  - 1. Caterpillar Inc: [www.cat.com/en\\_US/products/new/power-systems.html](http://www.cat.com/en_US/products/new/power-systems.html).
  - 2. Cummins Power Generation Inc: [power.cummins.com](http://power.cummins.com).
  - 3. Kohler Co: [www.kohlerpower.com](http://www.kohlerpower.com).
  - 4. Pre-bid approved equivalent.
- C. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.

### 2.2 PACKAGED ENGINE GENERATOR SYSTEM

- A. Provide new engine generator system consisting of all required equipment, sensors, conduit, boxes, wiring, piping, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.
- B. System Description:
  - 1. Application: NEC Article 702/Optional Standby System.
  - 2. Configuration: Single packaged engine generator set operated independently (not in parallel).
- C. Packaged Engine Generator Set:
  - 1. Type: Gaseous (spark ignition).
  - 2. Basis of Design: Generac Power Systems; [www.generac.com/industrial](http://www.generac.com/industrial).
    - a. Industrial Gaseous Generator Set; with ratings as indicated on drawings.
  - 3. Voltage: As indicated on drawings.
- D. Generator Set General Requirements:
  - 1. Prototype tested in accordance with NFPA 110 for Level 2 systems.
  - 2. Factory-assembled, with components mounted on suitable base.
  - 3. List and label engine generator assembly as complying with UL 2200.
  - 4. Power Factor: Unless otherwise indicated, specified power ratings are at 0.8 power factor for three phase voltages and 1.0 power factor for single phase voltages.

5. Provide suitable guards to protect personnel from accidental contact with rotating parts, hot piping, and other potential sources of injury.
  6. Main Line Circuit Breakers: Provide factory-installed line side connections with suitable lugs for load side connections.
- E. Service Conditions: Provide engine generator system and associated components suitable for operation under the service conditions at the installed location.
1. Altitude: 1510 feet (460 m).
  2. Ambient Temperature: Between -30 deg F (-35 deg C) and 104 deg F (40 deg C).
- F. Starting and Load Acceptance Requirements:
1. Cranking Method: Cycle cranking complying with NFPA 110 (15 second crank period, followed by 15 second rest period, with cranking limiter time-out after 3 cycles), unless otherwise required.
  2. Cranking Limiter Time-Out: If generator set fails to start after specified cranking period, indicate overcrank alarm condition and lock-out generator set from further cranking until manually reset.
  3. Start Time: Capable of starting and achieving conditions necessary for load acceptance within 10 seconds (NFPA 110, Type 10).
  4. Maximum Load Step: Supports 100 percent of rated load in one step.
- G. Exhaust Emissions Requirements:
1. Comply with federal (EPA), state, and local regulations applicable at the time of commissioning; include factory emissions certification with submittals.
  2. Do not make modifications affecting generator set factory emissions certification without approval of manufacturer and Engineer. Where such modifications are made, provide field emissions testing as necessary for certification.

### 2.3 ENGINE AND ENGINE ACCESSORY EQUIPMENT

- A. Provide engine with adequate horsepower to achieve specified power output at rated speed, accounting for alternator efficiency and parasitic loads.
- B. Engine Fuel System - Gaseous (Spark Ignition):
1. Fuel Source: Propane (LP), vapor withdrawal.
  2. Engine Fuel Connections: Provide suitable, approved flexible fuel lines for coupling engine to fuel source.
  3. Provide components/features indicated and as necessary for operation and/or required by applicable codes, including but not limited to:
    - a. Carburetor.
    - b. Gas pressure regulators.
    - c. Fuel shutoff control valves.
    - d. Low gas pressure switches.
    - e. Vaporizer (for propane liquid withdrawal). Only if vaporizer not provided independent of engine-generator.
- C. Engine Starting System:
1. System Type: Electric, with DC solenoid-activated starting motor(s). Include remote starting control circuit, with RUN/OFF-RESET/AUTO selector switch, local/remote two-wire, mounted on engine-generator control panel.

2. Battery(s):
    - a. Battery Type: Lead-acid.
    - b. Battery Capacity: Size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature; capable of providing cranking through two complete periods of cranking limiter time-outs without recharging.
    - c. Provide battery rack, cables, and connectors suitable for the supplied battery(s); size battery cables according to manufacturer's recommendations for cable length to be installed.
  3. Battery-Charging Alternator: Engine-driven, with integral solid-state voltage regulation.
  4. Battery Charger:
    - a. Provide dual rate battery charger with automatic float and equalize charging modes and minimum rating of 10 amps; suitable for maintaining the supplied battery(s) at full charge without manual intervention.
    - b. Capable of returning supplied battery(s) from fully discharged to fully charged condition within time required by NFPA 110 for Level indicated while carrying normal loads.
    - c. Recognized as complying with UL 1236.
    - d. Furnished with integral overcurrent protection; current limited to protect charger during engine cranking; reverse polarity protection.
    - e. Provide integral DC output ammeter and voltmeter with five percent accuracy.
    - f. Provide alarm output contacts as necessary for alarm indications.
  5. Battery Heater: Provide thermostatically controlled battery heater to improve starting under cold ambient conditions.
- D. Engine Speed Control System (Governor):
1. Single Engine Generator Sets (Not Operated in Parallel): Provide electronic isochronous governor for controlling engine speed/alternator frequency.
  2. Frequency Regulation, Electronic Isochronous Governors: No change in frequency from no load to full load; plus/minus 0.25 percent at steady state.
- E. Engine Lubrication System:
1. System Type: Full pressure, with engine-driven, positive displacement lubrication oil pump, replaceable full-flow oil filter(s), and dip-stick for oil level indication. Provide oil cooler where recommended by manufacturer.
  2. Oil Heater: Provide thermostatically controlled oil heater to improve starting under cold ambient conditions.
  3. Engine shall be provided with oil as recommended by manufacturer.
- F. Engine Cooling System:
1. System Type: Closed-loop, liquid-cooled, with unit-mounted radiator/fan and engine-driven coolant pump; suitable for providing adequate cooling while operating at full load under worst case ambient temperature. Provide antifreeze as recommended by manufacturer.
  2. Fan Guard: Provide suitable guard to protect personnel from accidental contact with fan.
  3. Engine Jacket Heater: Thermal circulation type water heater with integral thermostatic control, sized to maintain engine jacket water at 90 degrees F (32 degrees C), and suitable for operation on 120V or 208V, single-phase.
- G. Engine Air Intake and Exhaust System:
1. Air Intake Filtration: Provide engine-mounted, replaceable, dry element filter.

2. Engine Exhaust Connection: Provide suitable, approved flexible connector for coupling engine to exhaust system.
  3. Exhaust Silencer: Provide critical grade or better exhaust silencer with sound attenuation not less than basis of design; select according to manufacturer's recommendations to meet sound performance requirements, where specified.
- H. Safety Devices: Engine shutdown on high engine temperature, low coolant temperature, low oil pressure, overspeed, and engine overcrank. Limits as selected by manufacturer.
- I. Engine Accessories: Fuel filter, lube oil filter, intake air filter, lube oil cooler. Include lube oil pressure gauge, running time meter, AC Voltmeter, AC ammeter and frequency meter on engine/generator control panel.
- J. Provide drain line extensions for both the engine oil and radiator coolant fluids.
- K. Mounting: Provide unit with integral combination pad and spring type vibration isolators, mounted on structural steel base.

#### 2.4 ALTERNATOR (GENERATOR)

- A. Alternator: 4-pole, 1800 rpm (60 Hz output) revolving field, synchronous generator complying with NEMA MG 1; connected to engine with flexible coupling; voltage output configuration as indicated, with reconnectable leads for 3-phase alternators. Alternator windings shall be 12 leads.
- B. Exciter:
1. Exciter Type: Brushless; provide permanent magnet generator (PMG) excitation system; self-excited (shunt) systems are not permitted.
  2. PMG Excitation Short-Circuit Current Support: Capable of sustaining 300 percent of rated output current for 10 seconds.
  3. Voltage Regulation (with PMG excitation): Plus/minus 0.5 percent for any constant load from no load to full load.
- C. Insulation System: NEMA MG 1, Class H; suitable for alternator temperature rise.
- D. Enclosure: NEMA MG 1, drip-proof.
- E. Insulation Class: F.
- F. Temperature Rise: 130 degrees C Standby.

#### 2.5 GENERATOR SET CONTROL SYSTEM

- A. Provide microprocessor-based control system for automatic control, monitoring, and protection of generator set. Include sensors, wiring, and connections necessary for functions/indications specified.
- B. Control Panel:
1. Control Panel Mounting: Unit-mounted unless otherwise indicated; vibration isolated.
  2. Generator Set Control Functions:

- a. Automatic Mode: Initiates generator set start/shutdown upon receiving corresponding signal from remote device (e.g. automatic transfer switch).
  - b. Manual Mode: Initiates generator set start/shutdown upon direction from operator.
  - c. Reset Mode: Clears all faults, allowing generator set restart after a shutdown.
  - d. Emergency Stop: Immediately shuts down generator set (without time delay) and prevents automatic restarting until manually reset.
  - e. Cycle Cranking: Programmable crank time, rest time, and number of cycles.
  - f. Time Delay: Programmable for shutdown (engine cooldown) and start (engine warmup).
  - g. Voltage Adjustment: Adjustable through range of plus/minus 5 percent.
3. Generator Set Status Digital (LCD) Indications:
- a. AC Voltages (3-phase) (Vab, Vbc, Vca & Van, Vbn, Vcn).
  - b. AC Current (3-phase) (Ia, Ib, Ic, and Iaverage).
  - c. Real power (kW) (total and per phase).
  - d. Reactive power (kVAR) (total and per phase).
  - e. Apparent power (kVA) (total and per phase).
  - f. Duty Level: Actual Load as % of rated power (total) (kW, kVAR, kVA).
  - g. kW-hr (total).
  - h. kVAR-hr (total).
  - i. kVA-hr (total).
  - j. Power factor (PF) (average and per phase).
  - k. Frequency (Hz).
  - l. Engine speed (rpm).
  - m. Battery voltage (VDC).
  - n. Engine run time (hours).
  - o. Engine successful start counter (number of times).
  - p. Engine crank attempt counter (number of times).
  - q. Engine oil pressure (psi).
  - r. Engine coolant temperature (deg F).
4. Generator Set Protection and Warning/Shutdown Indications:
- a. Comply with NFPA 110; configurable for NFPA 110 Level 1 or Level 2, or NFPA 99 systems including but not limited to the following protections/indications:
    - 1) Overcrank (shutdown).
    - 2) Low coolant temperature (warning).
    - 3) High coolant temperature (warning).
    - 4) High coolant temperature (shutdown).
    - 5) Low oil pressure (warning).
    - 6) Low oil pressure (shutdown).
    - 7) Overspeed (shutdown).
    - 8) Low fuel level (warning).
    - 9) Low coolant level (warning/shutdown).
    - 10) Generator control switch not in automatic mode (warning).
    - 11) Generator powering load (position signal from transfer switch).
    - 12) Air shutdown damper status.
    - 13) High battery voltage (warning).
    - 14) Low cranking voltage (warning).
    - 15) Low battery voltage (warning).
    - 16) Battery charger AC failure (warning).
  - b. In addition to NFPA 110 requirements, provide the following protections/indications:
    - 1) High AC voltage (shutdown).

- 2) Low AC voltage (shutdown).
  - 3) High frequency (shutdown).
  - 4) Low frequency (shutdown).
  - 5) Overcurrent (shutdown).
  - c. Provide contacts for local and remote common alarm.
  - d. Provide lamp test function that illuminates all indicator lamps.
  - 5. Other Control Panel Features:
    - a. Service Maintenance Interval (Engine Operating Hours or Calendar Days).
    - b. Event log (Minimum 20 events).
    - c. Control panel shall come equipped and be capable to communicate to building management system by way of Mod-bus protocol. This Contractor shall coordinate with the Mechanical Contractor and Temperature Control Contractor to ensure that all points identified are accessible to the building management system for viewing.
- C. Remote Annunciator:
- 1. Remote Annunciator Mounting: Wall-mounted; Provide flush-mounted annunciator for finished areas and surface-mounted annunciator for non-finished areas unless otherwise indicated.
  - 2. Generator Set Status Indications:
    - a. Generator powering load (via position signal from transfer switch).
    - b. Communication functional.
  - 3. Generator Set Warning/Shutdown Indications:
    - a. Comply with NFPA 110 for Level 2 systems including but not limited to the following indications:
      - 1) Overcrank (shutdown).
      - 2) Low coolant temperature (warning).
      - 3) High coolant temperature (warning).
      - 4) High coolant temperature (shutdown).
      - 5) Low oil pressure (warning).
      - 6) Low oil pressure (shutdown).
      - 7) Overspeed (shutdown).
      - 8) Low fuel level (warning).
      - 9) Low coolant level (warning/shutdown).
      - 10) Generator control switch not in automatic mode (warning).
      - 11) Air shutdown damper status.
      - 12) High battery voltage (warning).
      - 13) Low cranking voltage (warning).
      - 14) Low battery voltage (warning).
      - 15) Battery charger AC failure (warning).
    - b. Provide audible alarm with horn silence function.
    - c. Provide lamp test function that illuminates all indicator lamps.
  - 4. Remote Alarm Contacts: Pre-wire SPDT contacts to terminal strip for remote alarm functions required by the above. Any alarm conditions will cause the remote alarm contacts to operate, sending an alarm signal to the Owner's IT network. Provide conduit rough-in to nearest input device to Owner's IT network.

## 2.6 GENERATOR SET ENCLOSURE

- A. Enclosure Type: Sound attenuating, weather protective. Level 2 Acoustic.

- B. Enclosure Material: Steel or aluminum.
- C. Hardware Material: Stainless steel.
- D. Color: Standard manufacturer's color.
- E. Access Doors: Lockable, with all locks keyed alike.
- F. Openings: Designed to prevent bird/rodent entry.
- G. External Drains: Extend oil and coolant drain lines to exterior of enclosure for maintenance service.
- H. Sound Attenuating Enclosures: Line enclosure with non-hydroscopic, self-extinguishing sound-attenuating material.
- I. Exhaust Silencers: Mounted within enclosure in main engine compartment, insulate silencer to minimize heat dissipation as necessary for operation at rated load under worst case ambient temperature.

## 2.7 ACCESSORIES

- A. Batteries: Heavy duty, lead-acid storage batteries, 75 ampere-hours minimum capacity. Match battery voltage to starting system. Include necessary cables, clamps and battery tray.
- B. Battery Tray: Treated for electrolyte resistance, constructed to contain spillage.
- C. Battery Charger: Current limiting type designed to float at 2.17 volts per cell and equalize at
- D. 2.33 volts per cell. Include overload protection, full wave rectifier, DC voltmeter and ammeter, and 120 volts AC fused input. Provide wall-mounted enclosure to meet NEMA 250, Type 1 requirements.
- E. Line Circuit Breaker: NEMA AB 1, molded case circuit breaker on generator output with integral thermal and instantaneous magnetic trip in each pole, sized in accordance with NFPA
- F. 70. Unit mount in enclosure to meet NEMA 250, Type 1 requirements. Provide breakers as sized and shown on drawings.
- G. Integral Loadcenter: 125A MLO, 8P, 1-phase for 208Y/120V feeder. All branch circuits from Loadcenter are factory pre-wired.

## 2.8 GENERATOR OUTDOOR FOUNDATION AND MOUNTING

- A. Generator Foundation - Install the generator set on a concrete pad or base slab able to support its weight and accessories. A proper foundation is needed to resist dynamic loading and reduce transmitted noise and vibration. The exact composition of the mounting pad must follow standard engineering practices for the required loading and application. Securely fasten the generator set frame to the concrete pad using suitable grade, size and style fasteners. Holes are

provided in the steel frame rails for this purpose. Provide additional vibration isolation pads between the generator set frame and the concrete pad.

1. Concrete pad - Seat the concrete pad or base slab on a prepared solid subsurface and use appropriate reinforcing bar or expanded wire mesh. A common specification calls for 2500 psi concrete reinforced with 8 gauge wire mesh or number 6 reinforcing bars on 12 inch centers.
2. Dimensions - Extend the concrete pad beyond the frame of the unit at least 6 inches and above the surrounding ground surface by 4 inches. This provides a mounting surface for fuel line support, as well as space for maintenance and repair. The surface should have a smooth hard finish (especially on the inside) to minimize oil absorption and stains. It is beneficial to have a custom made drip pan that can be laid on the concrete pad before the generator is put in place. It's best to be made of aluminum to avoid corrosion. This can also be sized to the maximum fluid capacities of the engine. This will catch oil drips that will occur over time. It will also avoid contamination of the ground surrounding the pad should a major coolant loss occur.
  - a. The base pad shall be:
    - 1) Capable of supporting 125% of the unit wet weight for single unit applications. Wet weight is the dry weight plus the weight of the fuel in the base tank.
    - 2) Flat and level to within 1/2 inch.
    - 3) Capable of withstanding severe torque reactions, especially on paralleling systems.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Perform work in a neat and workmanlike manner in accordance with NECA 1.
- B. Install products in accordance with manufacturer's instructions.
- C. Install generator sets and associated accessories in accordance with NECA/EGSA 404.
- D. Arrange equipment to provide minimum clearances and required maintenance access.
- E. Provide required support and attachment in accordance with Section 260529.
- F. Use manufacturer's recommended oil and coolant, suitable for the worst case ambient temperatures.
- G. Provide gas piping in accordance with requirements noted on plans.
- H. Provide grounding and bonding in accordance with Section 260526.
- I. Identify system wiring and components in accordance with Section 260553.

### 3.2 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Notify Owner and Engineer at least two weeks prior to scheduled inspections and tests.
- C. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
- D. All inspections, start-up, demonstrations and training will be performed by a manufacturer's representative with at least 3 years of specialized training related to the specific equipment being installed as part of this project.
- E. Provide all equipment, tools, and supplies required to accomplish inspection and testing, including load bank and fuel.
- F. Preliminary inspection and testing to include, at a minimum:
  - 1. Inspect each system component for damage and defects.
  - 2. Verify tightness of mechanical and electrical connections are according to manufacturer's recommended torque settings.
  - 3. Check for proper oil and coolant levels.
- G. Prepare and start system in accordance with manufacturer's instructions.
- H. Perform acceptance test in accordance with NFPA 110.
- I. Inspection and testing to include, at a minimum:
  - 1. Verify compliance with starting and load acceptance requirements.
  - 2. Verify voltage and frequency; make required adjustments as necessary.
  - 3. Verify phase sequence.
  - 4. Verify control system operation, including safety shutdowns.
  - 5. Verify operation of auxiliary equipment and accessories (e.g. battery charger, heaters, etc.).
  - 6. Perform load tests in accordance with NFPA 110 (1.5 hour building load test followed by 2 hour full load test). Load test shall be performed using a resistive load bank. Contractor shall provide the load bank for this testing.
    - a. Load testing shall be scheduled with Owner and Architect/Engineer at least 2 weeks in advance.
    - b. Record in 20 minute intervals during test: kW, A, V:
      - 1) Real power (kW) (total and per phase).
      - 2) AC Voltages (3-phase) (Vab, Vbc, Vca & Van, Vbn, Vcn).
      - 3) AC Current (3-phase) (Ia, Ib, Ic, and Iaverage).
      - 4) Engine coolant temperature (deg F).
      - 5) Ambient temperature surrounding Engine-Generator (deg F).
      - 6) Frequency (Hz).
      - 7) Engine oil pressure (psi).
- J. Test alarm and shutdown circuits by simulating conditions. Record results of each condition.
- K. Provide field emissions testing where necessary for certification. Work shall be in compliance with the South Dakota Department of Environmental and Natural Resources (DENR). Coordinate requirements with DENR.

1. The Contractor/Generator Supplier is required to submit all DENR permit applications (Air Quality, etc) for the Generator on behalf of the Owner.
  2. The Contractor/Generator Supplier is responsible for verifying all DENR requirements, addresses (website, physical), forms, etc for amendments and where necessary provide any and all forms and associated data to meet DENR requirements.
- L. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.
- M. Furnish the following spare parts:
1. Three lubricating oil filters.
  2. Three fuel filters.
  3. Racor water separator fuel filter.
  4. Three intake air filters.
  5. Three complete sets of fuses for battery charger.
  6. Three complete sets of fuses for each control and supervisory panel.

### 3.3 MANUFACTURER'S FIELD SERVICES

- A. Provide the services of manufacturer's representative (a competent, factory trained engineer or technician) to do training of owner's representative for operation and maintenance of the equipment.
- B. Provide a set of operating instructions for the system and install the instructions, laminated or under plexiglass, within a frame mounted on the wall near the generator set as requested by the owner.
- C. Provide the services of manufacturer's representative to prepare and start system.

### 3.4 ADJUSTING

- A. Adjust generator output voltage and engine speed.

### 3.5 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

### 3.6 CLOSEOUT ACTIVITIES

- A. Demonstrate operation to Owner's operating personnel.
- B. Simulate power outage by interrupting normal source, and demonstrate that system operates to provide standby power.

### 3.7 PROTECTION

- A. Protect installed engine generator system from subsequent construction operations.

3.8 MAINTENANCE

- A. Furnish one set of tools required for preventative maintenance of the engine generator system. Package tools in adequately sized metal tool box. See also Section 260035 paragraph 3.20A.
- B. Contractor shall provide service and maintenance of engine generator system for two years from date of Substantial Completion at no additional cost to the Owner.
  - 1. This service and maintenance shall be provided in accordance with the recommended maintenance and service for the generator installed and shall include all preventative maintenance, systematic examination, adjustment, inspection, and testing.
  - 2. Contractor shall at a minimum conduct a site visit once every three months to perform inspection, testing, and preventive maintenance. More site visits shall be included if recommended by the standard maintenance requirements of the generator manufacturer. Submit report to Owner indicating maintenance performed along with evaluations and recommendations.
  - 3. All testing and maintenance required by NFPA 110 shall be performed as part of this maintenance as well. Contractor shall supply all materials and equipment necessary to perform these tests at no additional cost to the Owner.
- C. At the completion of the two year maintenance provided as part of this project, the Contractor shall prepare and offer a maintenance contract to the Owner that meets all required maintenance and service needs for the generator system.
- D. Provide trouble call-back service upon notification by Owner:
  - 1. Provide on-site response within 4 hours of notification. All call-backs shall be provided at no additional cost to the Owner.
- E. Maintain an on-site log listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced.

END OF SECTION 263213

## SECTION 263600 - TRANSFER SWITCHES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Transfer switches for low-voltage (600 V and less) applications and associated accessories:
- B. Automatic Transfer Switch.

#### 1.2 RELATED REQUIREMENTS

- A. Section 260526 - Grounding and Bonding for Electrical Systems.
- B. Section 260529 - Hangers and Supports for Electrical Systems.
- C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 263213 - Engine Generators: For interface with transfer switches.
  - 1. Includes code requirements applicable to work of this section.
  - 2. Includes related demonstration and training requirements.
- E. Section 264300 - Surge Protective Devices.

#### 1.3 REFERENCE STANDARDS

- A. NEMA ICS 10 Part 1 - Industrial Control and Systems Part 1: Electromechanical AC Transfer Switch Equipment; 2005.
- B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. NFPA 110 - Standard for Emergency and Standby Power Systems; 2022.
- D. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.
- E. UL 1008 - Transfer Switch Equipment; Current Edition, Including All Revisions.

#### 1.4 SUBMITTALS

- A. See Section 013330 and Section 260000 for submittal procedures.

- B. Product Data: Provide catalog sheets showing voltage, switch size, ratings and size of switching and overcurrent protective devices, operating logic, short circuit ratings, dimensions, and enclosure details.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- D. Operation Data: Instructions for operating equipment under emergency conditions when engine generator is running.
- E. Maintenance Data: Routine preventative maintenance and lubrication schedule. List special tools, maintenance materials, and replacement parts.

## 1.5 QUALITY ASSURANCE

- A. Comply with the following:
  1. NFPA 70 (National Electrical Code).
  2. NFPA 110 (Standard for Emergency and Standby Power Systems); meet requirements for system Level specified in Section 263213.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
  1. Authorized service facilities located within 300 miles (483 km) of project site.
- C. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with power transfer systems of similar size, type, and complexity; manufacturer's authorized installer.
- D. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.
  1. Contract maintenance office located within 300 miles (483 km) of project site.
- E. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years experience and with service facilities within 300 miles (483 km) of Project.
- F. Supplier Qualifications: Authorized distributor of specified manufacturer with minimum three years documented experience.
- G. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store transfer switches in accordance with manufacturer's instructions.
- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

- C. Handle carefully in accordance with manufacturer's instructions to avoid damage to transfer switch components, enclosure, and finish.

## 1.7 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

## 1.8 TESTS AND CERTIFICATIONS

- A. The complete transfer switch shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage frequency, and time delay settings are in compliance with the specification requirements.
- B. The transfer switch and control panel shall be subjected to a dielectric strength test per NEMA Standard ICS1-109.21.
- C. Upon request, the manufacturer shall provide a notarized letter certifying compliance with all the requirements of this specification including compliance with the above codes and standards, and withstand an closing ratings. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, shall be included in the certification.
- D. The manufacturer shall be certified to ISO 9001 International Quality Standard and the manufacturer shall have third part certification verifying quality assurance in design/development, production, installation, and servicing in accordance with ISO 9001.

## 1.9 WARRANTY

- A. See Section 017700 Closeout Procedures and Section 260000 for additional warranty requirements.
- B. Provide minimum five-year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. ASCO Power Technologies, a brand of Emerson Network Power:  
[www.emersonnetworkpower.com](http://www.emersonnetworkpower.com).
- B. Russelectric: [www.russelectric.com](http://www.russelectric.com).
- C. Same as manufacturer of engine generator(s) used for this project:
  - 1. Generac Power Systems: [www.generac.com/industrial](http://www.generac.com/industrial).

2. Kohler: [www.kohlerpower.com](http://www.kohlerpower.com).
3. Cummins Onan: [www.powersystems.cummins.com](http://www.powersystems.cummins.com).
4. Caterpillar Inc: [www.cat.com/en\\_US/products/new/power-systems.html](http://www.cat.com/en_US/products/new/power-systems.html).

