

# Ravinia

515-555 Roger Williams Avenue  
Highland Park, IL 60035

## Imperial Realty Co.

4747 West Peterson Avenue  
Suite 200  
Chicago, IL 60646

### **Project Manual Issued for Bidding Volume 2**

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# FitzGerald

Associates Architects

912 West Lake Street Chicago Illinois 60607-1707

t 312 563 9100

f 312 563 1919

[www.fitzgeraldassociates.net](http://www.fitzgeraldassociates.net)

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## RAVINIA - PROJECT MANUAL

The following listed documents comprise the project manual for the project listed above. Where numerical sequence of sections is interrupted, such interruptions are intentional.

The complete Project Manual for this project consists of this entire Volume 1 and 2, which must not be separated for any reason. The Architect and Owner disclaim any responsibility for any assumptions made by a contractor or subcontractor who does not receive a complete Project Manual, including all sections listed in the Table of Contents.

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## SECTION 210513

### COMMON MOTOR REQUIREMENTS FOR FIRE SUPPRESSION EQUIPMENT

#### 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 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.

##### 1.3 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
  - 1. Motor controllers.
  - 2. Torque, speed, and horsepower requirements of the load.
  - 3. Ratings and characteristics of supply circuit and required control sequence.
  - 4. Ambient and environmental conditions of installation location.

#### PART 2 - PRODUCTS

##### 2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with requirements in this Section except when stricter requirements are specified in fire suppression equipment schedules or Sections.
- B. Comply with NEMA MG 1 unless otherwise indicated.

##### 2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet (1000 m) 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. Multispeed Motors: Separate winding for each speed.
- F. Rotor: Random-wound, squirrel cage.
- G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- H. Temperature Rise: Match insulation rating.
- I. Insulation: **Class F**
- J. Code Letter Designation:
  - 1. Motors **15 HP** and Larger: NEMA starting Code F or Code G.
- K. Enclosure Material: Cast iron for motor frame sizes **324T** and larger; rolled steel for motor frame sizes smaller than **324T**.

## 2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers:
  - 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. 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 210513

## SECTION 210517

### SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- A. Section Includes:
  - 1. Sleeves.
  - 2. Stack-sleeve fittings.
  - 3. Sleeve-seal systems.
  - 4. Sleeve-seal fittings.
  - 5. Grout.

##### 1.3 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 (0.6-mm)** minimum thickness; round tube closed with welded longitudinal joint.
- F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- G. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

## 2.2 STACK-SLEEVE 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:**
- B. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
  - 1. Smith, Jay R. Mfg. Co.
  - 2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
- C. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
  - 1. Underdeck Clamp: Clamping ring with setscrews.

## 2.3 SLEEVE-SEAL SYSTEMS

- 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:**
- B. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product 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 NBR** interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  - 2. Pressure Plates: **Carbon steel**.

3. Connecting Bolts and Nuts: **Carbon steel, with corrosion-resistant coating**, of length required to secure pressure plates to sealing elements.

## 2.4 SLEEVE-SEAL 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:**
- B. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
  1. Presealed Systems.
- C. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

## 2.5 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 (34.5-MPa)**, 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 (25-mm)** 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. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
  2. 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 (50 mm)** above finished floor level.
  3. 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 (6.4-mm)** 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 Division 07 Section "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 Division 07 Section "Penetration Firestopping."

### 3.2 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
1. Install fittings that are large enough to provide **1/4-inch (6.4-mm)** annular clear space between sleeve and pipe or pipe insulation.
  2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Division 07 Section "Sheet Metal Flashing and Trim."
  3. Install section of cast-iron soil pipe to extend sleeve to **2 inches (50 mm)** above finished floor level.
  4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
  5. Using grout, seal the space around outside of stack-sleeve fittings.
- B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

### 3.3 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.

### 3.4 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

### 3.5 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 (DN 150)**: **Galvanized-steel wall sleeves Galvanized-steel-pipe sleeves, Sleeve-seal fittings.**
    - b. Piping **NPS 6 (DN 150)** and Larger: **Galvanized-steel wall sleeves Galvanized-steel-pipe sleeves.**
  - 2. Exterior Concrete Walls below Grade:
    - a. Piping Smaller Than **NPS 6 (DN 150)**: **Galvanized-steel wall sleeves with sleeve-seal system Galvanized-steel-pipe sleeves with sleeve-seal system Sleeve-seal fittings.**
      - 1) Select sleeve size to allow for **1-inch (25-mm)** annular clear space between piping and sleeve for installing sleeve-seal system.
    - b. Piping **NPS 6 (DN 150)** and Larger: **Galvanized-steel wall sleeves with sleeve-seal system Galvanized-steel-pipe sleeves with sleeve-seal system.**