D. Pre-bid approved equivalent.

## 2.2 AUTOMATIC TRANSFER SWITCH

- A. Description: NEMA ICS 10, automatic transfer switch.
- B. Configuration: Electrically operated, mechanically held transfer switch.
- C. Includes: ATS.
- D. Withstand Current Rating: 65,000 rms symmetrical amperes, when used with molded case circuit breaker.
- E. Integral SPD per Specification Section 264300 requirements.
- F. NEMA 1 Enclosure.

## 2.3 SERVICE CONDITIONS

- A. Service Conditions: NEMA ICS 10.
- B. Altitude: 1510 feet (460 m).

## 2.4 RATINGS

- A. Voltage: 208V, 3-phase, 4-wire, 60Hz.
- B. Switched Poles: 3 (Open-Transition).
- C. Load Inrush Rating: Combination load.
- D. Continuous Rating: As indicated on Drawings.

## 2.5 COMPONENTS

- A. Indicating Lights: Mount in cover of enclosure to indicate NORMAL SOURCE AVAILABLE, ALTERNATE SOURCE AVAILABLE, and SWITCH POSITION.
- B. Test Switch: Mount in cover of enclosure to simulate failure of normal source.
- C. Return to Normal Switch: Mount in cover of enclosure to initiate manual transfer from alternate source to normal source.
- D. Transfer Switch Auxiliary Contacts: 2 normally open; 2 normally closed.

- E. Normal Source Monitor: Monitor normal source voltage and frequency; initiate transfer when voltage drops below 85 percent or frequency varies more than 3 percent from rated nominal value.
- F. Alternate Source Monitor: Monitor alternate source voltage and frequency; inhibit transfer when voltage is below 85 percent or frequency varies more than 3 percent from rated nominal value.
- G. In-Phase Monitor: Inhibit transfer until source and load are within 15 electrical degrees.
- H. Enclosure: ICS 10, Type 1, finished with manufacturer's standard gray enamel.
- I. Microprocessor Control Panel:
  - 1. The control panel shall direct the operation of the transfer switch. The panel's sensing and logic shall be controlled by a built-in microprocessor for maximum reliability, minimum maintenance, and inherent serial communications capability. The control panel shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the control panel to be disconnected from the transfer switch for routine maintenance.
  - 2. The control panel shall be enclosed with a protective cover and be mounted separately from the transfer switch unit for safety and ease of maintenance. Sensing and control logic shall be provided on printed circuit boards. Interfacing relays shall be industrial plug-in type with dust covers.
  - 3. The control panel shall meet or exceed the requirements of Electromagnetic Compatibility (EMC) as follows:
    - a. Ring Wave Test per IEE 472 (ANSI C37.090A).
    - b. Electrostatic Discharge (ESD) - IEC 801-2, Level 4.
    - c. Electrical Face Transients (EFT) - IEC 801-4, Level 4.
    - d. Surge Withstand - IEC 801-5, Level 4.
    - e. Electromagnetic Interference - Mil Std 461, Class 3C.
- J. Voltage and Frequency Sensing: Repetitive accuracy of all setting shall be within 2 percent over an operating temperature of -20 deg C to 70 deg C. Setting shall be field adjustable in 1 percent increments.
- K. Trickle battery charger.
- L. Remote Annunciator: Full duplex RS-422 communications system, LED indicators, key switch to prevent unauthorized use, test switch, time delay bypass switch normal to emergency or emergency to normal.

## 2.6 AUTOMATIC SEQUENCE OF OPERATION

- A. Provide control and start command wiring as required, such that upon loss of power at the ATS, the generator is automatically started.
- B. Initiate Time Delay to Start Alternate Source Engine Generator: Upon initiation by normal source monitor.

- C. Initiate Transfer Load to Alternate Source: Upon initiation by normal source monitor and permission by alternate source monitor.
- D. Initiate Retransfer Load to Normal Source: Upon permission by normal source monitor.
- E. Time Delay Before Transfer to Normal Power: 0 to 15 seconds, adjustable; bypass time delay in event of alternate source failure.
- F. Time Delay Before Engine Shut Down: 0 to 30 minutes, adjustable, of unloaded operation.
- G. Engine Exerciser: Start engine every 7 days; run for 30 minutes before shutting down. Bypass exerciser control if normal source fails during exercising period.

### PART 3 - EXECUTION

#### 3.1 PREPARATION

- A. Mount on interior wall of Boiler room (located in Center Core).

#### 3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provided engraved phenolic nameplates under the provisions of Section 260553.
- C. Install transfer switches plumb and level.
- D. Provide grounding and bonding in accordance with Section 260526.

#### 3.3 FIELD QUALITY CONTROL

- A. All testing shall be in conjunction with testing outlined for the Generator System in specification section 263213.

#### 3.4 MANUFACTURER'S FIELD SERVICES

- A. Provide the services of the manufacturer's Technical Representative (a competent, factory trained engineer or technician) to provide installation assistance.
- B. The manufacturer's Technical Representative shall perform the following services on-site:
  1. Verify Contractor connections, control power availability, visually inspect relay settings.
  2. With the engine/generator supplier's Technical Representative controlling the engine/generator, verify that the panelboards and control equipment are fully operational and perform per the sequence of operation specified. Equipment or services shall be provided by the engine/generator set supplier.

3. With the engine/generator supplier's Technical Representative controlling the engine/generator, demonstrate all functions of the control system, both automatic and manual, to the satisfaction of the approving Engineer.
4. Provide documentation in the form of functional checklists and recorded data for each section to the approving Engineer.
5. Provide Owner's representative with on-site training for operation and maintenance of the equipment after acceptance by the approving Engineer.
  - a. Provide a set of operating instructions for the system and install the instructions, laminated or under plexiglass, on the inside of the engine/generator enclosure adjacent to a door opening as requested by the Owner.

### 3.5 CLOSEOUT ACTIVITIES

- A. Demonstration: Demonstrate proper operation of transfer switches to Owner, and correct deficiencies or make adjustments as directed.
- B. Training: Train Owner's personnel on operation, adjustment, and maintenance of transfer switches.
  1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
  2. Location: At project site.
- C. Coordinate with related generator demonstration and training as specified in Section 263213.

### 3.6 PROTECTION

- A. Protect installed transfer switches from subsequent construction operations.

### 3.7 MAINTENANCE

- A. Provide to Owner at no extra cost, a separate maintenance contract for the service and maintenance of Automatic Transfer Switches as part of the Generator system for two years from date of Substantial Completion; Include a complete description of preventive maintenance, systematic examination, adjustment, inspection, and testing, with a detailed schedule. See also Section 260000.
- B. Conduct site visit at least once every three months to perform inspection, testing, and preventive maintenance. Submit report to Owner indicating maintenance performed along with evaluations and recommendations.
- C. Provide trouble call-back service upon notification by Owner:
  1. Provide on-site response within 4 hours of notification. All call-backs shall be provided at no additional cost to the Owner.
- D. Maintain an on-site log listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced.

END OF SECTION 263600

## SECTION 264300 - SURGE PROTECTIVE DEVICES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Surge protective devices for service entrance locations and panelboards.

#### 1.2 RELATED REQUIREMENTS

- A. Section 260526 - Grounding and Bonding.
- B. Section 262416 - Panelboards.

#### 1.3 ABBREVIATIONS AND ACRONYMS

- A. EMI/RFI: Electromagnetic Interference/Radio Frequency Interference.
- B. SPD: Surge Protective Device.

#### 1.4 REFERENCE STANDARDS

- A. MIL-STD-220 - Method of Insertion Loss Measurement; 2009c (Validated 2014).
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2018.
- D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. UL 1283 - Standard for Electromagnetic Interference Filters; Current Edition, Including All Revisions.
- F. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.

#### 1.5 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate size and location of overcurrent device compatible with the actual surge protective device and location to be installed. Notify Engineer of any conflicts or deviations from the contract documents to obtain direction prior to ordering equipment.

#### 1.6 SYSTEM DESCRIPTION

- A. Provide surge suppression in Panelboards scheduled to have SPD's on drawings.

#### 1.7 SUBMITTALS

- A. See Section 013330 and Section 260000 for submittal procedures.
- B. Product Data: Include detailed component information, voltage, surge current ratings, repetitive surge current capacity, voltage protection rating (VPR) for all protection modes, maximum continuous operating voltage (MCOV), nominal discharge current (I-n), short circuit current rating (SCCR), connection means including any required external overcurrent protection, enclosure ratings, outline and support point dimensions, weight, service condition requirements, and installed features.
  - 1. SPDs with EMI/RFI filter: Include noise attenuation performance.
- C. Shop Drawings: Include wiring diagrams showing all factory and field connections with wire and circuit breaker/fuse sizes.
- D. Certificates: Manufacturer's documentation of listing for compliance with the following standards:
  - 1. UL 1449. Third Edition or most recent edition.
  - 2. UL 1283 (for Type 2 SPDs).

#### 1.8 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

#### 1.9 DELIVERY, STORAGE, AND PROTECTION

- A. Store in a clean, dry space in accordance with manufacturer's written instructions.

#### 1.10 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Manufacturer's Warranty: Provide minimum five year warranty covering repair or replacement of surge protective devices showing evidence of failure due to defective materials or workmanship.
- C. Exclude surge protective devices from any clause limiting warranty responsibility for acts of nature, including lightning, stated elsewhere.

### PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

- A. Factory-installed, Internally Mounted Surge Protective Devices:
  - 1. Same as manufacturer of equipment containing surge protective device, to provide a complete listed assembly including SPD.
  - 2. Advanced Protection Technologies, Inc (APT): [www.aptspd.com](http://www.aptspd.com).
  - 3. Current Technology; a brand of Thomas & Betts Power Solutions: [www.tnbpowersolutions.com](http://www.tnbpowersolutions.com).

## 2.2 ALL SURGE PROTECTIVE DEVICES

- A. Description: Factory-assembled surge protective devices (SPDs) for 60 Hz service, listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated; system voltage as indicated on the drawings.
- B. Protected Modes:
  - 1. Wye Systems: L-N, L-G, N-G, L-L.
- C. UL 1449 Voltage Protection Ratings (VPRs):
  - 1. 208Y/120V System Voltage: Not more than 700V for L-N, L-G, and N-G modes and 1,200V for L-L mode.
- D. UL 1449 Maximum Continuous Operating Voltage (MCOV): Not less than 115% of nominal system voltage.
- E. Enclosure Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
  - 1. Indoor clean, dry locations: Type 1.
- F. Equipment Containing Factory-installed, Internally Mounted SPDs: Listed and labeled as a complete assembly including SPD.
  - 1. Panelboards: See Section 262416.

## 2.3 SURGE PROTECTIVE DEVICES FOR SERVICE ENTRANCE LOCATIONS

- A. Unless otherwise indicated, provide factory-installed, internally mounted SPDs.
- B. List and label as complying with UL 1449 (verifiable at [UL.com](http://UL.com)) or manufacturer declared as a Type 2 not requiring external or supplemental overcurrent controls. SPD's relying upon external or supplementary installed safety disconnectors do not meet the intent of this specification. Every suppression component of every mode, including N-G, shall be protected by internal overcurrent and thermal overtemperature controls.
- C. Provide SPDs utilizing field-replaceable modular or non-modular protection circuits.
- D. Surge Current Rating: Not less than 150 kA per mode/300 kA per phase.
- E. UL 1449 Nominal Discharge Current (I-n): 20 kA.
- F. UL 1449 Short Circuit Current Rating (SCCR): Not less than 200 kA.

- G. EMI/RFI Filtering: Provide EMI/RFI filter to attenuate electrical noise; listed as complying with UL 1283 for Type 2 SPDs (UL 1283 listing not available for Type 1 SPDs).
  - 1. Noise Attenuation: Not less than 40 dB at 100 kHz using MIL-STD-220 insertion loss test method.
- H. Diagnostics:
  - 1. Protection Status Monitoring: Provide indicator lights to report the protection for each phase.
  - 2. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.
  - 3. Surge Counter: Provide surge event counter with manual reset button, surge count retention upon power loss, and six digit LCD display that indicates quantity of surge events.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that the service voltage and configuration marked on the SPD are consistent with the service voltage and configuration at the location to be installed.
- C. Verify that electrical equipment is ready to accept connection of the SPD and that installed overcurrent device is consistent with requirements of drawings and manufacturer's instructions.
- D. Verify system grounding and bonding is in accordance with Section 260526, including bonding of neutral and ground for service entrance and separately derived systems where applicable. Do not energize SPD until deficiencies have been corrected.
- E. Verify that conditions are satisfactory for installation prior to starting work.

#### 3.2 INSTALLATION

- A. Perform work in a neat and workmanlike manner in accordance with NECA 1.
- B. Install SPD in accordance with manufacturer's instructions.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Unless indicated otherwise, connect service entrance surge protective device on load side of service disconnect main overcurrent device.
- E. Provide conductors with minimum ampacity as indicated on the drawings, as required by NFPA 70, and not less than manufacturer's recommended minimum conductor size.
- F. Install conductors between SPD and equipment terminations as short and straight as possible, not exceeding manufacturer's recommended maximum conductor length. Breaker locations may

be reasonably be rearranged in order to provide leads as short and straight as possible. Twist conductors together to reduce inductance.

- G. Do not energize SPD until bonding of neutral and ground for service entrance and separately derived systems is complete in accordance with Section 260526 where applicable. Replace SPDs damaged by improper or missing neutral-ground bond.

### 3.3 FIELD QUALITY CONTROL

- A. See Section 0140000 – Quality Requirements, for additional requirements.
- B. Procure services of a qualified manufacturer's representative to observe installation and assist in inspection, testing, and adjusting. Include manufacturer's reports with field quality control submittals.

### 3.4 CLEANING

- A. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 264300

## SECTION 265100 - INTERIOR LIGHTING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Interior luminaires.
- B. Exit signs.
- C. Emergency Lighting Relay.
- D. LED lighting systems.
- E. Luminaire accessories.

#### 1.2 RELATED REQUIREMENTS

- A. Section 260519 - Low-Voltage Power Conductors and Cables (600V and Less).
- B. Section 260526 - Grounding and Bonding for Electrical Systems.
- C. Section 260534 - Conduit.
- D. Section 260537 - Boxes.
- E. This section specifies a system or part of a system being commissioned as defined in 01 9113 General Commissioning Requirements. Testing of these systems, as well as Operations & Maintenance (O&M) Manuals and Training of the Owner's personnel, is required in cooperation with the Owner, General Contractor, and the Commissioning Professional. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to 01 9113 General Commissioning Requirements for detailed commissioning requirements.

#### 1.3 REFERENCE STANDARDS

- A. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules; Illuminating Engineering Society; 2015.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- C. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems; 2006.
- D. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems; 2006.
- E. NEMA WD 6 - Wiring Devices - Dimensional Requirements; National Electrical Manufacturers Association; 2002.

- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. NFPA 101 - Life Safety Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction.
- H. UL 924 - Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.
- I. UL 1598 - Luminaires; Current Edition, Including All Revisions.
- J. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

#### 1.4 SUBMITTALS

- A. See Section 013330 and Section 260000 for submittal procedures.
- B. Shop Drawings: Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
- C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.
  - 1. LED Luminaires:
    - a. Include estimated useful life, calculated based on IES LM-80 test data.
- D. Shop drawing submittals for luminaires shall be complete in all aspects and at a minimum shall contain, but are not limited to, the following: (1) Luminaire cutsheet, (2) Ballast or LED driver board cutsheet, (3) Integral emergency ballast/battery pack or LED driver board/battery pack cutsheet (as applicable to the project) and (4) Lamps or LED device board cutsheet. Shop Drawing submittals for luminaires shall have a complete luminaire schedule included at the front of the submittal.
- E. Operation and Maintenance Data: Instructions for each product including information on replacement parts.
- F. Refer to Section 01 9113 General Commissioning Requirements for commissioning-related submittals and submittal review processes.

#### 1.5 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70 and NFPA 101.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five years documented experience.
- C. Electrical Components: Listed and classified by Underwriters Laboratories Inc. or other organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) as

suitable for the purpose specified and indicated. NRTL must also be acceptable to Authority Having Jurisdiction (AHJ).

#### 1.6 DELIVERY, STORAGE, AND PROTECTION

- A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.
- B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

#### 1.7 WARRANTY

- A. See Section 260000 - Product Requirements, for additional warranty requirements.
- B. Provide five year manufacturer warranty for all LED luminaires, including drivers.

#### 1.8 EXTRA MATERIALS

- A. See Section 260000 - Product Requirements, for additional provisions.
- B. Furnish 2% or a minimum of 2 of each LED driver board and LED device board. Emergency battery packs are not included. Luminaire manufacturer shall keep reasonable LED driver board and LED device board stocks on hand for replacement during warranty period.

### PART 2 - PRODUCTS

#### 2.1 LUMINAIRES

- A. Furnish products as indicated in Luminaire Schedule included on the Drawings.
- B. All luminaires shall be provided with a disconnecting means meeting the requirements of the NEC.

#### 2.2 EXIT SIGNS

- A. All Exit Signs: Internally illuminated with LEDs unless otherwise indicated; complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
  - 1. Number of Faces: Single or double as indicated or as required for the installed location.
  - 2. Directional Arrows: As indicated or as required for the installed location.

#### 2.3 LED LIGHTING SYSTEMS

- A. General: All LED lighting system components must be UL or other NRTL listed.

- B. Engines/lamps:
  - 1. Meets or exceeds 70% lumen maintenance at 50,00 hours based on IESNA LM-79-2008.
  - 2. Minimum 80+ CRI rating.
  - 3. Color Temperature as scheduled on drawings.
  - 4. Minimum delivered lumens as scheduled on drawings.
  - 5. Minimum Luminous Efficacy as scheduled on drawings.
  
- C. LED Electronic Drivers:
  - 1. Factory installed.
  - 2. Multi-volt for use on either 120VAC or 277VAC systems.
  - 3. THD: <10%.
  - 4. Factory installed quick-disconnect plug internal to the luminaire for driver removal.
  - 5. Rated for a minimum of 50,000 hours.
  - 6. 0-10VDC dimming standard. Provide non-dimming drivers only as scheduled on drawings.
    - a. Controls and wiring as per manufacturer's recommendations. Provide power packs for wall-box dimmers as required for positive luminaire off.
  
- D. Emergency battery packs:
  - 1. Include self-testing/self-diagnostics with audible alarm option.
  - 2. Factory installed.
  - 3. Minimum delivered lumens as scheduled on drawings.

## 2.4 EMERGENCY LIGHTING RELAY

- A. Manufacturer: Nine 24, Inc. Model BLTC-R or equal by Bodine.
- B. Description: Self-contained power supply and low voltage relay in a thermoplastic housing designed to override switches in case of normal utility power failure. UL 924 listed.
- C. Rating: 120VAC, 10A.
- D. Local test switch with LED indicators for normal and emergency power. Mounts to a standard junction box. Mount test switch and LED indicator flush in ceiling near relay.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install products according to manufacturer's instructions.
- B. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 1 (general workmanship) and NECA 500 (commercial lighting).
- C. Install suspended luminaires and exit signs using pendants supported from swivel hangers or by chain as indicated in schedule. Provide pendant length or chain required to suspend luminaire at indicated height.
- D. Support luminaires independent of ceiling frame.

- E. Locate recessed ceiling luminaires as indicated on reflected ceiling plan.
- F. Install surface mounted luminaires plumb and adjust to align with building lines and with each other. Secure to prevent movement.
- G. Install recessed luminaires to permit removal from below.
- H. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.
- I. Install clips to secure recessed grid-supported luminaires in place.
- J. Install wall mounted luminaires and exit signs at height as indicated on Drawings.
- K. Install accessories furnished with each luminaire.
- L. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within fixture; use flexible conduit.
- M. Connect luminaires to branch circuit outlets provided under Section 260537 as indicated.
- N. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.
- O. Bond products and metal accessories to branch circuit equipment grounding conductor.
- P. Install specified lamps in each luminaire.
- Q. 0-10VDC LED Dimming Control Circuits
  - 1. Installed in accordance with NEC Article 725.
  - 2. Class 1 systems
    - a. #14 AWG THWN/THHN solid conductors installed in same raceway as associated power wiring.
  - 3. Class 2 systems
    - a. #18/2 non-shielded cable unless otherwise indicated on the drawings.
    - b. Plenum rated where required.
    - c. Cable shall be installed in raceway when concealed within walls, in mechanical or electrical rooms, or any room without a ceiling.
      - 1) DO NOT INSTALL IN SAME RACEWAY AS POWER CIRCUITRY.
    - d. Cable not required to be enclosed in raceway when installed above accessible ceilings.
      - 1) Route cables parallel or perpendicular to building construction.
      - 2) Support cables from building structure utilizing approved methods.
      - 3) Neatly coil excess cable length of pre-terminated assemblies.
      - 4) All cable runs shall be continuous between devices. NO SPLICING.

### 3.2 FIELD QUALITY CONTROL

- A. Inspect each product for damage and defects.
- B. Operate each luminaire after installation and connection to verify proper operation.

- C. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Engineer.

### 3.3 ADJUSTING

- A. Exit Signs with Field-Selectable Directional Arrows: Set as indicated or as required to properly designate egress path as directed by Engineer or authority having jurisdiction.
- B. Aim and adjust luminaires as directed by manufacturer and Engineer.

### 3.4 CLEANING

- A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.
- B. Clean electrical parts to remove conductive and deleterious materials.
- C. Remove dirt and debris from enclosures.
- D. Clean photometric control surfaces as recommended by manufacturer.
- E. Clean finishes and touch up damage.

### 3.5 CLOSEOUT ACTIVITIES

- A. Replace luminaires that have failed LED driver board or LED device board at Substantial Completion. Replacement shall not come from Owner spare stock.

### 3.6 DEMONSTRATION AND TRAINING

- A. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner, General Contractor, and the Commissioning Professional. Provide competent, factory-authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, troubleshooting, routine servicing and maintenance of the installed systems. The instruction shall be scheduled in coordination with the Owner and the Commissioning Professional after submission and approval of formal training agendas. Refer to Sections 01 9113 General Commissioning Requirements.

### 3.7 FUNCTIONAL PERFORMANCE TESTING

- A. System functional performance testing is part of the Commissioning Process as detailed in Section 01 9113 General Commissioning Requirements. Functional performance testing shall be performed by the contractor and witnessed and documented by the Commissioning Professional. Installation checklists shall be successfully completed by the contractor and submitted to the Commissioning Professional prior to functional performance testing.

END OF SECTION 265100

## SECTION 265600 - EXTERIOR LIGHTING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Exterior luminaires and accessories.
- B. Lamps.

#### 1.2 RELATED REQUIREMENTS

- A. Section 260537 - Boxes.
- B. Section 260519 - Low-Voltage Power Conductors and Cables (600V and Less).
- C. Section 260526 - Grounding and Bonding for Electrical Systems.
- D. Section 260534 - Conduit.
- E. This section specifies a system or part of a system being commissioned as defined in 01 9113 General Commissioning Requirements. Testing of these systems, as well as Operations & Maintenance (O&M) Manuals and Training of the Owner's personnel, is required in cooperation with the Owner, General Contractor, and the Commissioning Professional. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to 01 9113 General Commissioning Requirements for detailed commissioning requirements.

#### 1.3 REFERENCE STANDARDS

- A. ANSI C78.379 - American National Standard for Electric Lamps -- Reflector Lamps -- Classification of Beam Patterns; 2006.
- B. IEEE C2 - National Electrical Safety Code; 2017.
- C. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products; Illuminating Engineering Society; 2008.
- D. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules; Illuminating Engineering Society; 2015.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- F. NECA/IESNA 501 - Standard for Installing Exterior Lighting Systems; 2006.
- G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

- H. UL 1598 - Luminaires; Current Edition, Including All Revisions.
- I. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

#### 1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
  - 1. Notify Engineer of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

#### 1.5 SUBMITTALS

- A. See Section 013330 and Section 260000 for submittal procedures.
- B. Shop Drawings: Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer. Shop drawing submittals for luminaires shall be complete in all aspects and at a minimum shall contain, but are not limited to, the following: (1) Light fixture cutsheet, (2) Ballast or LED driver board cutsheet, (3) Integral emergency ballast/battery pack cutsheet (as applicable to the project), (4) Lamps or LED device board cutsheet., (5) Poles (as applicable to the project). Shop Drawing submittals for luminaires shall have a complete luminaire schedule included at the front of the submittal.
- C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, weight, effective projected area (EPA), and installed accessories; include model number nomenclature clearly marked with all proposed features.
  - 1. LED Luminaires:
    - a. Include estimated useful life, calculated based on IES LM-80 test data.
- D. Operation and Maintenance Data: Instructions for each product including information on replacement parts.
- E. Project Record Documents: Record actual connections and locations of pole foundations, luminaires, and any pull or junction boxes.
- F. Refer to Section 01 9113 General Commissioning Requirements for commissioning-related submittals and submittal review processes.

#### 1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five years documented experience.
- C. Electrical Components: Listed and classified by Underwriters Laboratories Inc. or other organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) as

suitable for the purpose specified and indicated. NRTL must also be acceptable to Authority Having Jurisdiction (AHJ).

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, handle, and store products according to NECA/IESNA 501 and manufacturer's written instructions.
- B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

#### 1.8 WARRANTY

- A. See Section 260000 - Product Requirements, for additional warranty requirements.
- B. Provide five year manufacturer warranty for all LED luminaires, including drivers.

#### 1.9 EXTRA MATERIALS

- A. See Section 260000 - Product Requirements, for additional provisions.
- B. Furnish 2% or a minimum of 2 of each LED driver board and LED device board. Emergency battery packs are not included. Luminaire manufacturer shall keep reasonable LED driver board and LED device board stocks on hand for replacement during warranty period.

### PART 2 - PRODUCTS

#### 2.1 LUMINAIRE TYPES

- A. Furnish products as indicated in luminaire schedule included on the drawings.

#### 2.2 LUMINAIRES

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- C. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.

- E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, poles, foundations, supports, trims, accessories, etc. as necessary for a complete operating system.
- F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
- G. LED Luminaires:
  - 1. Components: UL 8750 recognized or listed as applicable.
  - 2. Tested in accordance with IES LM-79 and IES LM-80.
  - 3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.
- H. LED Luminaire Components: UL 8750 recognized or listed as applicable.

## 2.3 LAMPS

- A. Lamp Types: As specified for each luminaire.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Coordinate locations of outlet boxes provided under Section 260537 as required for installation of luminaires provided under this section.
- B. Install products according to manufacturer's instructions.
- C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 1 (general workmanship) and NECA/IESNA 501 (exterior lighting).
- D. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- E. Install accessories furnished with each luminaire.
- F. Bond products and metal accessories to branch circuit equipment grounding conductor.
- G. Install lamps in each luminaire.

### 3.2 FIELD QUALITY CONTROL

- A. Inspect each product for damage and defects.
- B. Perform field inspection, testing, and adjusting in accordance with manufacturer's instructions.
- C. Operate each luminaire after installation and connection to verify proper operation.

- D. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Engineer.

### 3.3 ADJUSTING

- A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Engineer. Secure locking fittings in place.

### 3.4 CLEANING

- A. Clean surfaces according to NECA/IESNA 501 and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.
- B. Clean electrical parts to remove conductive and deleterious materials.
- C. Remove dirt and debris from enclosure.
- D. Clean photometric control surfaces as recommended by manufacturer.
- E. Clean finishes and touch up damage.

### 3.5 CLOSEOUT ACTIVITIES

- A. Relamp luminaires that have failed lamps at Substantial Completion.
- B. Demonstration: Demonstrate proper operation of luminaires to Engineer, and correct deficiencies or make adjustments as directed.

### 3.6 DEMONSTRATION AND TRAINING

- A. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner, General Contractor, and the Commissioning Professional. Provide competent, factory-authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, troubleshooting, routine servicing and maintenance of the installed systems. The instruction shall be scheduled in coordination with the Owner and the Commissioning Professional after submission and approval of formal training agendas. Refer to Sections 01 9113 General Commissioning Requirements.

### 3.7 FUNCTIONAL PERFORMANCE TESTING

- A. System functional performance testing is part of the Commissioning Process as detailed in Section 01 9113 General Commissioning Requirements. Functional performance testing shall be performed by the contractor and witnessed and documented by the Commissioning Professional. Installation checklists shall be successfully completed by the contractor and submitted to the Commissioning Professional prior to functional performance testing.

END OF SECTION 265600

## SECTION 270500 - COMMON WORK RESULTS FOR COMMUNICATIONS

### 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. Communications equipment coordination and installation.
  2. Sleeves for pathways and cables.
  3. Sleeve seals.
  4. Grout.
  5. Common communications installation requirements.

#### 1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

#### 1.4 COORDINATION

- A. Coordinate arrangement, mounting, and support of communications equipment:
  1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
  2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
  3. To allow right of way for piping and conduit installed at required slope.
  4. So connecting pathways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed.
- D. Coordinate sleeve selection and application with building type.

### PART 2 - PRODUCTS

## 2.1 SLEEVES FOR PATHWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Sleeves for Rectangular Openings: Galvanized sheet steel.
  - 1. Minimum Metal Thickness:
    - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
    - b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

## 2.2 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Advance Products & Systems, Inc.
    - b. Calpico, Inc.
    - c. Metraflex Co.
    - d. Pipeline Seal and Insulator, Inc.
  - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of pathway or cable.
  - 3. Pressure Plates: Plastic. Include two for each sealing element.
  - 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

## 2.3 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

## PART 3 - EXECUTION

### 3.1 COMMON REQUIREMENTS FOR COMMUNICATIONS INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both communications equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to piping systems installed at a required slope.

### 3.2 SLEEVE INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A. Communications penetrations occur when pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Extend sleeves installed in floors 6 inches (152 mm) above finished floor level.
- G. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pathway or cable, unless indicated otherwise.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry.
  - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Spec Section 079200 Joint Sealants.
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetrations. Install sleeves and seal pathway and cable penetration sleeves with firestop materials.
- K. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

- M. Underground, Exterior-Wall Penetrations: Install steel pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between pathway or cable and sleeve for installing mechanical sleeve seals.

### 3.3 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

### 3.4 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for communications installations to restore original fire-resistance rating of assembly.
- B. Comply with TIA/EIA-569-A, Annex A, Firestopping.
- C. Comply with requirements in Division 07 as well as requirements of Spec Section 260050 Firestopping.

END OF SECTION 270500

## SECTION 270507 - COMMUNICATIONS RACEWAY SYSTEM

### PART 1 - GENERAL

#### 1.1 WORK INCLUDED

- A. Access Control, Video Surveillance, and Television outlet and raceway system.

#### 1.2 RELATED WORK

- A. Division 099000 Painting and Coating.
- B. Section 260534 - Conduit.
- C. Section 260553 - Identification for Electrical Systems.
- D. Section 275132 – Television Systems.

#### 1.3 SYSTEM DESCRIPTION

- A. Conduit and other raceway components as well as junction boxes and low voltage rings to form an empty raceway system, for installation of cables and equipment that will be supplied and installed under by the Owner.

#### 1.4 REFERENCES

- A. TIA/EIA-568B - Commercial Building Telecommunications Cabling Standard; Telecommunications Industry Association; B, Latest adopted standard.
- B. TIA/EIA-607 - Commercial Building Bonding and Grounding Requirements for Telecommunications; Latest adopted standard.
- C. TIA/EIA-569A - Commercial Building Standard for Telecommunications Pathways and Spaces; Telecommunications Industry Association; Latest adopted standard and associated adopted Addenda.
- D. NFPA 70 - National Electrical Code; National Fire Protection Association; most recent edition approved by the Authority Having Jurisdiction, including all applicable Amendments and Supplements.

#### 1.5 SUBMITTALS

- A. See Section 013330 and Section 260000 for submittal procedures.
- B. Product data:

1. Materials list of items proposed to be provided under this section.
  2. Manufacturer's specifications and other data needed to provide compliance with the specified requirements.
- C. Project Record Documents: Record actual locations and sizes of pathways and outlets.

## 1.6 QUALITY ASSURANCE

- A. Work shall be installed in accordance with the manufacturer's recommendations of the equipment to be supplied and installed under this contract. Installations and materials shall be in accordance with latest edition of the International Building Code (IBC), Uniform Building Code (UBC), National Electrical Code (NEC), and Building Industry Consulting Service International (BICSI).

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Conduit: Refer to Section 260534 - Conduit.
- B. Backboards: 3/4" fire rated plywood.
- C. Outlet Boxes: Section 260537 - Boxes.
- D. Wallplates: Refer to Section 262726 – Wiring Devices.
- E. Pull and Junction Boxes: Refer to Section 260537 - Boxes.

### 2.2 SERVICE AND PATHWAYS

- A. Contractor shall provide new service conduits and extension of conductors as required from existing telecommunications service in Wing 1 to new IT RM 003 in the crawlspace of Wing 1.
- B. Contractor shall coordinate all work in communications rooms as well as layout of pathways with the Owner to ensure that a complete cabling system can be installed meeting industry standards. Before installing anything within communications rooms and before installing any conduit, this Contractor shall meet with Owner to field coordinate installation.
- C. Horizontal Pathway: Conform to TIA/EIA-569A, using raceway, racks, and backboards as indicated. Cabling above accessible ceiling space shall be installed in cable tray or conduit. All cables from cable tray to outlet shall be installed in conduit. Bond conduit in accordance with NEC requirements.
- D. At ceiling mounted Video Surveillance camera locations inside of building at lay-in ceiling locations provide a 4-11/16 inch by 4-11/16 inch dual device "deep" 2-1/8 inch style junction box (42 cubic inches) with a single gang mud ring. Place box above accessible ceiling.

- E. For wall and ceiling mounted Video Surveillance camera locations on exterior of building provide a weatherproof box and cover with 3/4 inch conduit to the nearest accessible ceiling space. At accessible ceiling space provide a 4-11/16 inch by 4-11/16 inch dual device "deep" 2-1/8 inch style junction box (42 cubic inches) with a standard cover and then a 3/4 inch conduit from this box to the cable tray. Coordinate with Video Surveillance Contractor exact requirements for weather proof box and cover as well as location for entering camera mounting bracket supplied by Video Surveillance Contractor. Bond conduit in accordance with NEC requirements.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Maintain twelve-inches (12") separation between power and communications service conduit.
- B. Provide pullboxes in conduit runs spaced not greater than 100 ft. apart, and on backboard side of runs with more than two right angle bends. Pull boxes shall be the following minimum sizes:
  - 1. 6" x 6" x 6" for 3/4" conduit runs.
  - 2. 4" x 4" x 36" for 1" through 2-1/2" conduit runs.
  - 3. 6" x 6" x 36" for 3" and larger conduit runs.
- C. Place label on pull and junction boxes.
- D. Provide 3/32" OD, 200 lb. strength polyethylene lines in each conduit run.
- E. Access Control, Video Surveillance, and Television Backboxes: Install backboxes at mounting heights and locations as shown on the electrical drawings. Reference electrical and architectural drawings for locations.

END OF SECTION 270507

## SECTION 271021 - VOICE/DATA SYSTEMS - CAT 6

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Installation of a conduit, cable and outlet system for telecommunications wiring that complies with TIA/EIA 568. All racks, termination blocks, cables, terminations etc. to be installed by this contractor.
- B. Telephone service entrance raceway.
- C. Equipment and terminal backboards.
- D. Communication racks.
- E. Data Systems
- F. Fiber Optic Cable, and termination.
- G. Voice/Data wiring, termination and outlets.

#### 1.2 RELATED SECTIONS

- A. Section 260000 – Electrical General Requirements.
- B. Section 260050 - Firestopping.
- C. Section 260534 - Conduit.
- D. Section 260537 - Boxes.
- E. Section 262726 - Wiring Devices.
- F. Section 270500 – Common Work Results for Communications.

#### 1.3 REFERENCES

- A. Category 6 requirements are found in the following American National Standards Institute (ANSI), the Electronics Industries Association/Telecommunications Industry (EIA/TIA) Standards and Technical Systems Bulletins (TSB):
- B. TIA/EIA-568B - Commercial Building Telecommunications Cabling Standard; Telecommunications Industry Association; B, 2001.
- C. TIA/EIA-607 - Commercial Building Bonding and Grounding Requirements for Telecommunications; 1997.

- D. TIA/EIA-569-A - Commercial Building Standard for Telecommunications Pathways and Spaces; Telecommunications Industry Association; 1998, and Addenda 1, 2, 3, 4 (ANSI/TIA/EIA 569-A).
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

#### 1.4 SUBMITTALS

- A. See Section 013300 - for submittal procedures.
- B. Submit communication closet layout per communication standards and per provided layout.
- C. Product data:
  - 1. NOTE: All components shall be as specified, or be 100% compatible (ie. completely interchangeable, etc.).
  - 2. Materials list of items proposed to be provided under this section.
  - 3. Manufacturer's specifications and other data needed to provide compliance with the specified requirements.
  - 4. Manufacturer's recommended installation procedures which, when approved by the Engineer, will become the basis for accepting or rejecting actual installation procedures used on the work.
- D. Submit information on the labeling scheme that will be used. MUST be coordinated with the owner.
- E. Shop Drawings: Show details of each cable type, outlets, terminal blocks, accessories, and related equipment.
- F. Project Record Documents: Record actual locations and sizes of pathways and outlets.

#### 1.5 QUALITY ASSURANCE

- A. Work shall be installed in accordance with the manufacturer's recommendations of the equipment to be supplied and installed under this contract. Installations and materials shall be in accordance with latest edition of the Uniform Building Code (UBC), National Electrical Code (NEC), and Building Industry Consulting Service International (BICSI).
- B. Installer Qualifications: Company specializing in installing similar systems, with minimum three years documented experience.
- C. Products: Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and indicated.
- D. Whenever conflicts between referenced standards are encountered, the more stringent will apply.

#### 1.6 COORDINATION

- A. Sequence, coordinate and schedule installation of material with other trades. Avoid unexpected interruptions with other contractors.

## 1.7 QUALIFICATIONS

- A. All cabling and terminations shall be by a telecommunications contractor. This contractor shall be a BICSI certified installer with at least 5 years of verifiable experience. References may be requested.
- B. Installer: Personnel installing and terminating the Cabling system shall be trained for voice and data installations, and testing work. All installers/testers shall provide proof of training. Training must be from a nationally recognized organization and must be able maintain system warranties of materials being installed. Proof of training shall be submitted as part of the submittal process prior to start of work.
- C. All Cisco equipment shall be installed by an approved installer.

## 1.8 SYSTEM DESCRIPTION

- A. Provide conduits, cable supports, backboards, racks, patch panels, termination blocks, cables, and outlet to form raceway and wiring systems for voice and data.
- B. Provide voice/data wiring from designated communication rack, see plans to each outlet, using wire and cable as specified. Telecommunications cabling will terminate on blocks in the appropriate communication rack in the telecommunications room.
- C. The Data and Voice Cable Distribution is intended to be a Category 6 Open System Architecture in accordance with EIA/TIA 568 Standard. There is no difference in cabling and faceplate jacks for voice and data. Voice and data are determined by different cross connects at the communications terminal board.
- D. Wiring configuration at all Data and Voice jack locations shall be per the EIA/TIA 568B standard. Cabling and connections shall be tested per EIA/TIA standards. All cabling and connections shall be CAT 6 compliant. Horizontal cabling shall be 4 pair minimum 23 ga., properly rated for ceiling and attic space.
- E. System Components: Products of single manufacturer unless otherwise specified
- F. Telecommunication work shall be in accordance with the latest BICSI Telecommunication Distribution Methods Manual. This manual shall be on site for reference at all times telecommunication work is in progress. All cable shall be color coded per BICSI Standards.
- G. Labeling scheme shall be coordinated, reviewed and approved by the Owner before implementation
- H. Total station wire length to each workstation area shall be a maximum of 90 meters (295 feet) and a minimum of 20 meters (60 feet).
- I. Data Only Outlets and Floor boxes with Data Only Outlets shall include two (2) RJ-45/8wire modular jacks or four (4) RJ-45/8wire modular jacks rated CAT 6. Each jack shall be fed by its

own CAT 6 4 pair cable. All cables will be terminated at patch panels in the Communications Rooms.

- J. Wall Phone Voice outlets shall have appropriate face plate for hanging phone with one
- K. RJ-45/8wire jack rated CAT 6. This jack shall be fed by one CAT 6 4 pair cable. This cable will be terminated at patch panels in the Communications Rooms.
- L. Provide a communications grounding bar equal to Cooper Industries #SBTMGB20K and dedicated building ground to all communication rooms as required by the NEC. A #6 Cu ground shall be provided from each grounding bar back to Electrical Service Grounding System. Bond all communications conduit to grounding bars.

## PART 2 - PRODUCTS

### 2.1 SERVICE AND PATHWAYS

- A. Contractor shall coordinate all work in communications rooms as well as layout of pathways with the Owner to ensure that a complete cabling system can be installed meeting industry standards. Before installing anything within communications rooms and before installing any conduit, this Contractor shall meet with Owner to field coordinate installation.
- B. Backbone Pathway: Conform to TIA/EIA-569-A using conduit as indicated.
- C. Horizontal Pathway: Conform to TIA/EIA-569-A, using raceway, racks and backboards as indicated. Cabling above accessible ceiling space shall be installed in j-hooks, cable tray or conduit. All cables from cable tray to outlet shall be installed in conduit. Bond conduit to cable tray.
- D. Any Wall Phone outlet to be provided 4-11/16 inch by 4-11/16 inch dual device "deep" 2-1/8 inch style junction box (42 cubic inches) with a single gang mud ring and a 3/4 inch conduit to above accessible ceiling space. Also provide rings and/or j-hooks to get cable to the cable tray. Conduit shall be bonded to structural steel or steel studs
- E. Non-Office Locations: At wall mounted telephone (except wall phone), data or combination telephone/data outlet to be provided with Arlington Industries, Inc (800-233-4717 or [www.aifittings.com](http://www.aifittings.com)) Low Voltage Mounting Bracket model LVH1K or equal and a 1 inch conduit to above accessible ceiling space. Also provide rings and/or j-hooks to get cable to the cable tray. Conduit shall be bonded to structural steel or steel studs.
- F. Office Locations: At wall mounted telephone (except wall phone), data or combination telephone/data outlet to be provided with Arlington Industries, Inc (800-233-4717 or [www.aifittings.com](http://www.aifittings.com)) Low Voltage Mounting Bracket model LVH1K or equal and a 1 inch conduit to above accessible ceiling space within the Office space. Also provide rings and/or j-hooks to get cable to the cable tray. Conduit shall be bonded to structural steel or steel studs.

### 2.2 BACKBOARDS

- A. All communications rooms shall be lined with Termination Backboards as follows:

1. Coated with fire-retardant gray paint.
2. Size: Floor to 8' AFF on all walls indicated on drawings..
3. Thickness: 3/4 inch (19 mm) plywood.
4. Provide extensions for all receptacles in these walls such that the receptacles will be flush with the finished plywood surface.

## 2.3 COMPONENTS

- A. NOTE: All components shall be as specified, or shall be 100% compatible (i.e. completely interchangeable, etc.).
- B. Manufacturers: Pre-approved manufactures include Avaya, Systimax, Panduit, Leviton, or ADC. All others will require prior approval.
- C. All references to manufacturer's model numbers and other pertinent information is intended to establish minimum standards of performance, function and quality. Items specified are manufactured by Systimax.
- D. Voice/Data Outlet: Each outlet will contain one each of the following Systimax GigaSpeed XL MGS400 jacks.
  1. MGS400BH-318 - Blue – Voice or pre-approved equal
  2. MGS400BH-226 - Green – Data or pre-approved equal
- E. Data Only Outlet: Shall be configured the same as the Voice/Data Outlets except all ports will be Data (Green).
- F. Modular Faceplates:
  1. Systimax M-Series "LE"
    - a. Voice/Data and Data Only Outlets shall be 2 port with ID window equal to M12LE-246 (Ivory). Confirm Color of faceplates before ordering.
    - b. Provide blank covers for unused openings; color to match faceplate.
  2. Wall Phone Plates shall have studs for hanging phone and one port equal to Leviton 4108W-0SP.
- G. Rack Mounted Patch Panels:
  1. Provide 48 Port CAT 6 patch panels equal to Systimax GigaSpeed XL No. 1100GS3-48.
  2. Provide with Rack Mounting Kit.
  3. Provide with Labeling Kit.
  4. Provide quantity of panels and accessories to provide a minimum of 25% spares beyond quantity required for cabling identified on drawings.
- H. Rack Mounted Surge Protection:
  1. Provide two Rack Mounted Surge Protective Devices per rack location.
  2. 120 Volt, 20 Amps
  3. Leviton 5500-192 or equal.
- I. Equipment Racks and Cabinets
  1. Equipment Racks for IT/Server room and IT rooms:
    - a. 19" Communications 4-Post server frames equal to Chatsworth model 15214-703 with cable management equal to Chatsworth model 11729-703.

- b. Each rack shall be provided with one horizontal metered Power Distribution Unit (PDU) equal to Chatsworth model 35693-212.
  - c. Provide quantity of racks as indicated on plans within each room.
- J. All cables shall be bonded with bond clamps (in buildings), and grounded to an NEC approved ground.
- K. Wire Management:
  - 1. As required.
  - 2. Finish: Gray baked enamel.

## 2.4 VOICE/DATA SYSTEM CABLING (COPPER):

- A. Feeder Cable:
  - 1. UL Listed Category 6, plenum rated.
    - a. Unshielded, twisted pairs.
    - b. Conductors: Copper.
    - c. Insulation type: CMP.
    - d. Systimax 2071E GigaSPEED XL Cable, Panduit or pre-approved equal.
    - e. Color: Blue
    - f. Wire size: 23 AWG.
    - g. Number of pairs: as shown on plans.
- B. Horizontal Cable to Data Only and Combination Voice/Data Outlets:
  - 1. UL Listed Category 6, plenum rated.
    - a. Unshielded, twisted pairs.
    - b. Conductors: Copper.
    - c. Insulation type: CMP.
    - d. Systimax 2071E GigaSPEED XL Cable, Panduit or pre-approved equal
    - e. Color: Blue for Voice; Green for Data to match jack colors.
    - f. Wire size: 23 AWG.
    - g. Number of pairs: 4.
- C. Patch Cord Assembly:
  - 1. UL Listed - Systimax patch cords.
    - a. Unshielded, twisted pairs.
    - b. Conductors: 4 pair, copper.
    - c. Closet Cable: Equal to Systimax CPC3312-02F007. Blue. 7ft length.
    - d. Office Cable: Equal to Systimax CPC3312-02F010. Blue. 10ft length.
    - e. Supply one closet cable and one office cable for every data jack in the building.
- D. Voice/Data Labeling
  - 1. Label both ends of each connection.
  - 2. Labeling scheme shall be coordinated, reviewed and approved by the Owner before implementation.

## 2.5 OPTICAL FIBER SYSTEMS

- A. Optical Fiber Cable: Shall be factory fabricated, jacketed, low loss, glass type, fiber optic, graded index.
  - 1. Systimax LazrSPEED 300 Series Cable, Panduit or approved equal.
    - a. 50 micron, multimode fiber with data rate of 10Gbps to 300 meters.
    - b. Indoor/Outdoor type.
    - c. Number of strands and routing as indicated on plans.
    - d. Plenum or Riser rated depending on location and application.
    - e. Maximum attenuation: Multimode: Minus 3.0 dB/km at 850 nm; minus 1.0 dB/km at 1300nm.
    - f. Shall have individual fiber tube colors per TIA/EIA-606A and overall Aqua colored jacket.
- B. Fiber Patch Panels in Racks located in Data Closets:
  - 1. Provide Systimax 600G2-1U-IP-SD Modular Shelf System, Panduit or pre-approved equal.
  - 2. Provide Systimax DM2-12LC-MM patch modules (quantity as needed to provide a minimum of one termination per fiber ran to closet plus 25%), Panduit or pre-approved equal.
- C. Fiber ends shall be terminated using type LC on each end and shall be tested to within 3db loss.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. RACEWAY INSTALLATION
  - 1. Provide conduit and raceway system as specified in 2.01.
  - 2. Bond all voice and/or data conduits to building grounding system.
  - 3. All voice and data wiring shall be installed in raceway, conduit, cable tray or other cable management system.
  - 4. Provide voice/data labels on all ends and in pull boxes.
  - 5. Provide pull wire in each spare conduit up to cable tray.
  - 6. Conduit size:
    - a. One voice/data outlet: 1 inch.
    - b. Two voice/data outlets: 1 inch.
    - c. Three voice/data outlets: 1 1/4 inch.
  - 7. Support raceways and cabinets under the provisions of Section 260529.
  - 8. Raceway shall be limited to 40% fill, with three or more conductors. Fill shall be limited to 30% for raceways with less than three conductors. No conduit smaller than 1" shall be allowed.
  - 9. Ground cable tray and bond conduits to cable tray.
- B. EQUIPMENT INSTALLATION
  - 1. Plan equipment backboard arrangements. Arrangements shall be uniform and well organized.
  - 2. Use commercially available wire management products to route wiring across backboards.
  - 3. Mark all punch down pairs in provided space on connecting blocks(block are existing) with indelible ink. Use room numbers as shown on the plans.

4. Splice cases shall be wrapped down with E-Z Wrap Elastic Vinyl by 3M model 2183.
5. All splice cases shall be tested with 7lbs of dry nitrogen gas for a minimum of 5 minutes and soaped.
6. All cables shall be bonded with bond clamps (in buildings), and grounded to an NEC approved ground.
7. Provide a #6 Cu ground tied to the electrical service grounding system.

C. VOICE/DATA WIRE AND CABLE INSTALLATION

1. Plan cable installation so no voice or data cable run is longer than 90m (295 ft).
2. Install in accordance with manufacturer's installation guidelines.
3. Punch wiring in accordance with TIA-568B.
4. Maintain bending radius as required. Install conduit to meet the CAT 6 bending radius.
5. Labeling scheme shall be coordinated, reviewed and approved by the Facilities Management Office before implementation. See detail on plans.
6. The finished installation shall meet the most current CAT 6 system installation standards.
7. Splices, bridge taps, and repairs to wire and cable are not acceptable. Replace damaged cables.
8. Maintain pair twists to termination index strip.
9. Install pair terminations tight with no physical distortion.
10. Replace all cabling that fails Field Quality Control Testing. (It is permissible to only re-terminate cable if terminations are cause of failure).
11. Ground cabling as per NEC and TIA/EIA-607.
12. Cable runs shall follow building lines discreetly in a neat and workman like manner, parallel and consistent throughout. No shortcuts or diagonal runs shall be allowed.

D. FIBER CABLE INSTALLATION

1. Install in accordance with manufacturer's instructions.
2. Maintain bending radius as required. Install conduit to meet the fiber bending radius.

E. FIELD QUALITY CONTROL

1. Testing Equipment: Microtest Omniscanner or equivalent.
  - a. With flash ROM for standard upgrades.
  - b. Use current ROM upgrade for testing all cabling and CAT 6 connections.
  - c. Maintain ROM updates throughout project.
  - d. Capable of testing;
    - 1) NEXT (Near End Cross Talk)
    - 2) Attenuation
    - 3) ACR (Attenuation to Cross Talk Ratio).
    - 4) Length of cable; 4% or 2 feet whichever is greater.
    - 5) Impedance.
    - 6) Loop Resistance.
    - 7) Capacitance.
    - 8) Measure Wire Map.
    - 9) Capable of indicating pass or failure of testing.
    - 10) Capable of providing hard copy printout results.
2. Voice/Data Wiring System Testing:
  - a. All testing to be conducted under observation of Owner's representative.
  - b. Notify Owner's representative at least 48 hours before commencing testing.
  - c. All testing to be conducted using data rates introduced at intervals up to 100 Gbps as recommended by test equipment manufacturer.
  - d. Perform testing on all four pairs of wire per cable.

- e. Label each cable test recorded on test equipment identical to the markings on the cable.
- f. Deliver Omniscanner to Owner's representative immediately after testing, to allow downloading of test results.
- g. Provide one electronic and one paper copy of results to Owner.
- 3. Frequency of testing:
  - a. Test 100% of the cables installed. Conduct testing after terminations have been made at room jack and patch panel.
  - b. Retest all cables required to be reinstalled or re-terminated.
- 4. Optical Fiber Testing
  - a. All optical connections must be tested for basic link with and Optical Time domain Reflectometer (OTDR).
  - b. Multimode fibers shall be tested at 850 and 1300 Nanometers wavelength in both directions.
  - c. Acceptable loss less than 0.5 dB, per mated pair, acceptable splice loss less than 0.2dB, acceptable cable loss per manufacturer's calculated maximum dB loss per KM.
  