- 1) Select sleeve size to allow for **1-inch (25-mm)** annular clear space between piping and sleeve for installing sleeve-seal system.
3. Concrete Slabs-on-Grade:
  - a. Piping Smaller Than **NPS 6 (DN 150)**: **Galvanized-steel-pipe sleeves with sleeve-seal system Sleeve-seal fittings.**
    - 1) Select sleeve size to allow for **1-inch (25-mm)** annular clear space between piping and sleeve for installing sleeve-seal system.
  - b. Piping **NPS 6 (DN 150)** and **Galvanized-steel wall sleeves with sleeve-seal system Galvanized-steel-pipe sleeves with sleeve-seal system Galvanized-steel-pipe sleeves.**
    - 1) Select sleeve size to allow for **1-inch (25-mm)** annular clear space between piping and sleeve for installing sleeve-seal system.
4. Concrete Slabs above Grade:
  - a. Piping Smaller Than **NPS 6 (DN 150)** : **Galvanized-steel-pipe sleeves Sleeve-seal fittings sleeves .**
  - b. Piping **NPS 6 (DN 150)** and Larger: **Galvanized-steel-pipe Stack-sleeve fittings .**
5. Interior Partitions:
  - a. Piping Smaller Than **NPS 6 (DN 150)** : **Galvanized-steel-pipe sleeves .**
  - b. Piping **NPS 6 (DN 150)** and Larger: **Galvanized-steel-sheet sleeves.**

END OF SECTION 210517

## SECTION 210553

### IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

#### 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. Equipment labels.
  - 2. Warning signs and labels.
  - 3. Pipe labels.
  - 4. Stencils.
  - 5. Valve tags.
  - 6. Warning tags.

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment-Label Schedule: Include a listing of all equipment to be labeled and the proposed content for each label.
- D. Valve Schedules: Valve numbering scheme.

##### 1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each piping system to include in maintenance manuals.

## PART 2 - PRODUCTS

### 2.1 EQUIPMENT LABELS

#### A. Metal Labels for Equipment:

1. Material and Thickness: **Brass, 0.032 inch (0.8 mm) aluminum, 0.032 inch (0.8 mm) or anodized aluminum, 0.032 inch (0.8 mm)** thick, with predrilled holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than **2-1/2 by 3/4 inch (64 by 19 mm)**.
3. Minimum Letter Size: **1/4 inch (6.4 mm)** for name of units if viewing distance is less than **24 inches (600 mm)**, **1/2 inch (13 mm)** for viewing distances up to **72 inches (1830 mm)**, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel **rivets or self-tapping screws**.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

#### B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, **1/16 inch (1.6 mm) or 1/8 inch (3.2 mm)** thick, with predrilled holes for attachment hardware.
2. Maximum Temperature: Able to withstand temperatures up to **160 deg F (71 deg C)**.
3. Minimum Label Size: Length and width vary for required label content, but not less than **2-1/2 by 3/4 inch (64 by 19 mm)**.
4. Minimum Letter Size: **1/4 inch (6.4 mm)** for name of units if viewing distance is less than **24 inches (600 mm)**, **1/2 inch (13 mm)** for viewing distances up to **72 inches (1830 mm)**, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
5. Fasteners: Stainless-steel **rivets or self-tapping screws**.
6. 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 (A4)** 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. A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, **1/16 inch (1.6 mm)** thick, with predrilled holes for attachment hardware.
- B. Maximum Temperature: Able to withstand temperatures up to **160 deg F (71 deg C)**.
- C. Minimum Label Size: Length and width vary for required label content, but not less than **2-1/2 by 3/4 inch (64 by 19 mm)**.
- D. Minimum Letter Size: **1/4 inch (6.4 mm)** for name of units if viewing distance is less than **24 inches (600 mm)**, **1/2 inch (13 mm)** for viewing distances up to **72 inches (1830 mm)**, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- E. Fasteners: Stainless-steel **rivets or self-tapping screws**.
- F. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- G. Label Content: Include caution and warning information, plus emergency notification instructions.

## 2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to **partially cover** of **cover full** circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; pipe size; and an arrow indicating flow direction.
  - 1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
  - 2. Lettering Size: At least **1-1/2 inches (38 mm)** high.

- E. Pipe-Label Colors:
  - 1. Background Color: Red.
  - 2. Letter Color: White.

## 2.4 STENCILS

- A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of **3/4 inch (19 mm)** for access panel and door labels, equipment labels, and similar operational instructions.
  - 1. Stencil Material: **Aluminum or Brass.**
  - 2. Stencil Paint: Exterior, gloss, **alkyd enamel or acrylic enamel** black unless otherwise indicated. Paint may be in pressurized spray-can form.
  - 3. Identification Paint: Exterior, **alkyd enamel or acrylic enamel** in colors according to ASME A13.1 unless otherwise indicated.