- F. Install wire and cable in accordance with manufacturer's instructions and in accordance with TIA/EIA-568.
  
- G. Finish paint termination backboards with durable gray enamel prior to installation of telephone equipment.
  
- H. All requirements shall be coordinated with the Utility. This Contractor is responsible for all charges from the Utility.
  
- I. Install pullwire in each empty telecommunications conduit over 10 feet (3 m) in length or containing a bend.

END OF SECTION 271021

## SECTION 275132 - TELEVISION SYSTEMS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Television signal distribution equipment, cable and accessories, and splitters and outlets with finished device plates.

#### 1.2 RELATED REQUIREMENTS

- A. Section 260526 - Grounding and Bonding for Electrical Systems.
- B. Section 260534 - Conduit.
- C. Section 260537 - Boxes.

#### 1.3 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

#### 1.4 SYSTEM DESCRIPTION

- A. Provide broadband type cable television system. Provide all necessary cabling, plates, modulators, splitters, combiners, amplifiers and channel filters. Provide TV outlet and cable (RG-6) from each outlet to the appropriate local splitter (see plans for locations) and terminate to splitter(s). Provide an RG-11 cable from the local splitter(s) to IT RM, and terminate as indicated. Termination at IT RM shall be rack mounted splitters.

#### 1.5 PERFORMANCE REQUIREMENTS

- A. Signal at each outlet: 3 dBmV across 75 ohms, minimum, plus 5 dB, minus 0 dB. Isolation between outlets of plus 20 dB.
- B. Operating Bandwidth: Between 5 and 1000 MHz.

#### 1.6 SUBMITTALS

- A. See Division 01 and Section 260000 - for submittal procedures.
- B. Product Data: Provide showing electrical characteristics and connection requirements for each component.
- C. Project Record Documents: Record actual locations of outlets, devices, and cable routing.
- D. Operation Data: Instructions for setting and tuning channels.

- E. Maintenance Data: Basic troubleshooting procedures.

## 1.7 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70 standards.
- B. Supplier Qualifications: Authorized distributor of specified manufacturer with minimum three years documented experience.
- C. Installer Qualifications: Authorized installer of specified manufacturer with service facilities within 150 miles of the project.
- D. Products: Furnish products listed and classified by Underwriters Laboratories Inc. as suitable for purpose specified and indicated.

## PART 2 - PRODUCTS

### 2.1 ALL COMPONENTS SHALL BE AS SPECIFIED, OR SHALL BE 100% COMPATIBLE (IE. COMPLETELY INTERCHANGEABLE, ETC).

#### A. AMPLIFIERS AND CONVERTERS

1. Manufacturer: Blonder Tongue Laboratories, Inc; Model BIDA 5900 Series or equal: [www.blondertongue.com](http://www.blondertongue.com).
2. 550 to 1000 MHz bandwidth.
3. Sized to meet specified performance.

#### B. SPLITTER

1. Manufacturer: Blonder Tongue SXRS series or equal.
2. Frequency Response: 5 - 1000 MHz.
3. Isolation: 21 dB minimum.
4. Return Loss: 16 dB minimum.
5. Insertion Loss: 6.8 dB maximum.
6. RFI shielding: 120 dB minimum.
7. Quantity as required for TV Outlet locations as shown on Drawings.

#### C. COMBINER

1. Manufacturer: Blonder Tongue OC-8D or equal.
2. 8 passive inputs, 1 output with test port.
3. Rack Mount Device.

#### D. CHANNEL FILTER

1. Manufacturer: Blonder Tongue CEF Series or equal.
2. Channel Suppression: 52 dB.
3. Adjacent channel insertion loss: 2 to 23: 3 dB, 24 to 38: 4 dB.

#### E. MODULATOR

1. Manufacturer: Blonder Tongue AM Series Agile Modulator, ZeeVee Zvbox 180 or equal.
2. Single input channel.
3. Video Input: 1.0 V p-p.

4. Output Level Min: 60 dbmV.
5. Output Level Adjust: 10 dB.
6. 50 - 550 MHz output.
7. Rack mount device.

F. OUTLETS

1. Manufacturer: Panduit CMFSR series or equal by Leviton.
2. Mini-com self-terminating F connector.
3. Provide with matching Panduit mini-com faceplate, color to match devices specified in Section 262726.
  1. Four inch square box with single gang plaster ring as specified in Section 260537.

G. VIDEO CABLE

1. Main Distribution Cable: West Penn 25821 RG-11 or equal by Belden, CommScope.
  - a. 14 AWG Solid Copper Center Conductor.
  - b. 100% BiFoil Shield with 65% Aluminum Braid.
  - c. Plenum Rated Cable.
2. Branch Distribution Cable: West Penn 25841 RG-6/U or equal by Belden, CommScope.
  - a. 18 AWG Solid Copper Center Conductor.
  - b. 100% BiFoil Shield with 65% Aluminum Braid.
  - c. Plenum Rated Cable.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install in accordance with Manufacturer's instructions.
- B. Conduit size shall be 1 inch for each outlet location.
- C. Install TV cable in conduit. Conduit shall be routed from outlet to head-end equipment.
- D. Where a telecommunication raceway, cable tray, or cable rack is provided, all video cables shall utilize the system. Other wiring in video conduits is prohibited.
- E. Cables shall be neatly bundled and routed in a direct path between termination points.
- F. Cables shall not be routed in any manner that violates manufacturer's specifications for minimum bend radius.
- G. At the termination wiring locations, route cables along the backboard vertically and horizontally to avoid diagonal routing. Where the termination location is unspecified, neatly coil enough cable slack in each wiring closet to reach the farthest corner of the backboard routing vertically and horizontally.
- H. All wire and cable shall be kept clear of radiated heat, power feeders, and a minimum separation distance of 5 inches from fluorescent light fixtures.
- I. Cable pulled through an enclosure shall have a service loop to insure the cable does not kink or cut.

- J. Cable should be run in one piece without splices made. In the event a splice is absolutely necessary it shall be done to provide proper impedance. Video cable shall use a female to female F type barrel with crimped F connectors on each end. Splices must be accessible and not internal to conduit as per code regulations.
- K. Label all video cables at each end with origination and termination designation. Labels must be permanent and legible. Peel off numbers is not acceptable unless clear heat shrink is used over the numbers. Cable numbering shall be documented on the as-built drawings to provide instant access to the cable origination and destination.
- L. Provide proper grounding of television system components and wiring.

### 3.2 ADJUSTING

- A. Adjust amplifier gain and make other system adjustments to achieve specified output levels at each outlet.

### 3.3 TESTING AND ALIGNMENT

- A. All new equipment shall be aligned as recommended per the manufacturer.
- B. Video signals shall be 100 IRE at the designation point. Sync levels shall be at -40 IRE. SC and horizontal phasing shall be done using a vector scope and waveform monitor.
- C. After testing and alignment is complete, the contractor shall contact the Architect/Engineer to request a final inspection of the project. After the final inspection is complete, demonstration and training shall be scheduled with the Owner.

### 3.4 CLOSEOUT ACTIVITIES

- A. Demonstration: Demonstrate operation of system to Owner's personnel.
  - 1. Conduct walking tour of project and briefly describe function, operation, and maintenance of each component.
  - 2. Include demonstration of television operation specified signal level at two outlets selected by Owner.
- B. Training: Train Owner's personnel on operation and maintenance of system.
  - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
  - 2. Provide minimum of one hour of training.
  - 3. Instructor: Manufacturer's training personnel.
  - 4. Location: At project site.

END OF SECTION 275132

## SECTION 280500 - COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

### 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. Electronic safety and security equipment coordination and installation.
  2. Sleeves for raceways and cables.
  3. Sleeve seals.
  4. Grout.
  5. Common electronic safety and security installation requirements.

#### 1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

#### 1.4 COORDINATION

- A. Coordinate arrangement, mounting, and support of electronic safety and security equipment:
  1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
  2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
  3. To allow right of way for piping and conduit installed at required slope.
  4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for electronic safety and security items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 as well as requirements of Section 260050 Firestopping.

## PART 2 - PRODUCTS

### 2.1 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Sleeves for Rectangular Openings: Galvanized sheet steel.
  - 1. Minimum Metal Thickness:
    - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
    - b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

### 2.2 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
    - a. Advance Products & Systems, Inc.
    - b. Calpico, Inc.
    - c. Metraflex Co.
    - d. Pipeline Seal and Insulator, Inc.
  - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
  - 3. Pressure Plates: Plastic. Include two for each sealing element.
  - 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

### 2.3 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

## PART 3 - EXECUTION

### 3.1 COMMON REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electronic safety and security equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to piping systems installed at a required slope.

### 3.2 SLEEVE INSTALLATION FOR ELECTRONIC SAFETY AND SECURITY PENETRATIONS

- A. Electronic safety and security penetrations occur when raceways, pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Extend sleeves installed in floors 6 inches (152 mm) above finished floor level.
- G. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable, unless indicated otherwise.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry:
  1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
  2. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 Joint Sealants.
  3. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements of Division 07 as well as requirements of Section 260050 Firestopping.
  4. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
  5. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

6. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

### 3.3 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

### 3.4 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electronic safety and security installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 as well as requirements of Section 260050 Firestopping.

END OF SECTION 280500

## SECTION 283111 – ADDRESSABLE FIRE ALARM SYSTEM

### PART 1 - GENERAL

#### 1.1 SCOPE

- A. The Electrical Contractor and (through subcontract) the Fire Alarm contractor shall furnish and install, complete and ready for operation, a Fire Alarm System, including alarm panels, detectors, pull stations, devices, door holders, local alarms, wiring, any and all other equipment necessary for a complete operational system, as shown on the drawings and indicated herein.
  - 1. Furnish and install fire protection supervision.
  - 2. Furnish and install signal appliances and controls for safe and orderly evacuation of building.
  - 3. Work will include all devices to accomplish HVAC equipment shutdown and duct damper activation.
  - 4. Work will include installation of smoke detectors, manual pull stations, etc.
  - 5. Work will include all signal transmission to Remote Fire Alarm Panels or Central Stations.
  - 6. Provide for proper sealing of openings, cracks and penetrations.
  
- B. The Fire Alarm contractor shall be licensed by the State in which the project is located. All fire alarm equipment shall be installed exclusively by installers and workmen that are employees of the fire alarm system contractor. All installers and workmen shall be National Institute for Certification in Engineering Technologies (NICET) Level II or higher certified fire alarm technician. All supervisors and submittal preparers shall be resident NICET Level III or IV certified fire alarm technician and shall be state licensed. The equipment supplier shall employ NICET Level III or IV certified fire alarm technician at their local office to prepare installation drawings and verify compliance with the specifications Contractors and workmen not complying with this specification shall not be allowed to perform this work.
  
- C. The Fire Alarm contractor shall prepare plans and calculations required by the Authority Having Jurisdiction (AHJ), shall submit all required documents to the AHJ for approval, and shall obtain all necessary permits or approvals from the AHJ including anything required prior to installation and/or after completion and testing.
  
- D. All portions of the Fire Alarm system shall be installed in accordance with the drawings, details, and specifications or as required by AHJ and codes. The AHJ and codes shall take precedence over plans, details and specifications in the event of a dispute between the requirements of contract documents and jurisdictional authorities or codes.
  
- E. The Fire Alarm Control Panel (FACP) and peripheral devices shall be manufactured 100% by a single U.S. manufacturer (or division thereof).
  
- F. The system and its components shall be Underwriters Laboratories, Inc. listed under the appropriate UL testing standard as listed herein for fire alarm applications and the installation shall be in compliance with the UL listing.
  
- G. The Electrical contractor shall provide for all rough-in (including supply and installation of electrical boxes and raceways) and wire pulling. The Fire Alarm contractor shall supply wiring and any specialty backboxes required for the fire alarm contractors equipment. The Electrical contractor

shall NOT install any fire alarm system components beyond rough-in and wire pulling. The Fire Alarm contractor shall coordinate all requirements with the Electrical Contractor prior to bidding.

- H. The position is taken that the Owner is entitled to a project which meets or exceeds the minimum requirements of nationally recognized fire protection standards. All efforts and installations shall be directed toward this end. All deficiencies as noted by fire rating bureaus, insurance service offices or jurisdictional authorities shall be corrected. No extra charges will be allowed on this account.
- I. The intent of these specifications is to describe the complete systems to be installed. The Contractors shall provide such minor details of work or materials not specifically mentioned or shown, but necessary for the successful operation and completion of the installation.
- J. The Fire Alarm contractor shall coordinate all requirements with the electrical, fire protection, temperature control and/or other subcontractors. Any additional requirements or detail not shown on the drawings, but required for a complete working integrated system will be the responsibility of the Fire Alarm contractor.
- K. The Temperature Control contractor shall connect to appropriate devices or modules provided and installed by the Fire Alarm contractor to accomplish HVAC control and shutdown.
- L. Work to be performed under this section shall include, but not be limited to the following:
  - 1. Fire Alarm System
    - a. Fire Alarm Control Panel
    - b. Battery Supplies
    - c. Audible/Visual Alarm Devices
    - d. Pull Stations
    - e. Smoke/Heat/Duct Detectors
    - f. Carbon Monoxide Detectors
    - g. Door Holders
    - h. Remote Fire Alarm Annunciator Panel
    - i. Interface to HVAC Equipment.
    - j. Interface to fire/smoke dampers including packaged smoke detectors, where present
    - k. Wiring
    - l. Installation of autodialer.
    - m. Programming.

## 1.2 RELATED REQUIREMENTS

- A. All work performed under this section of the specifications shall be subject to the requirements of both the General and Special Conditions and the Mechanical and Electrical Specification.
- B. Related work specified elsewhere:
  - 1. Section 260050 Firestopping: Materials and methods for work to be performed by this installer.
  - 2. Section 233300 - Air Duct Accessories: Smoke dampers monitored and controlled by fire alarm system.
  - 3. Section 260519 - Low-Voltage Power Conductors and Cables
  - 4. Section 260533 - Raceway and Boxes for Electrical Systems

- C. Examine the above referenced specification parts thoroughly before submitting a proposal for accomplishment of work in this section.

### 1.3 REGULATORY AGENCIES

- A. The term jurisdictional authority used in this section of the specification shall include, as applicable, but not be limited to the following:
  - 1. Local Building Department and Fire Department.
  - 2. State Fire Marshal.
  - 3. Insurance Services Office or Insuring Authority Having Jurisdiction.
  - 4. Owner.

### 1.4 REFERENCE STANDARDS

- A. The design and installation of all systems of fire protection shall conform to all requirements of applicable codes and publications herein defined:
  - 1. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines; current edition.
  - 2. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design; Current Adopted Version.
  - 3. IEEE C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits; 2002 (Cor 1, 2012)
  - 4. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
  - 5. NFPA 72 - National Fire Alarm and Signaling Code, 2022.
  - 6. NFPA 101 - Life Safety Code; Current Adopted Version.
  - 7. International Fire Code (IFC); Current Adopted Version.
  - 8. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
  - 9. The system shall have the proper listing and/or approvals from the following recognized organizations as required:
    - a. Underwriters Laboratories Inc. (UL).
    - b. Factory Mutual (FM).
  - 10. Local and State Building Codes.
  - 11. All requirements of the Authority Having Jurisdiction (AHJ).

### 1.5 SUBMITTALS

- A. The successful Contractor shall provide submittal data as required under other portions of this specification. Submittals shall conform to the instructions set forth in the General and Special Conditions of these specifications entitled Shop Drawings and Submittals.
- B. The contractor shall submit to each authority having jurisdiction (AHJ) all necessary documents, detailed shop drawings (including plans), calculations and any other details required by NFPA and the AHJ necessary to receive approval and permitting from the AHJ for the work required. After approval from each AHJ has been received and returned to the Contractor, the shop drawings shall be submitted to the Architect for final acceptance. These final acceptance sets shall have all

agencies' stamps of review and acceptance. Where there is conflict between the Contract Drawings and/or Specifications, and the recommendations of the jurisdictional authorities, the conflict shall be brought to the attention of the Architect at least ten (10) days prior to bidding or be resolved at no cost to the Owner. Include NICET certifications in all submittals.

- C. Should the AHJ require professionally engineered (P.E) stamped plans the contractor shall engage the proper engineering services, at contractors cost, to meet the requirements of the AHJ at no additional cost to the project. Associated Construction Engineering will not stamp plans for this purpose.
- D. Full catalog information shall be provided for all materials intended for use on this project. Catalog information indicating more than one item shall be highlighted to clearly indicate the proposed equipment.
- E. Manufacturer's certificate of acceptance of the qualifications of the installing Contractor to install, test and maintain the manufacturer's equipment shall be submitted.
- F. Detailed sequences of operation, electrical schematics and connection diagrams shall be provided to completely describe the operation of the fire alarm system controls.
- G. Standby battery calculations shall be submitted.
- H. Architect's review will be for general location only. It will be the Contractor's responsibility to check his drawings for interferences and to do shop fabrication from measurements taken at the job site.
- I. Work on the project shall not begin until plans have been reviewed by the Architect.

#### 1.6 JOBSITE CONDITIONS

- A. The Electrical Contractor shall investigate the structural, architectural, mechanical, electrical, and finished conditions affecting the conduit and devices, and shall arrange the equipment accordingly; furnishing required fittings, offsets and accessories. Route conduit to avoid interference with ductwork and drain piping. In the event it becomes necessary to make field changes in locations due to building construction, the Contractor shall consult with the Architect before making any changes. Any such changes required shall be made without added cost to the Owner.
- B. The Electrical Contractor shall determine, and be responsible for, the proper locations and character of inserts for hangers, chases, sleeves, and other openings in the construction required for fire alarm system work, and shall obtain this information well in advance of the construction progress to avoid delay of the work.
- C. All fees and permits specifically required for fire alarm work, not obtained by others as specified elsewhere shall be applied for and paid for by the Fire Alarm Contractor.
- D. All fire alarm systems shall be installed by a licensed (for the location of installation) Fire Alarm Contractor, fully experienced in fire protection installation as specified herein. Fire Alarm Contractors may be required to provide in writing, specific information as to successfully completed projects and references to show cause as to why they should be considered acceptable to the Architect.

- E. The system shall be installed by an experienced firm with full time personnel who are factory certified and are regularly engaged in the installation of fire alarm systems in strict accordance with NFPA Standards. The Installing Contractor shall be an authorized stocking distributor of the manufacturer for the equipment included in the system so that immediate replacement parts can be made from inventory and, if needed, on an emergency basis. The Contractor shall provide service personnel who shall be available for emergency service at all times, twenty-four (24) hours a day.

#### 1.7 RECORD DRAWINGS

- A. One approved set of drawings shall be maintained on the job at all times.
- B. One reproducible set of As-Built drawings shall be provided to the Architect upon completion of the work.

#### 1.8 OPERATION AND MAINTENANCE MANUALS

- A. Three (3) sets of operating and maintenance instructions shall be provided the Owner upon completion. Manuals shall include, as a minimum, the following:
  - 1. As-Built Drawings showing location of all devices and panels, all routing including conduit size, wire, wire color codes.
  - 2. Catalog cut sheets of all materials installed.
  - 3. Operational sequences.
  - 4. Manufacturer's operations and maintenance manuals.
  - 5. Electrical schematics of all circuiting (wiring diagrams).
  - 6. Final approval of all jurisdictional agencies.
  - 7. Final test certificates.
  - 8. Written certification by the fire alarm equipment manufacturer, stating that the system and its component parts are as listed and approved by the State Fire Marshal, and that the installation conforms in all respects to requirements of applicable codes.
- B. Maintenance Materials, Tools, and Software Modification: Furnish the following for Owner's use in maintenance of project:
  - 1. Furnish the following to the Owner:
    - a. Provide the services of a factory trained and authorized technician to perform all system software modifications, upgrades or changes. Response time of the technician to the site shall not exceed 8 hours.
    - b. Provide all hardware, software, programming tools and documentation necessary to modify the fire alarm system on site. Modification includes addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices or zones. The system structure and software shall place no limit on the type or extent of software modifications on-site. Modification of software shall not require power-down of the system or loss of system fire protection while modifications are being made.
    - c. One copy, on CD-ROM or USB Flash Drive, of all software not resident in read-only-memory.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store fire alarm system in accordance with manufacturer's instructions.
- B. Maintain storage area conditions for products of this section in accordance with manufacturer's instructions.
- C. Smoke detectors shall not be installed until the project has undergone FINAL cleaning in accordance with NFPA 72. In the event detectors are installed prior to final cleaning, the contractor shall clean or replace all detectors at no additional cost to the Owner. Installation of protective plastic covers does not meet the intent of this requirement.
- D. Handle carefully in accordance with manufacturer's written instructions to avoid damage to fire alarm system internal components, enclosure, and finish.

## 1.10 WARRANTY

- A. Provide installer's warranty that the installation is free from defects and will remain so for at least one (1) year from the date of Substantial Completion (this date will be after acceptance of the system by all Authorities Having Jurisdiction). The full cost of maintenance, labor and materials required to correct any defect during this one year period shall be included in the submittal bid.

## PART 2 - PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
  - 1. UTC Edwards System Technology (EST): [www.edwardsfiresafety.com](http://www.edwardsfiresafety.com)
  - 2. Honeywell Security & Fire Solutions/Notifier: <https://www.securityandfire.honeywell.com/notifier/en-us>
  - 3. Johnson Controls Simplex <https://simplex-fire.com/en/us/Pages/default.aspx>
  - 4. Siemens Building Technologies, Inc: [www.buildingtechnologies.siemens.com](http://www.buildingtechnologies.siemens.com)
  - 5. Provide control units made by the same manufacturer.
- B. The system and components shall be produced by one (1) Manufacturer of established reputation and experience who shall have produced similar apparatus for a period of at least five (5) years.
- C. All references to manufacturer's model numbers and other pertinent information is intended to establish minimum standards of performance, function and quality. Items specified are manufactured by UTC Edwards System Technology (EST).

### 2.2 EQUIPMENT AND MATERIAL, GENERAL:

- A. All equipment and components shall be new, and the manufacturer's current model.

- B. All equipment and components shall be installed in strict compliance with manufacturers' recommendations.
- C. All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place.

## 2.3 FIRE ALARM SYSTEM

- A. Fire Alarm System: Provide a new automatic fire detection and alarm system:
  - 1. Provide all components necessary, regardless of whether shown in the contract documents or not.
  - 2. Protected Premises: Entire building shown on drawings.
  - 3. Comply with the following; where requirements conflict, order of precedence of requirements is as listed:
    - a. ADA Standards.
    - b. The requirements of the State Fire Marshal.
    - c. The requirements of the local Authority Having Jurisdiction.
    - d. Applicable local codes.
    - e. The contract documents (drawings and specifications).
    - f. NFPA 101.
    - g. NFPA 72; where the word "should" is used consider that provision mandatory; where conflicts between requirements require deviation from NFPA 72, identify deviations clearly on design documents.
  - 4. Evacuation Alarm: Multiple smoke zones; allow for evacuation notification of any individual zone or combination of zones, in addition to general evacuation of entire premises.
  - 5. General Evacuation Zones: Each smoke zone is considered a general evacuation zone unless otherwise indicated, with alarm notification in all zones on the same floor, on the floor above, and the floor below.
  - 6. Program notification zones as directed by Owner.
  - 7. Fire Command Center: Located in on-premises supervising station.
  - 8. Fire Alarm Control Panel: New, located in room IT 120.
- B. Supervising Stations and Fire Department Connections:
  - 1. Public Fire Department Notification: By on-premises supervising station.
  - 2. On-Premises Supervising Station: Front Desk room ADMIN 109.
  - 3. Means of Transmission to On-Premises Supervising Station: Directly connected noncoded system.
- C. Circuits:
  - 1. Initiating Device Circuits (IDC): Class B, Style A.
  - 2. Signaling Line Circuits (SLC) Within Single Building: Class B, Style 0.5.
  - 3. Notification Appliance Circuits (NAC): Class B, Style W.
- D. Power Sources:
  - 1. Primary: Dedicated branch circuits of the facility power distribution system.
  - 2. Secondary: Storage batteries.
  - 3. Capacity: Sufficient to operate entire system for period specified by NFPA 72.
  - 4. Each Computer System: Provide uninterruptible power supply (UPS).

## 2.4 CONDUIT AND WIRE:

### A. Conduit:

1. Conduit shall be in accordance with the National Electrical Code (NEC), local and state requirements.
2. All Fire Alarm system wiring shall be installed in conduit. The Fire Alarm Contractor shall be responsible for the supply and installation of the conduit, wire, wire pulling, junction boxes, electrical boxes, and terminal cabinets in accordance with the manufacturer's recommendations. All junction boxes shall be painted red and labeled "Fire Alarm". No Fire Alarm system wiring shall be placed in any other type of wireway. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.
3. Cable must be separated from any open conductors of power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, per NEC Article 760.28.
4. Wiring for 24 VDC control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits.
5. Conduit shall not enter the Fire Alarm Control Panel, or any other remotely mounted control panel equipment or backboxes, except where conduit entry is specified by the FACP manufacturer.
6. Conduit shall be 3/4 inch minimum, unless specifically shown otherwise or required by FACP manufacturer.

### B. Wire:

1. Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than stranded #18 AWG THHN or equal for Initiating Device Circuits and Signaling Line Circuits, and stranded #12 AWG THHN or equal for Notification Appliance Circuits. Minimum voltage on 24 VDC Notification Appliance Circuits shall be 20 VDC.
2. No wiring other than detector and alarm circuits shall be permitted in fire alarm conduits. No detector wiring shall be mixed with alarm circuit wiring or any other functional wiring without the use of approved shielded cable. Wiring splices are to be avoided to the extent possible, and if needed, they must be made only in junction boxes and shall be crimp connected. Transposing or changing color-coding of wires shall not be permitted.
3. All telephone wiring shall use building standard data cabling or shall be twisted, shielded, jacketed pair when run with other wiring. Minimum wire gauge shall be #22 AWG.
4. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.
5. Wiring used for the multiplex communication circuit (SLC) shall support a minimum wiring distance of 10,000 feet.
6. All field wiring shall be electrically supervised for open circuit and ground fault.
7. The Fire Alarm Control Panel shall be capable of t-tapping Class B (NFPA Style 4) Signaling Line Circuits (SLCs).
8. Each cable terminated shall be tagged and labeled. Ideal brand (or equivalent) shall be used.

### C. Terminal Boxes, Junction Boxes and Cabinets:

1. All boxes and cabinets shall be UL listed for their use and purpose.
2. Exact locations and sizes of all back boxes and conduit runs shall be verified with the equipment supplier prior to rough-in.

- D. Initiating circuits shall be arranged to serve like categories (manual, smoke, waterflow). Mixed category circuitry shall not be permitted except on signaling line circuits connected to intelligent reporting devices.
- E. The Fire Alarm Control Panel shall be connected to a separate dedicated branch circuit, maximum 20 Amps, as shown on the plans.
- F. The Fire Alarm Control Panel cabinet shall be grounded securely to the electrical service grounding system.

## 2.5 MAIN FIRE ALARM CONTROL PANEL (FACP)

- A. The FACP shall be equivalent to an Edwards System Technology (EST) Model iO500 with cabinet and trim for surface mounting. The FACP shall contain a microprocessor based Central Processing Unit (CPU). The CPU shall communicate with and control the following types of equipment:
  - 1. Intelligent addressable smoke and heat (thermal) detectors,
  - 2. Addressable modules,
  - 3. Annunciators, and
  - 4. Other system controlled devices.
- B. The Fire Alarm Control Panel shall allow for loading or editing special instructions and operating sequences as required. The system is to be capable of on-site programming to accommodate facility expansion, building parameter changes, or changes as required by local codes. All software operations are to be stored in a non-volatile programmable memory within the FACP. Loss of primary and secondary power shall not erase the instructions stored in memory.
- C. The ability for selective input/output control functions based on ANDing, ORing, NOTing, timing and special coded operations is to also be incorporated in the resident software programming of the system.
- D. Operator Control
  - 1. Acknowledge Switch:
    - a. Activation of the control panel acknowledge switch in response to new alarms and/or troubles shall silence the local panel piezo electric signal and change the alarm and trouble LEDs from flashing mode to steady-ON mode. If multiple alarm or trouble conditions exist, depression of this switch shall advance the 80-character LCD display to the next alarm or trouble condition.
    - b. Depression of the Acknowledge switch shall also silence all remote annunciator piezo sounders.
  - 2. Alarm Silence Switch:
    - a. Activation of the alarm silence switch shall cause all programmed alarm notification appliances to return to the normal condition after an alarm condition. The selection of notification circuits and relays that are silenceable by this switch shall be fully field programmable within the confines of all applicable standards. The FACP software shall include silence inhibit and auto-silence timers.
  - 3. Alarm Activate (Drill) Switch:
    - a. The Alarm Activate switch shall activate all notification appliance circuits. The drill function shall latch until the panel is silenced or reset.
  - 4. System Reset Switch:

- a. Activation of the System Reset switch shall cause all electronically-latched initiating devices, appliances or software zones, as well as all associated output devices and circuits, to return to their normal condition.
  - 5. Lamp Test:
    - a. The Lamp Test switch shall activate all system LEDs and light each segment of the liquid crystal display.
- E. System Capacity and General Operation
  - 1. The FACP shall have the capacity for the total number of intelligent/addressable devices shown in the fire alarm plans plus 50% spare capacity or a minimum of 500 intelligent/addressable devices whichever is greater.
  - 2. The FACP shall include common alarm relay with Form C Contact.
  - 3. The FACP shall include Trouble, Supervisory and Programmable relays with Form A Contacts.
  - 4. The FACP shall include a full featured operator interface control and annunciation panel that shall include a backlit Liquid Crystal Display (LCD), individual color coded system status LEDs, and an alphanumeric keypad for the field programming and control of the fire alarm system.
  - 5. The system shall allow the programming of any input to activate any output or group of outputs. Systems which have limited programming (such as general alarm), have complicated programming (such as a diode matrix), or require a laptop personal computer are not considered suitable substitutes.
  - 6. The FACP shall provide the following features:
    - a. Drift compensation to extend detector accuracy over life. Drift compensation shall also include a smoothing feature, allowing transient noise signals to be filtered out.
    - b. Detector sensitivity test, meeting requirements of NFPA 72, Chapter 10.
    - c. Maintenance alert, with two levels (maintenance alert/maintenance urgent), to warn of excessive smoke detector dirt or dust accumulation.
    - d. Sensitivity levels for alarm, selected by detector. The system shall also include levels of prealarm, selected by detector, to indicate to maintenance personnel of impending alarms.
    - e. The ability to display or print system reports.
    - f. Alarm verification, with counters and a trouble indication to alert maintenance personnel when a detector enters verification 20 times.
    - g. PAS presignal, meeting NFPA 72 6.8.1.2 requirements.
    - h. Non-alarm points for general (non-fire) control.
    - i. Periodic detector test, conducted automatically by the software.
    - j. Self optimizing pre-alarm for advanced fire warning, which allows each detector to learn its particular environment and set its prealarm level to just above normal peaks.
    - k. Cross zoning with the capability of counting: two detectors in alarm, two software zones in alarm, or one smoke detector and one heat detector.
    - l. Control-by-time for non-fire operations, with holiday schedules.
    - m. Day/night automatic adjustment of detector sensitivity.
    - n. UL-1076 security monitor points.
    - o. The FACP shall be capable of coding notification circuits to meet NFPA 72 6.8.6.4 and California code requirements. Main panel notification circuits shall also support special two and three stage operations.
  - 7. Acknowledge keys shall also require privileged access to acknowledge points. If the Operator presses acknowledge key with insufficient access, an error message will be displayed. The points will scroll with each key press to view the points on the list, but the points will not get acknowledged in the database.

F. Central Microprocessor

1. The microprocessor shall be a state-of-the-art, high speed, RISC device and it shall communicate with, monitor and control all external interfaces. It shall include an EEPROM for system program storage, non-volatile memory for building-specific program storage, and a "watch dog" timer circuit to detect and report microprocessor failure.
2. The microprocessor shall contain and execute all control-by-event programs for specific action to be taken if an alarm condition is detected by the system. Control-by-event equations shall be held in non-volatile programmable memory, and shall not be lost even if system primary and secondary power failure occurs.
3. The microprocessor shall also provide a real-time clock for time annotation of system displays, printer, and history file. The time-of-day and date shall not be lost if system primary and secondary power supplies fail. The real time clock may also be used to control non-fire functions at programmed time-of-day, day-of-week, and day-of-year.
4. A special program check function shall be provided to detect common operator errors.
5. An auto-program (self-learn) function shall be provided to quickly install initial functions and make the system operational.
6. For flexibility and to ensure program validity, an optional Windows™ based program utility shall be available. This program shall be used to off-line program the system with batch upload/download. This program shall also have a verification utility which scans the program files, identifying possible errors. It shall also have the ability to compare old program files to new ones, identifying differences in the two files to allow complete testing of any system operating changes. This shall be in compliance with the NFPA 72 requirements for testing after system modification.

G. Display

1. The display shall provide all the controls and indicators used by the system operator and may also be used to program all system operational parameters.
2. The display shall include status information and custom alphanumeric labels for all intelligent detectors, addressable modules, internal panel circuits, and software zones.
3. The display shall include a back-lit alphanumeric Liquid Crystal Display (LCD). It shall also provide a Light-Emitting Diode (LED) for each of the following system parameters: Alarm, Supervisory, Disable/Test, Monitor, Trouble, Ground Fault, CPU Fail, Power, and Panel Silenced.
4. Panel shall have a keypad that has the capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Two different password levels shall be provided to prevent unauthorized system control or programming.
5. The display shall include the following operator control switches: ACKNOWLEDGE, ALARM SILENCE, ALARM ACTIVATE (drill), SYSTEM RESET, and LAMP TEST.

H. Signaling Line Circuits (SLC)

1. The system shall include SLCs. SLCs interface shall provide power to and communicate with intelligent detectors (ionization, photoelectric or heat) and intelligent modules (monitor or control). Each SLC shall be capable of NFPA 72 Style 6 or Style 4 (Class A or B) wiring. The system must be able to accommodate a minimum of 500 intelligent detector and modules without adding any components to the system.
2. The detector software shall meet NFPA 72 requirements and be certified by UL as a calibrated sensitivity test instrument.
3. The detector software shall allow manual or automatic sensitivity adjustment.
4. The system shall be meet current NFPA polling rate requirements, with the maximum number of devices connected to the FACP.

- I. Serial Interfaces
  - 1. The system shall include one serial EIA-232 interfaces. The interface shall be a means of connecting UL Listed Electronic Data Processing (EDP) peripherals.
  - 2. The EIA-232 interface shall be used to connect an UL-Listed 40 or 80 column printer. Printers which are not UL-Listed are not considered acceptable substitutes.
  - 3. The system shall include an EIA-485 port for the serial connection of optional annunciators and remote LCD displays.
  - 4. The EIA-485 interface may be used for network connection to a proprietary receiving unit.
  
- J. Notification Appliance Circuit (NAC)
  - 1. The FACP shall provide two fully supervised Class A or B (NFPA Style Z or Y) notification circuits.
  - 2. The notification circuit capacity shall be a minimum of 2.0 Amps at 24 VDC for circuit #1 and 1.0 Amps at 24 VDC for circuit #2.
  - 3. The module shall not affect other module circuits in any way during a short circuit condition.
  - 4. Each notification circuit shall have a custom label associated in programming to identify each circuits location.
  - 5. Each circuit shall be capable of, through system programming, deactivating upon depression of the signal silence switch.
  
- K. Control Relay Module
  - 1. The control relay module shall provide four Form-C auxiliary relay circuits rated at 5 A, 28 VDC. An expansion circuit board shall allow expansion to eight Form-C relays per module.
  - 2. Each relay circuit shall be capable of being activated (change in state) by any initiating device or from any combination of initiating devices.
  - 3. The relay module shall provide 8 green ON/OFF LEDs and 8 yellow LEDs (indicates disabled status of the relay).
  - 4. The module shall provide a momentary switch per relay circuit that may be used to manually turn the relay ON/OFF or to disable the relay.
  - 5. Each relay circuit shall include a custom label inserted to identify its location. Labels shall be computer generated.
  - 6. The control relay module shall be provided with removable wiring terminal blocks for ease of installation and service. The terminal blocks shall be UL listed for use with up to 12 AWG wire.
  
- L. Enclosures:
  - 1. The control panel shall be housed in a UL-listed cabinet suitable for surface or semi-flush mounting. The cabinet and front shall be corrosion protected, given a rust-resistant prime coat, and manufacturer's standard finish.
  - 2. The backbox and door shall be constructed of steel with provisions for electrical conduit connections into the sides and top.
  - 3. The door shall provide a key lock and shall include a glass or other transparent opening for viewing of all indicators.
  
- M. Power supply
  - 1. The main power supply for the Fire Alarm Control Panel shall provide 6.0 Amps of available power for the FACP and peripheral devices. Only if required, additional remote power supplies shall be provided to satisfy the system power requirements – these remote power supplies shall be installed as close as possible to the FACP and their location shall be marked on the ceiling panel.

2. Provisions shall be made to allow the audio-visual power to be increased as required by adding modular expansion audio-visual power supplies.
3. Positive-Temperature-Coefficient (PTC) thermistors, circuit breakers, or other over-current protection shall be provided on all power outputs. The power supply shall provide an integral battery charger for use with batteries up to 60 AH or may be used with an external battery and charger systems. Battery arrangements may be configured in the field.
4. The main power supply shall continuously monitor all field wires for earth ground conditions, and shall have the following LED indicators:
  - a. Ground Fault LED.
  - b. AC Power Fail LED.
5. The FACP shall receive 120 VAC power (as noted on the plans) via a 120VAC, 20A dedicated circuit.
6. The main power supply shall provide a battery charger using dual-rate charging techniques for fast battery recharge.
7. The main power supply shall provide a very low frequency sweep earth detect circuit, capable of detecting earth faults.
8. All circuits requiring system operating power shall be 24VDC and shall be individually fused at the FACP.

N. Remote, Booster Power Supply (BPS): The BPS is a device designed for use as either a remote 24 VDC power supply or used to power Notification Appliances.

1. The BPS shall offer up to 10.0 amps (6.0 amps continuous) of regulated 24 VDC power. It shall include an integral charger designed to charge 10.0 amp hour batteries and to support 24 hour standby.
2. The BPS shall provide either 2 Class A or 4 Class B circuits. Each circuit shall be independently configurable as either a Notification Appliance Circuit or a 24 volt power supply.
3. The BPS shall be mounted in a surface mount backbox.
4. The BPS shall include the ability to delay the AC fail delay per 2008 NFPA requirements.
5. The BPS include power limited circuitry, per 1995 UL standards.
6. BPS module(s) shall be used if determined necessary or appropriate for the final system layout.
7. Wherever a BPS is installed, addition ceiling mounted smoke detectors shall be installed, if necessary, to insure the BPS is within the coverage area of at least one smoke detector.

O. Specific System Operations

1. Smoke Detector Sensitivity Adjust: A means shall be provided for adjusting the sensitivity of any or all addressable intelligent detectors in the system. Sensitivity range shall be within the allowed UL window.
2. Alarm Verification: Each of the intelligent addressable smoke detectors in the system may be independently selected and enabled to be an alarm verified detector.
3. Point Disable: Any addressable device or conventional circuit in the system may be enabled or disabled through the system keypad.
4. Point Read: The system shall be able to display or print the following point status diagnostic functions:
  - a. Device status.
  - b. Device type.
  - c. Custom device label.
  - d. View analog detector values.
  - e. Device zone assignments.
  - f. All program parameters.

5. System Status Reports: Upon command from an operator of the system, a status report will be generated and printed, listing all system status.
  6. System History Recording and Reporting: The FACP shall contain a history buffer that will be capable of storing up to 1000 events.
  7. Each of these activations will be stored and time and date stamped with the actual time of the activation.
  8. The contents of the history buffer may be manually reviewed, one event at a time, or printed in its entirety.
  9. The history buffer shall use non-volatile memory.
- P. Automatic Detector Maintenance Alert:
1. The Fire Alarm Control Panel shall automatically interrogate each intelligent detector and shall analyze the detector responses over a period of time.
  2. If any intelligent detector in the system responds with a reading that is above or below normal limits, then the system will enter the trouble mode, and the particular detector will be annunciated on the system display, and printed on the optional printer.
  3. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.
- Q. Pre-Alarm Function: The system shall provide optional pre-alarm warning to give advance notice of a possible fire situation.
1. The Fire Alarm Control Panel shall automatically interrogate each intelligent detector and shall analyze the detector responses over a period of time.
  2. It shall be possible to activate any system output and send a specific pre-alarm message to the Digital Alarm Communicator Transmitter (DACT) during pre-alarm activation.
- R. Software Zones: The FACP shall provide software zones.
- S. The Fire Alarm Control Panel shall include a walk test feature. It shall include the ability to test initiating device circuits and notification appliance circuits from the field without returning to the panel to reset the system. Operation shall be as follows:
1. Alarming an initiating device shall activate programmed outputs, which are selected to participate in walk test, for 3 seconds.
  2. Introducing a trouble into the initiating device shall activate the programmed outputs for 8 seconds.
  3. All devices tested in walk test shall be recorded in the history buffer.
- T. Supervisory Operation
1. An alarm from a supervisory device shall cause the appropriate indication on the 80 character display, light a common supervisory LED, but will not cause the system to enter the trouble mode.
- U. Signal Silence Operation
1. The FACP shall have the ability to program each output circuit (notification, relay, speaker etc) to deactivate upon depression of the signal silence switch.
- V. Non-Alarm Input Operation
1. Any addressable initiating device in the system may be used as a non-alarm input to monitor normally-open contact type devices. Non-alarm functions shall be a lower priority than fire alarm initiating devices.

- W. Combo Zone
  - 1. A special code shall be available to allow waterflow and supervisory devices to share a common addressable module. Waterflow devices shall be wired in parallel, and supervisory devices shall be wired in series.

## 2.6 SYSTEM COMPONENTS

- A. Programmable Electronic Sounders/Strobe
  - 1. Electronic sounders shall operate on 24 VDC nominal.
  - 2. Electronic sounders shall provide a temporal code, with an output sound level of at least 90 dBA measured at 10 feet from the device.
  - 3. The maximum pulse duration shall be 2/10 of one second.
  - 4. Strobe intensity shall meet requirements of UL 1971.
  - 5. Flash rates shall meet the requirements of UL 1971.
  - 6. Shall be flush mounted in finished spaces and surface mounted in unfinished spaces.
- B. Strobe lights shall meet the requirements of the ADA, UL Standard 1971 and shall meet the following criteria:
  - 1. The maximum pulse duration shall be 2/10 of one second.
  - 2. Strobe intensity shall meet the requirements of UL 1971.
  - 3. The flash rate shall meet the requirements of UL 1971.
  - 4. Shall be flush mounted in finished spaces and surface mounted in unfinished spaces.
- C. Duct Smoke Detectors
  - 1. Duct smoke detectors shall be a 24 VDC type with visual alarm and power indicators, and a reset switch. Each detector shall be installed upon the composite supply/return air ducts(s), with properly sized air sampling tubes.
  - 2. Duct smoke detectors close dampers indicated; shut down air handlers indicated.
- D. Serially Connected Annunciator
  - 1. The annunciator shall communicate with the Fire Alarm Control Panel via a two wire EIA 485 (multi-drop) communications circuit.
  - 2. The annunciator shall require no more than four wires for operation. Annunciation shall include: intelligent addressable points, system software zones, control relays, and notification appliance circuits.
- E. Alphanumeric LCD Type Annunciator (FAAP):
  - 1. The alphanumeric display annunciator shall be a supervised, remotely located back-lit LCD display containing a minimum of eighty (80) characters for alarm annunciation in clear English text.
  - 2. FAAP functions shall match those of the FACP for alarm, supervisory, and trouble indications. Manual switching functions shall match those of the FACP including acknowledging, silencing, resetting, and testing.
  - 3. An audible indication of alarm shall be integral to the alphanumeric display.
  - 4. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of the FACP. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.
  - 5. The display shall be UL listed for fire alarm application.
  - 6. Total quantity and locations as shown on drawings.

- F. All interfaces and associated equipment are to be protected so that they will not be affected by voltage surges or line transients consistent with UL Standard 864.
- G. Digital Alarm Communicator Transmitter (DACT). The DACT is an interface for communicating digital information between a Fire Alarm Control Panel and a UL-Listed central station.
  - 1. The DACT shall be compact in size, mounting in a standard module position of the fire alarm control cabinet.
  - 2. The DACT shall include connections for dual telephone lines (with voltage detect), per UL/NFPA/FCC requirements. It shall include the ability for split reporting of panel events up to two different telephone numbers.
  - 3. The DACT shall be capable of transmitting events in at least two different formats. This ensures compatibility with existing and future transmission formats.
  - 4. Communication shall include vital system status such as:
    - a. Independent Zone (Alarm, trouble, non-alarm, supervisory).
    - b. Independent Addressable Device Status.
    - c. AC (Mains) Power Loss.
    - d. Low Battery and Earth Fault.
    - e. System Off Normal.
    - f. 12 and 24 Hour Test Signal.
    - g. Abnormal Test Signal (per UL requirements).
    - h. EIA-485 Communications Failure.
    - i. Phone Line Failure.
  - 5. The DACT shall support independent zone/point reporting when used in the Contact ID format.
  - 6. Provide for battery backup capabilities.
  - 7. Coordinate signal requirements with Owner's security/fire alarm vendor.
  - 8. Dialer shall be equal to EST #SA-DACT.
- H. Surge Protection: In accordance with IEEE C62.41.2 category B combination waveform and NFPA 70; except for optical fiber conductors.

## 2.7 SYSTEM COMPONENTS - ADDRESSABLE DEVICES:

- A. Addressable Devices – General
  - 1. Addressable devices which use a binary-coded address setting method, such as a DIP switch, are not an allowable substitute.
  - 2. Detectors shall be intelligent (analog) and addressable, and shall connect with two wires to the Fire Alarm Control Panel signaling line circuits.
  - 3. Addressable smoke and heat detectors shall provide dual alarm and power/polling LEDs.
    - a. Green LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the FACP, and Red LEDs flash indicating that an alarm condition has been detected.
    - b. An output connection shall also be provided in the base to connect an external remote alarm LED.
  - 4. The FACP shall permit detector sensitivity adjustment through field programming of the system. Sensitivity may be automatically adjusted by the panel on a time-of-day basis.
  - 5. Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7.

6. The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature.
  7. Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (ION, PHOTO, HEAT).
  8. Detectors will operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the FACP based on real-time measured values.
  9. Detectors shall store an internal identifying code that the control panel shall use to identify the type of device. LEDs shall be provided that shall flash under normal conditions, indicating that the device is operational and is in regular communication with the control panel.
- B. Addressable Pull Box (manual station)
1. Addressable pull boxes shall send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
  2. All operated stations shall have a positive, visual indication of operation and utilize a key type reset.
  3. Manual stations shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, minimum 1.75" high.
  4. Manual stations shall be equivalent to EST #SIGA-278.
- C. Intelligent Photoelectric Smoke Detectors
1. The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density. These detectors shall be of the solid state type and shall contain no radioactive materials.
  2. Intelligent photoelectric smoke detectors shall be equivalent to EST #SIGA-OSD, complete with base.
- D. Intelligent Ionization Smoke Detectors
1. Ionization detectors will be dual chamber: one chamber for sampling and one chamber for reference. They will be sealed against rear air flow entry. The sampling chambers shall gather analog information from its smoke sensing element and converts it to a digital signal. The detectors' internal microprocessor measures and analyzes these signals and compares the data to historical readings and time patterns (reference chamber) to make an alarm decision. It then sends the digital signal to the FACP.
  2. Intelligent ionization smoke detectors shall be equivalent to EST #SIGA-IS, complete with base.
- E. Duct Smoke Detectors
1. Photoelectric duct smoke detectors shall be a 24 VDC type with visual alarm and power indicators, and DPDT relay (as needed).
  2. Each detector shall be installed in the supply air ducts(s), with properly sized air sampling tubes. For maintenance purposes it shall be possible to clean the duct housing sampling tubes by accessing them through the duct housing from cover. Coordinate locations of all detectors with air supply and return grills and maintain 36" separation.
  3. Each duct detector shall be provided with a Test Station (EST #SD-TRK), including an alarm LED (EST #SIGA-LED). Test Stations and Alarm LED, shall be mounted such that

they are easily accessible and testing can be performed without using ladders or other tools. Label each Test Station, LED, and Duct Detector the name of the Mechanical Unit being monitored.

4. Duct smoke detectors shall be equivalent to an EST #SIGA-SD detector assembly, an EST #SD-TRK remote test station, and complete with sampling tubes and all accessories required for operation.

F. Intelligent Heat (thermal) Detectors

1. Heat detectors shall be intelligent addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute. It shall connect via two wires to the fire alarm control panel signaling line circuit.
2. Heat detectors shall be equivalent to EST #SIGA-HRS with base.

G. Universal Class A/B Module

1. Addressable monitor module shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLCs. Provide as required.
2. The monitor module shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box.
3. The IDC zone shall be suitable for Style D or Style B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
4. Modules shall be equivalent to Edwards SIGA-UM.

H. Signal Module

1. Signal Module, upon command from the loop controller, shall connect supervised Class B signal circuits to their respective power inputs. The function of this module shall be determined by a selectable code.
2. The monitor module shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box.
3. Modules shall be equivalent to EST #SIGA-CC1.

I. Synchronization Output Module

1. Synchronization Output Module shall be used as a signal power riser selector to provide synchronization of fire alarm signals across multiple zones.
2. The module shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box.
3. Modules shall be equivalent to EST #SIGA-CC1S.

J. Addressable Control Module

1. Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24 VDC powered, polarized audio/visual notification appliances. For fan shutdown and other auxiliary control functions, the control module may be set to operate as a dry contract relay..
2. The control module shall mount in a standard 4-inch square, 2-1/8 inch deep electrical box, or to a surface mounted backbox.
3. The control module NAC may be wired for Style Z or Style Y (Class A/B) with up to 1 amp of inductive A/V signal, or 2 amps of resistive A/V signal operation, or as a dry contact (Form-C) relay. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.

4. Audio/visual power shall be provided by a separate supervised power circuit from the main fire alarm control panel or from a supervised, UL listed remote power supply.
5. Addressable control module shall be equivalent to EST # SIGA-CR.

K. Isolator Module

1. Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC Class A or Class B branch. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC loop segment or branch. At least one isolator module shall be provided for each floor or protected zone of the building.
2. If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.
3. The isolator module shall not require any address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.
4. The isolator module shall mount in a standard 4-inch (101.6 mm) deep electrical box or in a surface mounted backbox. It shall provide a single LED that shall flash to indicate that the isolator is operational and shall flash red to indicate that a short circuit condition has been detected and isolated.
5. Modules shall be equivalent to EST #SIGA-IM.

## 2.8 CARBON MONOXIDE DETECTORS

A. General: Carbon monoxide detector listed for connection to fire-alarm system.

1. Mounting: Adapter plate for outlet box mounting.
2. Testable by introducing test carbon monoxide into the sensing cell.
3. Detector shall provide alarm contacts and trouble contacts.
4. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
5. Comply with UL 2075.
6. Locate, mount, and wire according to manufacturer's written instructions.
7. Provide means for addressable connection to fire-alarm system.
8. Test button simulates an alarm condition.

## 2.9 END OF LINE DEVICE

- A. Use end of line supervision devices for each Class B circuit. Locate these devices beyond the last circuit device in a separate box accessible and visible from floor level.

## 2.10 SPECIALTIES

A. Sleeves and Seals

1. Where piping passes through walls, floors or other building construction, which by code requires a fire rating, sleeves shall be used. Proposed protection shall be submitted for approval.

B. Escutcheon Plates

1. Where exposed piping passes through finish work, chrome plated or other finish acceptable to the Architect shall be installed. Split wall plates or escutcheons shall be installed to fit snugly around piping.

## 2.11 BATTERIES:

- A. The batteries shall be sealed Gel Cell type, 12 VDC nominal (number and size as required).
- B. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal 120 VAC power in a normal supervisory mode for a period of twenty-four (24) hours with 30 minutes of alarm operation at the end of this period. The system shall automatically transfer to the standby batteries upon power failure. All battery charging and recharging operations shall be automatic.
- C. The batteries are to be completely maintenance free. No liquids are required. Fluid level checks for refilling, spills, and leakage shall not be required.
- D. If necessary to meet standby requirements, external battery and charger systems may be used.

## PART 3 - EXECUTION

### 3.1 DESIGN CRITERIA

- A. Approximate fire alarm devices, alarm panel, horn, and detector arrangement is indicated on the drawings. Contractor is responsible for all required devices and locations.
- B. The fire alarm system supplier shall design the system and detection to activate the system. Conduit shall be laid out so as not to interfere with the installation of other piping, ductwork or luminaires.
- C. The entire fire alarm system is not shown on plans. The intent is to provide complete fire alarm systems as required. This Contractor shall be responsible for surveying the site and new construction, and prepare working drawings for the total system. Contractor shall provide additional devices as required.
- D. All conduit shall be run concealed wherever possible. Where conduit is run exposed, special notation on Contractor's drawings to that effect shall be evident and conspicuous on the drawings. Any conduit determined to be a problem shall be relocated at no cost to the Owner.

### 3.2 SYSTEM ALARM SEQUENCE OPERATION

- A. The system alarm operation upon alarm activation of any manual station, automatic detection device, or sprinkler flow switch is to be as follows:
  1. All audible/visual alarm notification appliances shall sound a continuous fire alarm signal until silenced by the alarm silence switch at the control panel.
  2. Alarm and control functions shall not operate until two, 2 zones have been initiated, thus providing "Cross Zoning" of two or more zones.
  3. All doors normally held open by door control devices shall release.

4. A supervised signal to notify the local fire department or an approved central station is to be activated. To accommodate and facilitate job site changes, the type of "city connection circuit" is to be on-site configurable to provide either a "reverse polarity", "local energy", "shunt" or "dry contact connection".
  5. The mechanical controls shall activate the air handling systems per life safety code, NFPA 101.
  6. An alarm is to be displayed on the panel display. The alarm LED shall flash on the control panel until the alarm has been acknowledged at the control panel. Once acknowledged, this same LED shall latch on. A subsequent alarm received from another zone after acknowledged shall flash the alarm LED on the control panel and the panel display shall show the new alarm information. A pulsing alarm tone shall occur within the control panel and the remote Fire Alarm Annunciator Panel until acknowledged.
- B. The system shall be capable of being actuated by manual stations located at each fire exit. The manual discharge station shall be of the electrical actuation type and be supervised at the control panel.
- C. If trouble develops, the system functions as follows:
1. A visual and audible indication is activated at the main control panel. The visual signal indicates the zone of the trouble condition. Local audible and visual alarms shall sound at the Fire Alarm Control Panel and all remote Fire Alarm Annunciator Panels.
  2. Removal of any plug-in detection device shall cause a trouble condition to exist.
  3. All doors normally held open by door control devices shall release upon AC power failure.

### 3.3 INSTALLATION

- A. Installation shall be in accordance with the NEC, NFPA 72, local and state codes, as shown on the drawings, and as recommended by the major equipment manufacturer.
- B. All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.
- C. All fire detection and alarm system devices, control panels and remote Fire Alarm Annunciator Panel shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.
- D. Manual pull stations shall be suitable for surface mounting or semiflush mounting as shown on the plans, and shall be installed not less than 42 inches (1067 mm), nor more than 48 inches (122 mm) above the finished floor.
- E. All ceiling mounted devices (i.e. smoke detectors) installed in accessible ceilings shall be centered in the ceiling tiles, and shall be connected with flexible metal conduit, as detailed on the drawings.
- F. Horn/strobes and strobes shall be installed at 80 inches or 6 inches below the finished ceiling, whichever is lower.
- G. All provisions of the contract documents, including Divisions 01, 21, 23, 26, 27 and 28 shall apply to the work specified in this section.

- H. The following work shall be performed by factory trained personnel (minimum NICET level II) in the direct employ of the Fire Alarm equipment supplier:
  - 1. Connections of all remote Fire Alarm Annunciator Panels and digital communicators.
  - 2. All connections at FACP.
  
- I. The following work shall be performed by factory trained personnel (minimum NICET level II) in the direct employ of the Fire Alarm equipment supplier:
  - 1. On the fire alarm control panel indicating the panel and circuit supplying power to the panel.
  - 2. Next to the circuit breaker inside the panel supplying power to the fire alarm control panel stating "FIRE ALARM CONTROL PANEL".

### 3.4 TEST

- A. The service of a competent, factory certified technician authorized by the manufacturer of the fire alarm equipment shall be provided to technically supervise and participate during all of the adjustments and tests for the system. All testing shall be in accordance with NFPA 72, Chapter 10.
  - 1. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
  - 2. Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.
  - 3. Open initiating device circuits and verify that the trouble signal actuates.
  - 4. Open and short signaling line circuits and verify that the trouble signal actuates.
  - 5. Open and short notification appliance circuits and verify that trouble signal actuates.
  - 6. Ground all circuits and verify response of trouble signals.
  - 7. Check presence and audibility of tone at all alarm notification devices in every area of coverage to comply to the IFC. Testing shall cover Emergency Responder Radio Coverage requirements per IFC Section 510.
  - 8. Check installation, supervision, and operation of all intelligent smoke detectors using the walk test.
  - 9. Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.
  - 10. When the system is equipped with optional features, the manufacturer's manual shall be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addresses or grouped devices, sensitivity monitoring, verification, functionality and the like.
  - 11. A copy of the completed test report, as required by NFPA 72, shall be submitted for approval before final inspection and before final acceptance will be made of the building. Copies of this report shall also be included in the O&M manuals provided upon completion of the job.

### 3.5 FINAL INSPECTION AND TESTING FOR COMPLETION

- A. Contractor to notify Owner seven (7) days prior to beginning completion inspections and tests.
- B. Notify all Authorities Having Jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
- C. At the final inspection, a factory trained representative of the manufacturer of the major equipment shall demonstrate that the system functions properly in every respect.

- D. Provide the services of the installer's supervisor or person with equivalent qualifications to supervise inspection and testing, correction, and adjustments (minimum NICET Level II Certified in Fire Alarm Systems).
- E. Prepare for testing by ensuring that all work is complete and correct; perform preliminary tests as required.
- F. Provide all tools, software, and supplies required to accomplish inspection and testing.
- G. Have at least one copy of operation and maintenance data, preliminary copy of project record drawings, input/output matrix, and operator instruction chart(s) available during demonstration.
- H. Perform inspection and testing in accordance with NFPA 72 and requirements of local authorities; document each inspection and test. If the fire alarm system fails after one test, the Owner and Fire Marshal shall be compensated for time used on subsequent testing until system finally passes.
- I. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.
- J. Locks and Keys: Deliver keys to Owner.
- K. Instruction Charts: Printed instruction chart for operators, showing steps to be taken when a signal is received (normal, alarm, supervisory, and trouble); easily readable from normal operator's station.
  1. Frame: Stainless steel or aluminum with polycarbonate or glass cover.
  2. Provide one for each control unit where operations are to be performed.
  3. Obtain approval of Owner prior to mounting; mount in location acceptable to Owner.
  4. Provide extra copy with operation and maintenance data submittal.
- L. These tests are in addition to those specified elsewhere. Manufacturers Representative shall test all equipment and demonstrate the operation of the system to the Owner or his Representative. After completion and test, a Representative of the manufacturer shall meet with the code enforcing authorities, demonstrate the system and obtain written approval of the local Fire Marshal.
- M. All wiring shall be checked and tested by the installing Contractor to insure that there are not grounds or shorts. The minimum allowance resistance between any two conductors or between conductors and ground is ten (10) megohms, as checked with a megger. This test shall be made after all conduit, wire, detector bases, etc., are installed.
- N. Tests shall demonstrate that the entire control system functions as intended. All circuits shall be tested, including automatic and manual activation equipment shut-down, alarm devices and battery backup. In addition, supervision of each circuit shall be tested.
- O. If test results indicate that design intent was not achieved, the Contractor shall determine and correct cause of failure. The Contractor shall then conduct a retest at no additional cost to the Owner. Contractor shall continue testing until all requirements have been met.

### 3.6 OWNER PERSONNEL INSTRUCTION

- A. The Fire Alarm contractor shall provide on-site training at the Owner's facility. Provide the following instruction to designated Owner personnel:

1. Hands-On Instruction: On-site, using operational system. Hands-on demonstrations of the operation of all system components and the entire system shall be provided.
- B. Administrative: One-hour session(s) covering issues necessary for non-technical administrative staff; classroom:
  1. Initial Training: 1 session pre-closeout.
- C. Basic Operation: One-hour sessions for attendant personnel, security officers, and engineering staff; combination of classroom and hands-on:
  1. Initial Training: 1 session pre-closeout.
- D. Furnish the services of instructors and teaching aids; have copies of operation and maintenance data available during instruction.
- E. The contractor and/or the systems manufacturer's representatives shall provide a typewritten "Sequence of Operation."

### 3.7 CERTIFICATION

- A. Upon completion of the installation and system tests, the authorized and certified factory representative of the manufacturer shall submit to the Architect a Letter of Certification that the system has been thoroughly tested and is fully operational. There shall be forms provided by the manufacturer, to indicate the system has been fully tested in supervision, trouble and alarm modes and is fully operational conforming to the letter of these Specifications.
- B. The Letter of Certification shall contain, but is not limited to, the following:
  1. A complete list of equipment installed and wired.
  2. Indication that all equipment is properly installed.
  3. Tests of individual zones as applicable.
  4. Technician's name and date of certification.
  5. A signed written statement substantially in the form as follows:
    - a. The undersigned, having been engaged as the Contractor for the Fire Alarm System in the construction of the \_\_\_\_\_ hereby confirms that the fire alarm equipment was installed in accordance with the wiring diagrams, instructions and directions provided to the undersigned by the Fire Alarm Manufacturer. It has been completely tested, demonstrated to the Owner or his Representative and accepted by the appropriate code enforcing Authority.

### 3.8 MAINTENANCE

- A. The Contractor shall provide two inspections of each system under this Contract during the one (1) year contract period. See 017700 Closeout Procedures, for additional requirements relating to maintenance service.
- B. Maintenance Service Contract: Provide maintenance of fire alarm systems and equipment for a period of 12 months commencing with Substantial Completion using factory-authorized service representatives. The first inspection shall be at the six (6) month interval after system acceptance and the second at the 12 month interval. Inspections shall include that the system is in proper working order. Inspection shall also include a complete checkout of the control and alarm system.

Documents certifying satisfactory system conditions shall be submitted to the Owner's Technical Representative upon completion of each inspection.

- C. Perform routine inspection, testing, and preventive maintenance required by NFPA 72, including:
  - 1. Maintenance of fire safety interface and supervisory devices connected to fire alarm system.
  - 2. Repairs required, unless due to improper use, accidents, or negligence beyond the control of the maintenance contractor.
  - 3. Record keeping required by NFPA 72 and authorities having jurisdiction.
  
- D. Provide trouble call-back service upon notification by Owner:
  - 1. Provide on-site response within 2 hours of notification.
  - 2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
  - 3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.
  
- E. Provide a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.
  
- F. Maintain a log at each fire alarm control unit, listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced. Submit duplicate of each log entry to Owner's representative upon completion of site visit.
  
- G. Comply with Owner's requirements for access to facility and security.

END OF SECTION

## SECTION 311000 - SITE CLEARING

### 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. Protecting existing vegetation to remain.
  - 2. Removing existing vegetation.
  - 3. Clearing and grubbing.
  - 4. Stripping and stockpiling topsoil.
  - 5. Stripping and stockpiling rock.
  - 6. Removing above- and below-grade site improvements.
  - 7. Disconnecting, capping or sealing, and abandoning site utilities in place.
  - 8. Temporary erosion and sedimentation control.

#### 1.3 DEFINITIONS

- A. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.
- B. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil," but in disturbed areas such as urban environments, the surface soil can be subsoil.
- C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow.
- D. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and indicated on Drawings.
- E. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

#### 1.4 MATERIAL OWNERSHIP

- A. Except for materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.
  - 1. Use sufficiently detailed photographs or video recordings.
  - 2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plant designated to remain.
- B. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

## 1.6 FIELD CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
  - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
  - 2. Provide alternate routes around closed or obstructed trafficways if required by Owner or authorities having jurisdiction.
- B. Salvageable Improvements: Carefully remove items indicated to be salvaged and provide to Owner.
- C. Utility Locator Service: Notify South Dakota 811 for area where Project is located before site clearing.
- D. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."
  - 1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Verify that trees, shrubs, and other vegetation to remain or to be relocated have been flagged and that protection zones have been identified and enclosed.
- C. Protect existing site improvements to remain from damage during construction.
  - 1. Restore damaged improvements to their original condition, as acceptable to Owner.

### 3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.
- B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
- C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
- D. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.

### 3.3 TREE AND PLANT PROTECTION

- A. Protect trees and plants remaining on-site according to plan requirements.
- B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations.

### 3.4 EXISTING UTILITIES

- A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.
  - 1. Arrange with utility companies to shut off indicated utilities.
- B. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others, unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Owner not less than two 2 days in advance of proposed utility interruptions.
  2. Do not proceed with utility interruptions without Owner's written permission.
- C. Excavate for and remove underground utilities indicated to be removed.

### 3.5 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
  2. Grind down stumps and remove roots larger than 3 inches (75 mm) in diameter, obstructions, and debris to a depth of 18 inches (450 mm) below exposed subgrade.
  3. Use only hand methods or air spade for grubbing within protection zones.
  4. Chip removed tree branches and dispose of off-site.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches (200 mm), and compact each layer to a density equal to adjacent original ground.

### 3.6 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.
- B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials, and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 311000

## SECTION 312000 - EARTH MOVING

### 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.
- B. 2015 South Dakota Department of Transportation (SDDOT) Standard Specifications for Roads and Bridge Construction.

#### 1.2 SUMMARY

##### A. Section Includes:

1. Excavating and filling for rough grading the Site.
2. Preparing subgrades for slabs-on-grade, walks, pavements, and turf and grasses.
3. Excavating and backfilling for buildings and structures.
4. Drainage course for concrete slabs-on-grade.
5. Subbase course for concrete walks and pavements.
6. Subsurface drainage backfill for walls and trenches.
7. Excavating and backfilling trenches for utilities and pits for buried utility structures.

##### B. Related Requirements:

1. Section 013200 "Construction Progress Documentation" and Section 013233 "Photographic Documentation" for recording preexcavation and earth-moving progress.
2. Section 033000 "Cast-in-Place Concrete" for granular course if placed over vapor retarder and beneath the slab-on-grade.
3. Section 311000 "Site Clearing" for site stripping, grubbing, stripping, and removal of above- and below-grade improvements and utilities.
4. Section 329200 "Turf and Grasses" for finish grading in turf and grass areas, including preparing and placing planting soil for turf areas.

#### 1.3 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 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.
  - 1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Engineer. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit changes in the Work.
  - 2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be without additional compensation.
- 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 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.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of the following manufactured products required:
  - 1. Geotextiles.
  - 2. Warning tapes.

#### 1.5 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.
  - 2. Laboratory compaction curve according to ASTM D 698.

- C. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth-moving operations. Submit before earth moving begins.

## 1.6 FIELD 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 Owner and authorities having jurisdiction.
  - 2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- B. Utility Locator Service: Notify South Dakota 811 for area where Project is located before beginning earth-moving operations.
- C. Do not commence earth-moving operations until temporary site fencing and erosion- and sedimentation-control measures specified are in place.
- D. Do not commence earth-moving operations until plant-protection measures are in place.
- E. The following practices are prohibited within protection zones:
  - 1. Storage of construction materials, debris, or excavated material.
  - 2. Parking vehicles or equipment.
  - 3. Foot traffic.
  - 4. Erection of sheds or structures.
  - 5. Impoundment of water.
  - 6. Excavation or other digging unless otherwise indicated.
  - 7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
- F. Do not direct vehicle or equipment exhaust towards protection zones.
- G. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

## PART 2 - PRODUCTS

### 2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

Soil/Fill Product	Allowable Use	Material Specifications
Non-Structural Fill (Landscape Fill)	Any area that will not have structures (typically landscape areas)	<ul style="list-style-type: none"> <li>• Soil classified as GM, GW, SM, SW, SC, CL, CH or ML according to the USCS.</li> <li>• Soil may not contain particles larger than 8 inches in median diameter.</li> <li>• Soil must be reasonably free from deleterious substances such as wood, metal, plastic, waste, etc.</li> <li>• Approved by Landscape Architect</li> </ul>
General Fill	<ul style="list-style-type: none"> <li>• Site grading outside the building footprint.</li> <li>• Utility backfill areas</li> <li>• Non-structural fill</li> <li>• Foundation wall backfill</li> </ul>	<ul style="list-style-type: none"> <li>• Soil classified as GP, GM, GW, GC, SP, SM, SW, SC, CL, or ML according to the USCS.</li> <li>• Site soil free of vegetation, organics and debris meets these requirements.</li> <li>• Soil may not contain particles larger than 6 inches in diameter.</li> <li>• Soil must contain less than 3% (by weight) of organics, vegetation, wood, metal, plastic, or other deleterious substances</li> </ul>
Engineered Fill	<ul style="list-style-type: none"> <li>• General fill</li> <li>• Over-excavations</li> <li>• Soil improvements</li> <li>• Retaining Wall backfill</li> </ul>	<ul style="list-style-type: none"> <li>• Soil classified as GP, GM, GW, SP, SM, or SP with at least 30 percent retained on a number 4 sieve and less than 15 percent passing a number 200 sieve.</li> <li>• Soil may not contain particles larger than 2 inches in diameter.</li> <li>• Soil must contain less than 3% (by weight) of organics, vegetation, wood, metal, plastic, or other deleterious substances</li> </ul>
Unsatisfactory Soil	NONE	<ul style="list-style-type: none"> <li>• Soil classified as MH, OH, CH, OL or PT may not be used at the project site</li> <li>• Any soil type not maintaining moisture contents within 5% of optimum during compaction is unsatisfactory soil that must be moisture conditioned prior to disposal and replacement</li> <li>• Any soil containing more than 3% (by weight) of organics, vegetation, wood, metal, plastic or other deleterious substances</li> </ul>

- A. Subbase Material: Per 2015 South Dakota Department of Transportation (SDDOT) Standard Specifications for Roads and Bridge Construction.
- B. Base Course: Per 2015 South Dakota Department of Transportation (SDDOT) Standard Specifications for Roads and Bridge Construction.
- C. Bedding Course: Per 2015 South Dakota Department of Transportation (SDDOT) Standard Specifications for Roads and Bridge Construction.
- D. Sand: ASTM C 33/C 33M; fine aggregate.

## 2.2 GEOTEXTILES

- A. Geotextiles and Impermeable Plastic Membrane per the South Dakota Department of Transportation 2015 Standard Specifications for Road and Bridges (AASHTO Designation: M 288).

## 2.3 ACCESSORIES

- A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility; 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 DEWATERING

- A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
- B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
  - 1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

### 3.3 EXPLOSIVES

- A. Explosives: Do not use explosives.

### 3.4 EXCAVATION, GENERAL

- A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
  - 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
  - 2. Remove rock to lines and grades indicated to permit installation of permanent construction.

### 3.5 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch (25 mm). If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
  - 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

### 3.6 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

### 3.7 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 inches (300 mm) higher than top of pipe or conduit unless otherwise indicated.
  - 1. Clearance: 12 inches (300 mm) each side of pipe or conduit.
- C. Trench Bottoms: Excavate trenches 4 inches (100 mm) deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.
  - 1. Excavate trenches 6 inches (150 mm) deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

### 3.8 SUBGRADE INSPECTION

- A. Notify Owner when excavations have reached required subgrade.
- B. If Engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
- C. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes) 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, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph (5 km/h).
  - 2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Engineer, and replace with compacted backfill or fill as directed.
- D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
- E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer, without additional compensation.

### 3.9 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi (17.2 MPa), may be used when approved by Architect.
  - 1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

### 3.10 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.

### 3.11 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, 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.

### 3.12 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. Backfill voids with satisfactory soil while removing shoring and bracing.

D. Initial Backfill:

1. Per 2015 South Dakota Department of Transportation (SDDOT) Standard Specifications for Roads and Bridge Construction.

E. Final Backfill:

1. Per 2015 South Dakota Department of Transportation (SDDOT) Standard Specifications for Roads and Bridge Construction.

F. Warning Tape: Install warning tape directly above utilities, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

### 3.13 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.

### 3.14 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 4 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 4 percent and is too wet to compact to specified dry unit weight.

### 3.15 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than 8 inches (200 mm) in loose depth for material compacted by heavy compaction equipment and not more than 4 inches (100 mm) in 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:

Application	Moisture Content (% of optimum)	Minimum Compaction
Subgrade	±4	95% ASTM D698
Below Foundations	±4	98% ASTM D698
Below Slabs-On-Grade	±4	97% ASTM D698
Base and Subbase Courses	±4	97% ASTM D698
Utility Trenches	±4	95% ASTM D698
Site Grading Fill	±4	95% ASTM D698
Foundation Backfill	±4	95% ASTM D698

### 3.16 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 elevations required to achieve indicated finish elevations, within the following subgrade tolerances:
  1. Turf or Unpaved Areas: Plus or minus 1 inch (25 mm).
  2. Walks: Plus or minus 1 inch (25 mm).
  3. Pavements: Plus or minus 1/2 inch (13 mm).
- C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch (13 mm) when tested with a 10-foot (3-m) straightedge.

### 3.17 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. Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
  - 2. Place base course material over subbase course.
  - 3. Shape subbase course and base course to required crown elevations and cross-slope grades.
  - 4. Place subbase course and base course 6 inches (150 mm) or less in compacted thickness in a single layer.
  - 5. Place subbase course and base course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.

### 3.18 FIELD QUALITY CONTROL

- A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:
  - 1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
  - 2. Determine that fill material classification and maximum lift thickness comply with requirements.
  - 3. Determine, during placement and compaction, that in-place density of compacted fill complies with requirements.
- B. Testing Agency: Engage a qualified geotechnical engineering testing agency to perform tests and inspections.
- C. 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.
- D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.
- E. 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. Structural Fill below Footing and Subgrade: 1 compaction test every 50 linear feet (lf) of footing trench or 2 tests per wall line, whichever results in the greater number of tests, per each 1-foot lift of fill.

2. Foundation/Retaining Wall Backfill: 1 compaction test every 100 lf of wall or 2 tests per wall line (interior and exterior sides), whichever results in the greater number of tests, per each 1' lift of backfill.
  3. Interior and Exterior Slab Subgrade: 1 compaction test every 1,000 square feet (sf) of slab area or 2 tests per slab area, whichever results in the greater number of tests, per 1-foot lift of fill.
  4. Pavements: 1 compaction test every 2,500 sf of pavement area on each subgrade, subbase, and base course layer as applicable, per each 1-foot lift of backfill.
  5. Trenches: 1 compaction test every 150 linear feet or 2 per trench, whichever results in the greater number of tests, per each 1-foot lift of backfill
- F. 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.

### 3.19 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 Architect; 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.

### 3.20 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 Owner's property.

END OF SECTION 312000

## SECTION 313700 – RIPRAP

### 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. Installation of Riprap.

#### B. Related Requirements:

- 1. Section 311000 "Site Clearing" for site stripping, grubbing, stripping, and removal of above- and below-grade improvements and utilities.
- 2. Section 312000 "Earth Moving" for excavation and subgrade preparation.

### 1.3 ACTION SUBMITTALS

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

## PART 2 - PRODUCTS

### 2.1 RIPRAP

- A. Comply with 2015 South Dakota Department of Transportation Standard Specifications for Roads and Bridge Construction, Section 700.
- B. Class F per 2015 South Dakota Department of Transportation Standard Specifications for Roads and Bridge Construction, Section 830.

### 2.2 FILTER (DRAINAGE) FABRIC

- A. Comply with 2015 South Dakota Department of Transportation Standard Specifications for Roads and Bridge Construction, Section 700.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with 2015 South Dakota Department of Transportation Standard Specifications for Roads and Bridge Construction, Section 700.

END OF SECTION 321730

## SECTION 321313 - CONCRETE PAVING

### 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.
- B. 2015 South Dakota Department of Transportation (SDDOT) Standard Specifications for Roads and Bridge Construction.

#### 1.2 SUMMARY

- A. Section Includes Concrete Paving Including the Following:
  - 1. Parking lots.
  - 2. Curbs and gutters.
  - 3. Walks.
- B. Related Requirements:
  - 1. Section 033000 "Cast-in-Place Concrete" for general building applications of concrete.
  - 2. Section 321373 "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within concrete paving and in joints between concrete paving and asphalt paving or adjacent construction.
  - 3. Section 321713 "Parking Bumpers."
  - 4. Section 321723 "Pavement Markings."
  - 5. Section 321726 "Tactile Warning Surfacing" for detectable warning mats.

#### 1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.
- B. W/C Ratio: The ratio by weight of water to cementitious materials.

#### 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference via teleconference.
  - 1. Review methods and procedures related to concrete paving, including but not limited to, the following:
    - a. Concrete mixture design.
    - b. Quality control of concrete materials and concrete paving construction practices.

## 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. 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.

## 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified ready-mix concrete manufacturer and testing agency.
- B. Material Certificates: For the following, from manufacturer:
  - 1. Cementitious materials.
  - 2. Steel reinforcement and reinforcement accessories.
  - 3. Fiber reinforcement.
  - 4. Admixtures.
  - 5. Curing compounds.
  - 6. Applied finish materials.
  - 7. Bonding agent or epoxy adhesive.
  - 8. Joint fillers.
- C. Field quality-control reports.

## 1.7 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. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
  - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

## 1.8 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on concrete paving mixtures.

## 1.9 FIELD CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

- B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
  - 1. When air temperature has fallen to or is expected to fall below 40 deg F (4.4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.
  - 2. Do not use frozen materials or materials containing ice or snow.
  - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.
  
- C. Hot-Weather Concrete Placement: Comply with ACI 301 (ACI 301M) and as follows when hot-weather conditions exist:
  - 1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
  - 2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
  - 3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

## PART 2 - PRODUCTS

### 2.1 CONCRETE, GENERAL

- A. Comply with 2015 South Dakota Department of Transportation Standard Specifications for Roads and Bridge Construction, Section 380.

### 2.2 FORMS

- A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.
  - 1. Use flexible or uniformly curved forms for curves with a radius of 100 feet (30.5 m) or less. Do not use notched and bent forms.
  
- B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

### 2.3 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420); deformed.

- B. Epoxy-Coated, Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60 (Grade 420) plain-steel bars.
- C. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded-wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:
  - 1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
- D. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.

#### 2.4 CONCRETE MATERIALS

- A. Cementitious Materials: Comply with 2015 South Dakota Department of Transportation Standard Specifications for Roads and Bridge Construction, Section 380.
- B. Aggregates: Comply with 2015 South Dakota Department of Transportation Standard Specifications for Roads and Bridge Construction, Section 380.
- C. Admixtures: Comply with 2015 South Dakota Department of Transportation Standard Specifications for Roads and Bridge Construction, Section 380.
- D. Water: Comply with 2015 South Dakota Department of Transportation Standard Specifications for Roads and Bridge Construction, Section 380.

#### 2.5 CURING MATERIALS

- A. Comply with 2015 South Dakota Department of Transportation Standard Specifications for Roads and Bridge Construction, Section 380.

#### 2.6 RELATED MATERIALS

- A. Joint Fillers: Comply with 2015 South Dakota Department of Transportation Standard Specifications for Roads and Bridge Construction, Section 380.
- B. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.

#### 2.7 CONCRETE MIXTURES

- A. Comply with 2015 South Dakota Department of Transportation Standard Specifications for Roads and Bridge Construction, Section 380.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.

## 2.8 CONCRETE MIXING

- A. Ready-Mixed Concrete: Comply with 2015 South Dakota Department of Transportation Standard Specifications for Roads and Bridge Construction, Section 380.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Remove loose material from compacted subbase surface immediately before placing concrete.

### 3.3 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.

### 3.4 STEEL REINFORCEMENT INSTALLATION

- A. Comply with 2015 South Dakota Department of Transportation Standard Specifications for Roads and Bridge Construction, Section 380.

### 3.5 JOINTS

- A. General: Comply with 2015 South Dakota Department of Transportation Standard Specifications for Roads and Bridge Construction, Section 380.
  1. When joining existing paving, place transverse joints to align with previously placed joints 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.
1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
  2. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
- 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.
1. Locate expansion joints at intervals of 50 feet (15.25 m) unless otherwise indicated.
  2. Extend joint fillers full width and depth of joint.
  3. Terminate joint filler not less than 1/2 inch (13 mm) or more than 1 inch (25 mm) below finished surface if joint sealant is indicated.
  4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
  5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
  6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
- 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.
1. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
    - a. Tolerance: Ensure that sawed joints are within 3 inches (75 mm) either way from centers of dowels.
  2. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
- E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch (6-mm) radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

### 3.6 CONCRETE PLACEMENT

- A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.

- B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.
- C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- D. Comply with ACI 301 (ACI 301M) requirements for measuring, mixing, transporting, and placing concrete.
- E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.
- F. 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.
- G. Consolidate concrete according to ACI 301 (ACI 301M) by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
  - 1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.
- H. Screed paving surface with a straightedge and strike off.
- I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.
- J. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.
- K. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.
  - 1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

### 3.7 FLOAT FINISHING

- A. General: Comply with 2015 South Dakota Department of Transportation Standard Specifications for Roads and Bridge Construction, Section 380.

### 3.8 DETECTABLE WARNING INSTALLATION

- A. Cast-in-Place Detectable Warning Tiles: Form blockouts in concrete for installation of tiles specified in Section 321726 "Tactile Warning Surfacing." Screed surface of concrete where tiles are to be installed to elevation, so that edges of installed tiles will be flush with surrounding

concrete paving. Embed tiles in fresh concrete to comply with Section 321726 "Tactile Warning Surfacing" immediately after screeding concrete surface.

### 3.9 CONCRETE PROTECTION AND CURING

- A. General: Comply with 2015 South Dakota Department of Transportation Standard Specifications for Roads and Bridge Construction, Section 380.
- B. Comply with ACI 306.1 for cold-weather protection.

### 3.10 PAVING TOLERANCES

- A. Comply with 2015 South Dakota Department of Transportation Standard Specifications for Roads and Bridge Construction, Section 380.

### 3.11 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Testing Services: Testing and inspecting of composite samples of fresh concrete obtained according to ASTM C 172/C 172M shall be performed according to the following requirements:
  - 1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. (76 cu. m) or fraction thereof of each concrete mixture placed each day.
  - 2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
  - 3. Air Content: ASTM C 231/C 231M, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
  - 4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when it is 80 deg F (27 deg C) and above, and one test for each composite sample.
  - 5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of five standard cylinder specimens for each composite sample.
  - 6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days, one specimen at 14 days, and two specimens at 28 days. One specimen will be a spare.
    - a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.
- C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).
- D. Test results shall be reported in writing to Owner, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency,

location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7-, 14-, and 28-day tests.

- E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
- F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
- G. Concrete paving will be considered defective if it does not pass tests and inspections.
- H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- I. Prepare test and inspection reports.

### 3.12 REPAIR 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. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.
- C. 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.
- D. 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 321313

## SECTION 321373 - CONCRETE PAVING JOINT SEALANTS

### 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.
- B. 2015 South Dakota Department of Transportation (SDDOT) Standard Specifications for Roads and Bridge Construction.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Joint sealants.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Paving-Joint-Sealant Schedule: Include the following information:
  - 1. Joint-sealant application, joint location, and designation.
  - 2. Joint-sealant manufacturer and product name.
  - 3. Joint-sealant formulation.
  - 4. Joint-sealant color.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of joint sealant and accessory.

#### 1.5 FIELD 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.
  - 2. When joint substrates are wet.
  - 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
  - 4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

## PART 2 - PRODUCTS

### 2.1 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. Comply with 2015 South Dakota Department of Transportation Standard Specifications for Roads and Bridge Construction, Section 380.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine joints 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.

### 3.2 PREPARATION

- A. Surface Cleaning of Joints: Before installing joint sealants, clean out joints immediately to comply with joint-sealant manufacturer's written instructions.
  - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
- B. Joint Priming: Prime joint substrates where indicated or 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.

### 3.3 INSTALLATION OF JOINT SEALANTS

- A. Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.
- B. Comply with 2015 South Dakota Department of Transportation Standard Specifications for Roads and Bridge Construction, Section 380.

### 3.4 CLEANING AND PROTECTION

- A. Clean off excess joint sealant as the Work progresses, by methods and with cleaning materials approved in writing by joint-sealant manufacturers.
- B. 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 and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

### 3.5 PAVING-JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Joints within concrete paving.
  - 1. Joint Location:
    - a. Expansion and isolation joints in concrete paving.
    - b. Contraction joints in concrete paving.
    - c. Other joints as indicated.

END OF SECTION 321373

## SECTION 321713 – PARKING BUMPERS

### 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 concrete wheel stops.

#### 1.3 ACTION SUBMITTALS

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

#### 1.4 PARKING BUMPERS

- A. Concrete Wheel Stops: Precast, steel-reinforced, air-entrained concrete, 4000-psi (27.6-MPa) minimum compressive strength, manufacturer's standard height and width. Provide chamfered corners, transverse drainage slots on underside, and a minimum of two factory-formed or -drilled vertical holes through wheel stop for anchoring to substrate.
  - 1. Surface Appearance: Free of pockets, sand streaks, honeycombs, and other obvious defects. Corners shall be uniform, straight, and sharp.
  - 2. Surface Sealer: Manufacturer's standard salt-resistant, clear sealer, applied at precasting location.
  - 3. Mounting Hardware: 24-inch long #4 rebar anchor pins.

### PART 2 - EXECUTION

#### 2.1 EXAMINATION

- A. Verify that pavement is in suitable condition to begin installation according to manufacturer's written instructions.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 2.2 INSTALLATION

- A. Install wheel stops according to manufacturer's written instructions unless otherwise indicated.

- B. Securely anchor wheel stops to pavement with rebar pins in each preformed vertical hole in wheel stop as recommended in writing by manufacturer. Recess head of rebar beneath top of wheel stop.

END OF SECTION 321713

## SECTION 321723 - PAVEMENT MARKINGS

### 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 painted markings applied to concrete pavement.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include technical data and tested physical and performance properties.

#### 1.4 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 (4.4 deg C) for alkyd materials or 55 deg F (12.8 deg C) for water-based materials, and not exceeding 95 deg F (35 deg C).

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design", the ABA standards of the Federal agency having jurisdiction, and, ICC A117.1.

#### 2.2 PAVEMENT-MARKING PAINT

- A. Pavement-Marking Paint: Alkyd-resin type, lead and chromate free, ready mixed, complying with AASHTO M 248, **Type S**; colors complying with FS TT-P-1952.
  - 1. Color: White, Yellow, and Blue as indicated.

## 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 Engineer.
- B. Sweep and clean surface to eliminate loose material and dust.
  - 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 stencil. Apply paint so that it cannot run beneath stencil.

### 3.3 PROTECTING AND CLEANING

- A. Protect pavement markings from damage and wear during remainder of construction period.
- B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 321723

## SECTION 321726 - TACTILE WARNING SURFACING

### 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. Cast-in-place detectable warning tiles.

- B. Related Requirements:

- 1. Section 321313 "Concrete Paving" for concrete walkways serving as substrates for tactile warning surfacing.

#### 1.3 ACTION SUBMITTALS

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

#### 1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For tactile warning surfacing, to include in maintenance manuals.

#### 1.5 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of tactile warning surfaces 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 and wear.
- b. Separation or delamination of materials and components.

- 2. Warranty Period: Five years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 TACTILE WARNING SURFACING, GENERAL

- A. Accessibility Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1 for tactile warning surfaces.
  - 1. For tactile warning surfaces composed of multiple units, provide units that when installed provide consistent side-to-side and end-to-end dome spacing that complies with requirements.
- B. Source Limitations: Obtain each type of tactile warning surfacing from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

### 2.2 DETECTABLE WARNING TILES

- A. Cast-in-Place Detectable Warning Tiles: Accessible truncated-dome detectable warning tiles, with replaceable surface, configured for setting flush in new concrete walkway surfaces, with slip-resistant surface treatment on domes and field of tile.
  - 1. Material: Molded glass- and carbon-fiber-reinforced polyester.
  - 2. Color: As selected by Owner from manufacturer's full line.
  - 3. Shapes and Sizes:
    - a. Rectangular panel, 24 inches by the full sidewalk width as indicated on the project plans.
  - 4. Dome Spacing and Configuration: Manufacturer's standard compliant spacing pattern.
  - 5. Mounting:
    - a. Replaceable detectable warning tile wet-set into freshly poured concrete and surface-fastened to permanently embedded anchors.

### 2.3 ACCESSORIES

- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of tactile warning surfaces, noncorrosive and compatible with each material joined, and complying with the following:
  - 1. Furnish Type 316 stainless-steel fasteners for exterior use.
  - 2. Fastener Heads: For nonstructural connections, use flathead or oval countersunk screws and bolts with tamper-resistant heads, colored to match tile.
- B. Adhesive: As recommended by manufacturer for adhering tactile warning surfacing unit to pavement.
- C. Sealant: As recommended by manufacturer for sealing perimeter of tactile warning surfacing unit.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that pavement is in suitable condition to begin installation according to manufacturer's written instructions. Verify that installation of tactile warning surfacing will comply with accessibility requirements upon completion.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION OF TACTILE WARNING SURFACING

- A. General: Prepare substrate and install tactile warning surfacing according to manufacturer's written instructions unless otherwise indicated.
- B. Place tactile warning surfacing units in dimensions and orientation indicated. Comply with location requirements of AASHTO MP 12.

### 3.3 INSTALLATION OF DETECTABLE WARNING TILES

- A. Removable Cast-in-Place Detectable Warning Tiles:
  - 1. Concrete Paving Installation: Comply with installation requirements in Section 321313 "Concrete Paving." Mix, place, and finish concrete to conditions complying with detectable warning tile manufacturer's written requirements for satisfactory embedment of removable tile.
  - 2. Set each detectable warning tile accurately and firmly in place with embedding anchors and fasteners attached, and firmly seat tile back in wet concrete by tamping or vibrating. If necessary, temporarily apply weight to tiles to ensure full contact with concrete.
  - 3. Set surface of tile flush with surrounding concrete and adjacent tiles, with variations between tiles and between concrete and tiles not exceeding plus or minus 1/8 inch (3 mm) from flush.
  - 4. Protect exposed surfaces of installed tiles from contact with wet concrete. Complete finishing of concrete paving surrounding tiles. Remove concrete from tile surfaces.
  - 5. Clean tiles using methods recommended in writing by manufacturer.

### 3.4 CLEANING AND PROTECTION

- A. Remove and replace tactile warning surfacing that is broken or damaged or does not comply with requirements in this Section. Remove in complete sections from joint to joint unless otherwise approved by Architect. Replace using tactile warning surfacing installation methods acceptable to Architect.
- B. Protect tactile warning surfacing from damage and maintain free of stains, discoloration, dirt, and other foreign material.

END OF SECTION 321726

## SECTION 321730 – PARKING SIGNAGE

### 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.
- B. Manual of Uniform Traffic Control Devices, Latest Edition.

### 1.2 SUMMARY

- A. Section Includes:
  - 1. Exterior, non-illuminated, single-sheet-type, post and panel traffic and parking signs.

### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
  - 1. Material Descriptions.
  - 2. Material Dimensions.
  - 3. Letter and Spacing Dimensions.
  - 4. Finishes.

### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protect signs and posts from dirt and damage.

## PART 2 - PRODUCTS

### 2.1 PARKING SIGNS

- A. Traffic Control Signs: Provide standard traffic control signs that conform to the requirements of the state highway standards, and U.S. Manual on Uniform Traffic Control Devices (MUTCD) standards.
  - 1. “STOP” Signs: Furnish 30 inches (762 mm) x 30 inches (762 mm), red/white reflective aluminum, octagon shaped, MUTCD compliant signs.
  - 2. Other highway-type signs as indicated on Drawings.
- B. Accessible Parking Signs: Provide reflective aluminum signs in widths, heights, text, colors and symbols that comply with federal-specific requirements.

## 2.2 SIGN SUPPORTS

- A. Provide support post systems engineered specifically for sign use as indicated on the project plans.
- B. General: Fabricate support posts to lengths required for mounting sign panels at heights indicated.

## 2.3 ACCESSORIES

- A. Sign Attachments: Use fasteners fabricated from metals that are noncorrosive to sign material and support posts.
- B. Accessible Sign Post Bollards: Provide sign post bollard with size and color as indicated on the drawings.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install Traffic Control Signs at the side of the drives, 6 feet (1800 mm) horizontally from edge of pavement to edge of sign.
- B. Install an Accessible Parking Sign at each designated parking space, centered at the end of the space.
- C. Sign Support Posts:
  - 1. Cast Concrete Base: Embed sign support posts into ready-mix concrete with a minimum 28-day compressive strength of 3000 psi.
    - a. In firm, undisturbed or compacted soil, drill or use a post-hole digger to excavate holes for each post to minimum diameter recommended by sign manufacturer.
    - b. Excavate hole depth approximately 39 inches (990 mm) below finished grade.
    - c. Protect portion of support posts above ground from concrete splatter. Place concrete and vibrate or tamp for consolidation. Check posts for vertical alignment and hold in position until concrete has achieved its initial set.

### 3.2 SIGN PANELS

- A. Unless otherwise indicated, install signs vertically, with 7 feet (2100 mm) vertical measurement from the bottom of the sign to the near edge of the pavement.

### 3.3 CLEANING

- A. At completion of installation, clean soiled surfaces of sign units according to manufacturer's written instructions.

END OF SECTION 321730

## SECTION 329113 - SOIL PREPARATION

### 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 planting soils specified by composition of the mixes.
- B. Related Requirements:
  - 1. Section 311000 "Site Clearing" for topsoil stripping and stockpiling.
  - 2. Section 329200 "Turf and Grasses" for placing planting soil for turf and grasses.

#### 1.3 ALLOWANCES

- A. AAPFCO: Association of American Plant Food Control Officials.
- B. Backfill: The earth used to replace or the act of replacing earth in an excavation. This can be amended or unamended soil as indicated.
- C. CEC: Cation exchange capacity.
- D. Compost: The product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth.
- E. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.
- F. Imported Soil: Soil that is transported to Project site for use.
- G. Layered Soil Assembly: A designed series of planting soils, layered on each other, that together produce an environment for plant growth.
- H. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.
- I. NAPT: North American Proficiency Testing Program. An SSSA program to assist soil-, plant-, and water-testing laboratories through interlaboratory sample exchanges and statistical evaluation of analytical data.

- J. Organic Matter: The total of organic materials in soil exclusive of undecayed plant and animal tissues, their partial decomposition products, and the soil biomass; also called "humus" or "soil organic matter."
- K. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- L. RCRA Metals: Hazardous metals identified by the EPA under the Resource Conservation and Recovery Act.
- M. SSSA: Soil Science Society of America.
- N. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- O. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.
- P. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.
- Q. USCC: U.S. Composting Council.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include recommendations for application and use.
  - 2. Include test data substantiating that products comply with requirements.
  - 3. Include sieve analyses for aggregate materials.
  - 4. Material Certificates: For each type of imported soil before delivery to the site, according to the following:
    - a. Manufacturer's qualified testing agency's certified analysis of standard products.
    - b. Analysis of fertilizers, by a qualified testing agency, made according to AAPFCO methods for testing and labeling and according to AAPFCO's SUIP #25.
    - c. Analysis of nonstandard materials, by a qualified testing agency, made according to SSSA methods, where applicable.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and compliance with state and Federal laws if applicable.
- B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Do not move or handle materials when they are wet or frozen.
4. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

## PART 2 - PRODUCTS

### 2.1 PLANTING SOILS SPECIFIED BY COMPOSITION

- A. Planting-Soil Type: Existing, on-site surface soil, with the duff layer, if any, retained; and stockpiled on-site; modified to produce viable planting soil. Blend existing, on-site surface soil with the following soil amendments and fertilizers in the following quantities to produce planting soil:
- B. Planting-Soil Type: Imported, naturally formed soil from off-site sources according to USDA textures; and modified to produce viable planting soil.
  1. Sources: Take imported, unamended soil from sources that are naturally well-drained sites where topsoil occurs at least 4 inches (100 mm) deep, not from agricultural land, bogs, or marshes; and that do not contain undesirable organisms; disease-causing plant pathogens; or obnoxious weeds and invasive plants including, but not limited to, quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and bromegrass.

### 2.2 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
- B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent elemental sulfur, with a minimum of 99 percent passing through a No. 6 (3.35-mm) sieve and a maximum of 10 percent passing through a No. 40 (0.425-mm) sieve.
- C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
- D. Perlite: Horticultural perlite, soil amendment grade.
- E. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through a No. 50 (0.30-mm) sieve.
- F. Sand: Clean, washed, natural or manufactured, free of toxic materials, and according to ASTM C 33/C 33M.

## 2.3 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter produced by composting feedstock, and bearing USCC's "Seal of Testing Assurance," and as follows:
  - 1. Feedstock: Limited to leaves.
  - 2. Reaction: pH of 5.5 to 8.
  - 3. Soluble-Salt Concentration: Less than 4 dS/m.
  - 4. Moisture Content: 35 to 55 percent by weight.
  - 5. Organic-Matter Content: 30 to 40 percent of dry weight.
  - 6. Particle Size: Minimum of 98 percent passing through a 2-inch (50-mm) sieve.
- B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture with 100 percent passing through a 1/2-inch (13-mm) sieve, a pH of 3.4 to 4.8, and a soluble-salt content measured by electrical conductivity of maximum 5 dS/m.
- C. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture with 100 percent passing through a 1/2-inch (13-mm) sieve, a pH of 6 to 7.5, a soluble-salt content measured by electrical conductivity of maximum 5 dS/m, having a water-absorbing capacity of 1100 to 2000 percent, and containing no sand.
- D. Wood Derivatives: Shredded and composted, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture and free of chips, stones, sticks, soil, or toxic materials.
- E. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, debris, and material harmful to plant growth.

## 2.4 FERTILIZERS

- A. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 50 percent available phosphoric acid.
- B. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
  - 1. Composition: 1 lb/1000 sq. ft. (0.5 kg/100 sq. m) of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
- C. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
  - 1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. Place planting soil and fertilizers according to requirements in other Specification Sections.
- B. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in planting soil.
- C. Proceed with placement only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION OF UNAMENDED, ON-SITE SOIL BEFORE AMENDING

- A. Excavation: Excavate soil from designated area(s) to a depth of 6 inches (150 mm) and stockpile until amended.
- B. Unacceptable Materials: Clean soil of concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
- C. Unsuitable Materials: Clean soil to contain a maximum of 8 percent by dry weight of stones, roots, plants, sod, clay lumps, and pockets of coarse sand.
- D. Screening: Pass unamended soil through a 2-inch (50-mm) sieve to remove large materials.

### 3.3 PLACING AND MIXING PLANTING SOIL OVER EXPOSED SUBGRADE

- A. General: Apply and mix unamended soil with amendments on-site to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Subgrade Preparation: Till subgrade to a minimum depth of 6 inches (150 mm). Remove stones larger than 1-1/2 inches (38 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
- C. Mixing: Spread unamended soil to total depth of 6 inches (150 mm), but not less than required to meet finish grades after mixing with amendments and natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.
  - 1. Amendments: Apply soil amendments, except compost, and fertilizer, if required, evenly on surface, and thoroughly blend them with unamended soil to produce planting soil.
    - a. Mix lime and sulfur with dry soil before mixing fertilizer.
    - b. Mix fertilizer with planting soil no more than seven days before planting.
  - 2. Lifts: Apply and mix unamended soil and amendments in lifts not exceeding 8 inches (200 mm) in loose depth for material compacted by compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.

- D. Compaction: Compact each blended lift of planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D 698 and tested in-place except where a different compaction value is indicated on Drawings.
- E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

### 3.4 APPLYING COMPOST TO SURFACE OF PLANTING SOIL

- A. Application: Apply compost component of planting-soil mix 4 inches (100 mm) of compost to surface of in-place planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Finish Grading: Grade surface to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

### 3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform the following tests:
  - 1. Compaction: Test planting-soil compaction after placing each lift and at completion using a densitometer or soil-compaction meter calibrated to a reference test value based on laboratory testing according to ASTM D 698. Space tests at no less than one for each 1000 sq. ft. of in-place soil or part thereof.
- C. Soil will be considered defective if it does not pass tests.
- D. Prepare test reports.
- E. Label each sample and test report with the date, location keyed to a site plan or other location system, visible conditions when and where sample was taken, and sampling depth.

### 3.6 PROTECTION

- A. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:
  - 1. Storage of construction materials, debris, or excavated material.
  - 2. Parking vehicles or equipment.
  - 3. Vehicle traffic.
  - 4. Foot traffic.
  - 5. Erection of sheds or structures.
  - 6. Impoundment of water.
  - 7. Excavation or other digging unless otherwise indicated.

3.7 CLEANING

- A. Protect areas adjacent to planting-soil preparation and placement areas from contamination. Keep adjacent paving and construction clean and work area in an orderly condition.
- B. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owner's property unless otherwise indicated.
  - 1. Dispose of excess subsoil and unsuitable materials on-site where directed by Owner.

END OF SECTION 329113

## SECTION 330500 - COMMON WORK RESULTS FOR UTILITIES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Piping joining materials.
  - 2. Transition fittings.
  - 3. Dielectric fittings.
  - 4. Sleeves.
  - 5. Identification devices.
  - 6. Grout.
  - 7. Flowable fill.
  - 8. Piped utility demolition.
  - 9. Piping system common requirements.
  - 10. Equipment installation common requirements.
  - 11. Painting.
  - 12. Concrete bases.
  - 13. Metal supports and anchorages.

#### 1.3 DEFINITIONS

- A. Exposed Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions.
- B. Concealed 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.
- C. ABS: Acrylonitrile-butadiene-styrene plastic.
- D. CPVC: Chlorinated polyvinyl chloride plastic.
- E. PE: Polyethylene plastic.
- F. PVC: Polyvinyl chloride plastic.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
  - 1. Dielectric fittings.
  - 2. Identification devices.

#### 1.5 QUALITY ASSURANCE

- A. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

#### 1.6 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.

#### 1.7 COORDINATION

- A. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- B. Coordinate installation of identifying devices after completing covering and painting if devices are applied to surfaces.
- C. Coordinate size and location of concrete bases. Formwork, reinforcement, and concrete requirements are specified in Section 033000 "Cast-in-Place Concrete."

### PART 2 - PRODUCTS

#### 2.1 PIPING 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 (3.2-mm) maximum thickness, unless otherwise indicated.
    - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
  - 2. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, 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, BAgl, silver alloy for refrigerant piping, unless otherwise indicated.
- F. 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.
- G. Solvent Cements for Joining Plastic Piping:
  - 1. ABS Piping: ASTM D 2235.
  - 2. CPVC Piping: ASTM F 493.
  - 3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
  - 4. PVC to ABS Piping Transition: ASTM D 3138.
- H. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

## 2.2 TRANSITION FITTINGS

- A. Transition Fittings, General: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
- B. Transition Couplings NPS 1-1/2 (DN 40) and Smaller:
  - 1. Underground Piping: Manufactured piping coupling or specified piping system fitting.
  - 2. Aboveground Piping: Specified piping system fitting.
- C. AWWA Transition Couplings NPS 2 (DN 50) and Larger:
  - 1. Description: AWWA C219, metal sleeve-type coupling for underground pressure piping.
- D. Plastic-to-Metal Transition Fittings:
  - 1. Description: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint or threaded end.
- E. Plastic-to-Metal Transition Unions:
  - 1. Description: MSS SP-107, CPVC and PVC four-part union. Include brass threaded end, solvent-cement-joint plastic end, rubber O-ring, and union nut.
- F. Flexible Transition Couplings for Underground Nonpressure Drainage Piping:

1. Description: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

## 2.3 DIELECTRIC FITTINGS

- A. Dielectric Fittings, General: 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. Description: Factory fabricated, union, NPS 2 (DN 50) and smaller.
    - a. Pressure Rating: 150 psig (1035 kPa) minimum.
    - b. End Connections: Solder-joint copper alloy and threaded ferrous; threaded ferrous.
- C. Dielectric Flanges:
  1. Description: Factory-fabricated, bolted, companion-flange assembly, NPS 2-1/2 to NPS 4 (DN 65 to DN 100) and larger.
    - a. Pressure Rating: 150 psig (1035 kPa) minimum.
    - b. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric-Flange Kits:
  1. Description: Nonconducting materials for field assembly of companion flanges, NPS 2-1/2 (DN 65) and larger.
    - a. Pressure Rating: 150 psig (1035 kPa) minimum.
    - b. Gasket: Neoprene or phenolic.
    - c. Bolt Sleeves: Phenolic or polyethylene.
    - d. Washers: Phenolic with steel backing washers.
- E. Dielectric Couplings:
  1. Description: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining, NPS 3 (DN 80) and smaller.
    - a. Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
    - b. End Connections: Threaded.
- F. Dielectric Nipples:
  1. 12
  2. Description: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining.
    - a. Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
    - b. End Connections: Threaded or grooved.

## 2.4 SLEEVES

- A. Mechanical sleeve seals for pipe penetrations are specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- B. Galvanized-Steel Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
- C. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized, plain ends.
- D. Cast-Iron Sleeves: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- E. Molded PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe Sleeves: ASTM D 1785, Schedule 40.
- G. Molded PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

## 2.5 IDENTIFICATION DEVICES

- A. General: Products specified are for applications referenced in other utilities Sections. If more than single type is specified for listed applications, selection is Installer's option.
- B. Equipment Nameplates: Metal permanently fastened to equipment with data engraved or stamped.
  - 1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and essential data.
  - 2. Location: Accessible and visible.
- C. Stencils: Standard stencils prepared with letter sizes complying with recommendations in ASME A13.1. Minimum letter height is 1-1/4 inches (30 mm) for ducts, and 3/4 inch (20 mm) for access door signs and similar operational instructions.
  - 1. Material: [Fiberboard] [Brass].
  - 2. Stencil Paint: Exterior, oil-based, alkyd-gloss black enamel, unless otherwise indicated. Paint may be in pressurized spray-can form.
  - 3. Identification Paint: Exterior, oil-based, alkyd enamel in colors according to ASME A13.1, unless otherwise indicated.
- D. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, color-coded, pressure-sensitive-vinyl type with permanent adhesive.
- E. Pipes with OD, Including Insulation, Less Than 6 Inches (150 mm): Full-band pipe markers, extending 360 degrees around pipe at each location.
- F. Pipes with OD, Including Insulation, 6 Inches (150 mm) and Larger: Either full-band or strip-type pipe markers, at least three times letter height and of length required for label.

- G. Lettering: Manufacturer's standard preprinted captions as selected by Architect.
- H. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
  - 1. Arrows: Either integrally with piping system service lettering to accommodate both directions of flow, or as separate unit on each pipe marker to indicate direction of flow.
- I. Plastic Tape: Manufacturer's standard color-coded, pressure-sensitive, self-adhesive vinyl tape, at least 3 mils (0.08 mm) thick.
  - 1. Width: 1-1/2 inches (40 mm) on pipes with OD, including insulation, less than 6 inches (150 mm); 2-1/2 inches (65 mm) for larger pipes.
  - 2. Color: Comply with ASME A13.1, unless otherwise indicated.
- J. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) sequenced numbers. Include 5/32-inch (4-mm) hole for fastener.
  - 1. Material: 0.032-inch- (0.8-mm-) thick, polished brass.
  - 2. Size: 1-1/2 inches (40 mm) in diameter, unless otherwise indicated.
  - 3. Shape: As indicated for each piping system.
- K. Valve Tag Fasteners: Brass, wire-link or beaded chain; or brass S-hooks.
- L. Engraved Plastic-Laminate Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.
  - 1. Engraving: Engraver's standard letter style, of sizes and with terms to match equipment identification.
  - 2. Thickness: 1/16 inch (1.6 mm), unless otherwise indicated.
  - 3. Fasteners: Self-tapping, stainless-steel screws or contact-type permanent adhesive.
- M. Plastic Equipment Markers: Manufacturer's standard laminated plastic, in the following color codes:
  - 1. Green: Cooling equipment and components.
  - 2. Yellow: Heating equipment and components.
  - 3. Brown: Energy reclamation equipment and components.
  - 4. Blue: Equipment and components that do not meet criteria above.
  - 5. Hazardous Equipment: Use colors and designs recommended by ASME A13.1.
  - 6. Terminology: Match schedules as closely as possible. Include the following:
    - a. Name and plan number.
    - b. Equipment service.
    - c. Design capacity.
    - d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.

7. Size: 2-1/2 by 4 inches (65 by 100 mm) for control devices, dampers, and valves; 4-1/2 by 6 inches (115 by 150 mm) for equipment.
- N. Plasticized Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with mat finish suitable for writing.
1. Size: 3-1/4 by 5-5/8 inches (83 by 143 mm).
  2. Fasteners: Brass grommets and wire.
  3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.
- O. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in piped utility identification with corresponding designations indicated. Use numbers, letters, and terms indicated for proper identification, operation, and maintenance of piped utility systems and equipment.
1. Multiple Systems: Identify individual system number and service if multiple systems of same name are indicated.

## 2.6 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 (34.5-MPa), 28-day compressive strength.
  3. Packaging: Premixed and factory packaged.

## 2.7 FLOWABLE FILL

- A. Description: Low-strength-concrete, flowable-slurry mix.
1. Cement: ASTM C 150, Type I, portland.
  2. Density: 115- to 145-lb/cu. ft. (1840- to 2325-kg/cu. M).
  3. Aggregates: ASTM C 33, natural sand, fine.
  4. Admixture: ASTM C 618, fly-ash mineral.
  5. Water: Comply with ASTM C 94/C 94M.
  6. Strength: 100 to 200 psig (690 to 1380 kPa) at 28 days.

## PART 3 - EXECUTION

### 3.1 PIPED UTILITY DEMOLITION

- A. Refer to Section 024116 "Structure Demolition" for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove piped utility 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. Fill abandoned piping with flowable fill, and cap or plug piping with same or compatible piping material.
  3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
  4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make operational.
  5. 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 DIELECTRIC FITTING APPLICATIONS

- A. Dry Piping Systems: Connect piping of dissimilar metals with the following:
1. NPS 2 (DN 50) and Smaller: Dielectric unions.
  2. NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Dielectric flanges or dielectric flange kits.
- B. Wet Piping Systems: Connect piping of dissimilar metals with the following:
1. NPS 2 (DN 50) and Smaller: Dielectric couplings or dielectric nipples.
  2. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Dielectric nipples.
  3. NPS 2-1/2 to NPS 8 (DN 65 to DN 200): Dielectric nipples or dielectric flange kits.
  4. NPS 10 and NPS 12 (DN 250 and DN 300): Dielectric flange kits.

### 3.3 PIPING INSTALLATION

- A. Install piping according to the following requirements and utilities 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 the Coordination Drawings.
- 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 to permit valve servicing.
- E. Install piping at indicated slopes.
- F. Install piping free of sags and bends.
- G. Install fittings for changes in direction and branch connections.

- H. Select system components with pressure rating equal to or greater than system operating pressure.
- I. Permanent sleeves are not required for holes formed by removable PE sleeves.
- J. Install sleeves for pipes passing through concrete and masonry walls 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 equipment areas or other wet areas 2 inches (50 mm) above finished floor level.
  - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
    - a. PVC Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
    - b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.
- K. Verify final equipment locations for roughing-in.
- L. Refer to equipment specifications in other Sections for roughing-in requirements.

### 3.4 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and utilities 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. 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.
- E. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- 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. Grooved Joints: Assemble joints with grooved-end pipe coupling with coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

- H. 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 (0.20 percent maximum lead content) complying with ASTM B 32.
- I. 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.
- J. Pressure-Sealed Joints: Assemble joints for plain-end copper tube and mechanical pressure seal fitting with proprietary crimping tool to according to fitting manufacturer's written instructions.
- K. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
  - 2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 appendixes.
  - 3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
  - 4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
  - 5. PVC Nonpressure Piping: Join according to ASTM D 2855.
  - 6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.
- L. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
- M. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.
- N. Plastic Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
  - 1. Plain-End PE Pipe and Fittings: Use butt fusion.
  - 2. Plain-End PE Pipe and Socket Fittings: Use socket fusion.
- O. Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

### 3.5 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
  - 1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
  - 2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
  - 3. Install dielectric fittings at connections of dissimilar metal pipes.

### 3.6 EQUIPMENT INSTALLATION

- A. Install equipment level and plumb, unless otherwise indicated.

- B. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference with other installations. Extend grease fittings to an accessible location.
- C. Install equipment to allow right of way to piping systems installed at required slope.

### 3.7 IDENTIFICATION

- A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.
  - 1. Stenciled Markers: According to ASME A13.1.
  - 2. Plastic markers, with application systems. Install on insulation segment if required for hot noninsulated piping.
  - 3. Locate pipe markers on exposed piping according to the following:
    - a. Near each valve and control device.
    - b. Near each branch, excluding short takeoffs for equipment and terminal units. Mark each pipe at branch if flow pattern is not obvious.
    - c. Near locations where pipes pass through walls or floors or enter inaccessible enclosures.
    - d. At manholes and similar access points that permit view of concealed piping.
    - e. Near major equipment items and other points of origination and termination.
- B. Equipment: Install engraved plastic-laminate sign or equipment marker on or near each major item of equipment.
  - 1. Lettering Size: Minimum 1/4 inch (6.4 mm) high for name of unit if viewing distance is less than 24 inches (610 mm), 1/2 inch (13 mm) high for distances up to 72 inches (1800 mm), and proportionately larger lettering for greater distances. Provide secondary lettering two-thirds to three-fourths of size of principal lettering.
  - 2. Text of Signs: Provide name of identified unit. Include text to distinguish among multiple units, inform user of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
- C. Adjusting: Relocate identifying devices that become visually blocked by work of this or other Divisions.

### 3.8 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
  - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
  - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of 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 (20.7-MPa) minimum, 28-day compressive-strength concrete and reinforcement as specified in Section 033000 "Cast-in-Place Concrete."

### 3.9 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Section 055000 "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor piped utility materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

### 3.10 GROUTING

- A. Mix and install grout for equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION 330500

## SECTION 331416 – SITE WATER DISTRIBUTION PIPING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes water-distribution piping outside the building for water service and yard hydrant.

#### 1.3 ACTION SUBMITTALS

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

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of pipe and fitting.
- B. Field quality-control test reports.
- C. As-Built Plan

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

#### 1.6 QUALITY ASSURANCE

- A. Regulatory Requirements:
  - 1. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.
- B. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- C. NSF Compliance:
  - 1. Comply with NSF 14 for plastic potable-water-service piping.
  - 2. Comply with NSF 61 Annex G for materials for water-service piping and specialties for domestic water.

## PART 2 - PRODUCTS

### 2.1 PIPE AND FITTINGS

- A. Soft Copper Tube: ASTM B 88, Type K water tube, annealed temper.
  - 1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
- B. PVC, AWWA Pipe: AWWA C900, Class 150, with bell end with gasket, and with spigot end.
  - 1. Comply with UL 1285 for fire-service mains if indicated.
  - 2. PVC Fabricated Fittings: AWWA C900, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
  - 3. PVC Molded Fittings: AWWA C907, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
  - 4. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
    - a. Gaskets: AWWA C111, rubber.
  - 5. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
    - a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

### 2.2 JOINING MATERIALS

- A. Refer to Section 330500 "Common Work Results for Utilities" for commonly used joining materials.
- B. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

### 2.3 PIPING SPECIALTIES

- A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
- B. Tubular-Sleeve Pipe Couplings:

1. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners and with ends of same sizes as piping to be joined.
  - a. Standard: AWWA C219.

## 2.4 GATE VALVES

### A. AWWA, Cast-Iron Gate Valves:

1. Nonrising-Stem, Metal-Seated Gate Valves:
  - a. Description: Gray- or ductile-iron body and bonnet; with cast-iron or bronze double-disc gate, bronze gate rings, bronze stem, and stem nut.
    - 1) Standard: AWWA C500.
    - 2) Minimum Pressure Rating: 200 psig (1380 kPa).
    - 3) End Connections: Mechanical joint.
    - 4) Interior Coating: Complying with AWWA C550.

## 2.5 GATE VALVE ACCESSORIES AND SPECIALTIES

- A. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5 inches (125 mm) in diameter.
  1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.
- B. Indicator Posts: UL 789, FMG-approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.

## 2.6 SPECIALTIES

- A. Tools: Contractor to provide 2 sets of tools needed to operate all valves, valve box lids, and hydrants to the Contracting Officer.
- B. Transition Couplings: Center Rings -Ductile iron conforming to ASTM A536, Grade 65-45-12
  1. Fusion bonded epoxy coated
  2. Corrosion resistant allow bolts and nuts
  3. Color coded followers and gaskets
  4. Rated for minimum 200 psi working pressure
- C. Screened End for Drain Lines
  1. Schedule 40 galvanized steel conforming to ASTM A53.
  2. #4 mesh non-corrodible metal screen gasket type with flange union.

## 2.7 YARD HYDRANT

- A. Merrill Manufacturing 3/4 inch by 5 feet, no lead, stainless steel C-1000 hydrant (or approved equal).

## 2.8 WATER SERVICE PIPE

Pipe used in water service line construction shall be copper or polyethylene service pipe and shall conform to the following specifications:

- A. Copper Service Pipe shall be type K soft, conforming to Federal Specification WW-T-799 or ASTM B 88
- B. Polyethylene Service Pipe shall conform to the requirements of AWWA C901, "Polyethylene (PE) Pressure Pipe, Tubing and Fittings, one-half inch (1/2") through three inch (3") for water." PE Pipe shall be pressure tubing PE-3408 material conforming to Table 7 of said specification. Tubing shall be class 160 with a DR of 11 or class 200 with a DR of 9. If not specified, DR 9 shall be used.

## 2.9 CORPORATION STOPS

- A. Corporation stops shall be Mueller® 300 TM brass corporation stops with AWWA/CC taper thread inlet and Mueller 110® compression connection outlet or Ford F-1000 brass corporation stop with AWWA/CC taper thread inlet and Quick Joint compression connection outlet or Engineer approved equal.

## 2.10 COMPRESSION CONNECTIONS

- A. Ends of polyethylene tubing inserted in compression connections should be fitted with insert reinforcement.

## 2.11 SERVICE CLAMPS

- A. Service clamps, where required, shall be Mueller BR2S Series, or Ford 202 BS Series or Engineer approved equal, flat double stainless steel strap, bronze metal body, with Neoprene gaskets and AWWA tapered corporation stop threads. Service clamps for PVC shall provide full support around the circumference of the pipe, and have a bearing area of sufficient width along the axis of the pipe so that the pipe will not be distorted when tightened.

## 2.12 CURB STOPS

- A. Curb stop shall comply with AWWA C800, be Mueller® Series 300TM with Mueller 110™ compression connection or Engineer approved equal. For Type K Copper services, the curb stop shall be electrically insulated type.

## 2.13 CURB STOP BOXES

- A. Curb boxes for copper water services shall be cast iron, arch pattern base with a stationary rod. Curb boxes for one-inch (1") shall be Mueller Type H10334, or Engineer approved equal. All curb boxes shall have a fully extended length of at least six inches (6") more than the required length to ground surface. Curb boxes shall include a series 304 or 316 stainless steel stationary rod. The stationary rod shall be pinned to the curb stop. The stationary rod connection pin shall be either 304 or 316 stainless steel. The lid shall have a larger outer lid with a smaller internal plug.

## 2.14 TRACER WIRE

- A. Tracer wire for open cut trenching installations shall be Copperhead® SuperFlex 1030, #10 AWG copper-clad steel conductor with 30 mil HDPE insulation rated for direct bury use and 513 lb minimum break load, or Engineer approved equal. Insulation shall be blue in color. All wire connectors for splicing of tracer wire shall be rated for direct bury applications.

## 2.15 WARNING TAPE

- A. Warning tape shall be at least three inches (3") in width and shall have a minimum overall thickness of five (5) mils. Tape shall be impervious to all known alkalis, chemical reagents, and solvents found in soil. Color coding shall be in conformance with the APWA/ULCC Color Code. Warning tape shall have a maximum imprint length of thirty-six inches (36").

## PART 3 - EXECUTION

### 3.1 EARTHWORK

- A. Refer to Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

### 3.2 PIPING APPLICATIONS

- A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.
- B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.
- C. Do not use flanges or unions for underground piping.
- D. Flanges, unions, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.
- E. Underground water-service piping shall be soft copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.

### 3.3 VALVE APPLICATIONS

- A. General Application: Use mechanical-joint-end valves for NPS 3 and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FMG, nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 and smaller installation.

### 3.4 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. See Section 330500 "Common Work Results for Utilities" for piping-system common requirements.

### 3.5 PIPING INSTALLATION

- A. Install PVC, AWWA pipe according to ASTM F 645 and AWWA M23.
- B. Bury piping with depth of cover over top at least 5 feet with top at least 12 inches below level of maximum frost penetration.
- C. Extend water-service piping and connect to water-supply source and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.
  - 1. Terminate water-service piping at building wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building-water-piping systems when those systems are installed.
- D. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

### 3.6 JOINT CONSTRUCTION

- A. See Section 330500 "Common Work Results for Utilities" for basic piping joint construction.
- B. Make pipe joints according to the following:
  - 1. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139 and pipe manufacturer's written instructions.
  - 2. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure.

### 3.7 ANCHORAGE INSTALLATION

- A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
  - 1. Concrete thrust blocks.
  - 2. Locking mechanical joints.

3. Set-screw mechanical retainer glands.
4. Bolted flanged joints.
5. Heat-fused joints.
6. Pipe clamps and tie rods.

B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:

1. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.

C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

### 3.8 VALVE INSTALLATION

A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.

B. MSS Valves: Install as component of connected piping system.

### 3.9 CONNECTIONS

A. See Section 330500 "Common Work Results for Utilities" for piping connections to valves and equipment.

B. Connect water-distribution piping to well.

C. Connect water-distribution piping to interior domestic water piping.

D. Connect waste piping from concrete vault drains to sanitary sewerage system. See Section 221313 "Facility Sanitary Sewers" for connection to sanitary-sewer piping.

### 3.10 FIELD QUALITY CONTROL

A. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

B. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.

1. Increase pressure in 50-psig increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig. Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.

C. Prepare reports of testing activities.

### 3.11 IDENTIFICATION

- A. Install continuous underground detectable warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Section 312000 "Earth Moving."
- B. Permanently attach equipment nameplate or marker indicating plastic water-service piping, on main electrical meter panel. See Section 330500 "Common Work Results for Utilities" for identifying devices.

### 3.12 CLEANING

- A. Clean and disinfect water-distribution piping as follows:
  - 1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
  - 2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.
  - 3. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:
    - a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
    - b. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
    - c. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.
- B. Prepare reports of purging and disinfecting activities.

END OF SECTION 331416

## SECTION 333113 - SITE SANITARY SEWERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes sanitary sewer piping outside the building.

#### 1.3 ACTION SUBMITTALS

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

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of pipe and fitting.
- B. Field quality-control reports.
- C. As-Built Plan.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

#### 1.6 QUALITY ASSURANCE

- A. Regulatory Requirements:
  - 1. Comply with standards of authority having jurisdiction for septic systems including but not limited to materials, installation, and testing.
- B. Pumps, Piping, and other items shall bear label, stamp, or other markings of specified testing agency.
- C. South Dakota DENR Compliance:
  - 1. All installations shall follow the Administrative Rules of South Dakota, Chapter 74:53:01.

## PART 2 - PRODUCTS

### 2.1 PVC PIPE AND FITTINGS

#### A. PVC Type PSM Sewer Piping:

1. Pipe: ASTM D 3034, Schedule 40 PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM D 3034, PVC with bell ends.
3. Gaskets: ASTM F 477, elastomeric seals.

### 2.2 NONPRESSURE-TYPE TRANSITION COUPLINGS

#### A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling; for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and include corrosion-resistant-metal tension band and tightening mechanism on each end.

#### B. Sleeve Materials:

1. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
2. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

### 2.3 DUPLEX LIFT STATION

Duplex lift station shall include basin, pumps, controls and accessories as an assembly that is the product of a single manufacturer.

#### A. Basin

1. Zoeller QLS Prepackaged Duplex 48" x 108" lift station with Z-Rail system, stainless steel lifting cables or approved equal.
2. Basin shall include hinged aluminum lid with lockable hasp.
3. Design of pumps and floats shall allow for removal and maintenance without entering the basin.

#### B. Pumps

1. 2 EA Zoeller E153 0.5 HP, 60 HZ Pumps setup to run alternately and installed with an EZ-Pull disconnect or approved equal.

#### C. Controls, Floats, and Alarm

1. Duplex Electrical Alternator Control Panel mounted on backerboard or approved equal
2. Three float system (on, off, lag/high water)
3. Light beacon and audible alarm

### 2.4 MULTIZONE VALVE

#### A. Automatic Multizone Valve

1. Zoeller 4000 series, 4 zones operation or approved equal

2. A shut-off valve shall be supplied on the force main feeding the valve
3. Valve shall be installed in a 30" ID precast concrete or HDPE riser with lockable lid, insulated inside cover and insulation blanket.

## 2.5 SEPTIC TANK

- A. Comply with Administrative Rule of South Dakota 74:53:01: 23-24
  1. 1,500-gallon, 2 compartment precast concrete tank
    - a. Type II sulfate-resistant cement with a minimum strength rating of 3,000 psi
    - b. Shall meet the minimum static vertical load requirement of 1,000 psf when bedded and backfilled to the top of the tank.
    - c. Tanks shall be watertight by grouting with cement or corrosion-resistant sealants.
    - d. Accesses holes shall be 24" diameter, airtight, and equipped with a hasp and lock.
    - e. Tank inlet, outlet, and compartment openings shall be installed with a rubber boot and 4" Schedule 40 PVC to create a water tight seal.
    - f. The tank shall be installed with inlet and outlet sewer tees.

## PART 3 - EXECUTION

### 3.1 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

### 3.2 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details to indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.
- C. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- D. Install gravity-flow, nonpressure, drainage piping according to the following:
  1. Install piping pitched down in direction of flow, at minimum slope of 1 percent unless otherwise indicated.
  2. Install PVC Type PSM sewer piping according to ASTM D 2321 and ASTM F 1668.
- E. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

### 3.3 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure, drainage piping according to the following:
  - 1. Join PVC Type PSM sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
  - 2. Join dissimilar pipe materials with nonpressure-type, flexible couplings encased with slurry.
  
- B. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
  - 1. Use rigid couplings where required to join gravity-flow, nonpressure sewer piping of the same size and class unless otherwise indicated. Piping of the same material and class that differs in size will also require a rigid coupling that accommodates both pipe sizes.

### 3.4 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Install piping so cleanouts open in direction of flow in sewer pipe.
  
- B. Set cleanout frames and covers in earth in cast-in-place-concrete block. Set with tops 6 inches above surrounding grade or in proposed site concrete or asphalt pavement.

### 3.5 CONNECTIONS

- A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in "Sanitary Waste and Vent Piping."
  - 1. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

### 3.6 IDENTIFICATION

- A. Comply with requirements in Section 312000 "Earth Moving" for underground utility identification devices. Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.
  - 1. Use detectable warning tape over ferrous piping.
  - 2. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

### 3.7 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (600 mm) of backfill is in place, and again at completion of Project.
  - 1. Submit separate report for each system inspection.
  - 2. Defects requiring correction include the following:
    - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
    - d. Infiltration: Water leakage into piping.
    - e. Exfiltration: Water leakage from or around piping.
  - 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
  - 4. Reinspect and repeat procedure until results are satisfactory.
- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
  - 1. Do not enclose, cover, or put into service before inspection and approval.
  - 2. Test completed piping systems according to requirements of authorities having jurisdiction.
  - 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
  - 4. Submit separate report for each test.
  - 5. Air pressure testing shall follow ASTM C828 requirements for sewer air testing.
  - 6. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
    - a. Fill sewer piping with water. Test with pressure of at least 10-foot (3-m) head of water, and maintain such pressure without leakage for at least 15 minutes.
    - b. Close openings in system and fill with water.
    - c. Purge air and refill with water.
    - d. Disconnect water supply.
    - e. Test and inspect joints for leaks.
- C. Leaks and loss in test pressure constitute defects that must be repaired.
- D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

END OF SECTION 333113 - SITE SANITARY SEWERS

## SECTION 334100 - STORM UTILITY DRAINAGE PIPING

### 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. Pipe and fittings.

### 1.3 DEFINITIONS

### 1.4 ACTION SUBMITTALS

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

### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic pipe and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.

## PART 2 - PRODUCTS

### 2.1 STEEL PIPE AND FITTINGS

- A. Corrugated-Steel Pipe and Fittings: ASTM A 760/A 760M, Type I with fittings of similar form and construction as pipe.
  - 1. Special-Joint Bands: Corrugated steel with O-ring seals.
  - 2. Standard-Joint Bands: Corrugated steel.
  - 3. Coating: Aluminum.

## PART 3 - EXECUTION

### 3.1 EARTHWORK

- A. Excavation, trenching, and backfilling are specified in Section 312000 "Earth Moving."

### 3.2 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
- C. Install gravity-flow, nonpressure drainage piping according to the following:
  - 1. Install piping pitched down in direction of flow.
  - 2. Install piping with 12-inch (305-mm) minimum cover.
  - 3. Install corrugated steel piping according to ASTM A 798/A 798M.

### 3.3 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure drainage piping according to the following:
  - 1. Join corrugated steel sewer piping according to ASTM A 798/A 798M.

### 3.4 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after backfill is in place, and again at completion of Project.
  - 1. Submit separate reports for each system inspection.
  - 2. Defects requiring correction include the following:
    - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
    - d. Infiltration: Water leakage into piping.
    - e. Exfiltration: Water leakage from or around piping.
  - 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
  - 4. Reinspect and repeat procedure until results are satisfactory.

### 3.5 CLEANING

- A. Clean interior of piping of dirt and superfluous materials. Flush with water.

END OF SECTION 334100