## 2.5 VALVE TAGS

- A. Valve Tags: Stamped or engraved with **1/4-inch (6.4-mm)** letters for piping-system abbreviation and **1/2-inch (13-mm)** numbers.
  - 1. Tag Material: **Brass, 0.032 inch (0.8 mm), aluminum, 0.032 inch (0.8 mm), or anodized aluminum, 0.032 inch (0.8 mm)** thick, with predrilled holes for attachment hardware.
  - 2. Fasteners: Brass **beaded chain or S-hook.**
  - 3. Valve-Tag Color: Red.
  - 4. Letter Color: White.
- B. Valve Schedules: For each piping system, on **8-1/2-by-11-inch (A4)** bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
  - 1. Valve-tag schedule shall be included in operation and maintenance data.

## 2.6 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
  - 1. Size: **3 by 5-1/4 inches (75 by 133 mm) minimum**

2. Fasteners: **Brass grommet and wire** Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
3. Color: Yellow background with black lettering.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

### 3.2 LABEL INSTALLATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install or permanently fasten labels on each major item of mechanical equipment.
- D. Locate equipment labels where accessible and visible.
- E. Piping Color-Coding: Painting of piping is specified in Division 09 Section
- F. Stenciled Pipe-Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1 on each piping system.
  1. Identification Paint: Use for contrasting background.
  2. Stencil Paint: Use for pipe marking.
- G. 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. Where flow pattern is not obvious, mark each pipe at branch.
  3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
  4. At access doors, manholes, and similar access points that permit view of concealed piping.
  5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum intervals of **50 feet (15 m)** along each run. Reduce intervals to **25 feet (7.6 m)** in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

### 3.3 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems. List tagged valves in a valve-tag schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below:
  1. Valve-Tag Size and Shape:
    - a. Fire-Suppression Standpipe: **1-1/2 inches (38 mm) round or square**
    - b. Wet-Pipe Sprinkler System: **1-1/2 inches (38 mm), round or square**
    - c. Dry-Pipe Sprinkler System: **1-1/2 inches (38 mm) round or square**

### 3.4 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 210553

## SECTION 211200

### FIRE-SUPPRESSION STANDPIPES

#### 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. Pipes, fittings, and specialties.
2. Fire-protection valves.
3. Hose connections.
4. Hose stations.
5. Monitors.
6. Fire-department connections.
7. Alarm devices.
8. Manual control stations.
9. Control panels.
10. Pressure gages.

- B. Related Sections:

1. Division 21 Section "Wet-Pipe Sprinkler Systems" for wet-pipe sprinkler piping.
2. Division 21 Section **Fire Pumps** for fire pumps, pressure-maintenance pumps, and fire-pump controllers.

##### 1.3 DEFINITIONS

- A. Standard-Pressure Standpipe Piping: Fire-suppression standpipe piping designed to operate at working pressure **175 psig (1200 kPa)** maximum.

##### 1.4 SYSTEM DESCRIPTIONS

- A. Manual Wet-Type, Class I Standpipe System: Includes **NPS 2-1/2 (DN 65)** hose connections. Has small water supply to maintain water in standpipes. Piping is wet, but water must be pumped into standpipes to satisfy demand.

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## 1.5 PERFORMANCE REQUIREMENTS

- A. Standard-Pressure, Fire-Suppression Standpipe System Component: Listed for **175-psig (1200-kPa)** minimum working pressure.
- B. Fire-suppression standpipe design shall be approved by authorities having jurisdiction.
  - 1. Minimum residual pressure at each hose-connection outlet is as follows:
    - a. **NPS 2-1/2 (DN 65)** Hose Connections: **65 psig (690 kPa)**
  - 2. Maximum residual pressure at required flow at each hose-connection outlet is as follows unless otherwise indicated:
    - a. **NPS 2-1/2 (DN 65)** Hose Connections: **175 psig (1200 kPa)**

## 1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. **Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.**
- B. Shop Drawings: For fire-suppression standpipes. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Wiring Diagrams: For power, signal, and control wiring.

## 1.7 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Fire-suppression standpipes, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Domestic water piping.
  - 2. Sanitary, Waste and Vent piping.
  - 3. HVAC hydronic piping.
- B. Qualification Data: For qualified Installer **and professional engineer.**
- C. Approved Standpipe Drawings: Working plans, prepared according to NFPA 14, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- D. Welding certificates.
- E. Fire-hydrant flow test report.

- F. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 14. Include "Contractor's Material and Test Certificate for Aboveground Piping" and "Contractor's Material and Test Certificate for Underground Piping."
- G. Field quality-control reports.

## 1.8 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire-suppression standpipes specialties to include in emergency, operation, and maintenance manuals.

## 1.9 QUALITY ASSURANCE

- A. Installer Qualifications:

- 1. Installer's responsibilities include designing, fabricating, and installing fire-suppression standpipes and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
  - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

- B. 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.
- D. NFPA Standards: Fire-suppression standpipe equipment, specialties, accessories, installation, and testing shall comply with NFPA 14, "Installation of Standpipe and Hose Systems."

## 1.10 PROJECT CONDITIONS

- A. Interruption of Existing Fire-Suppression Standpipe Service: Do not interrupt fire-suppression standpipe service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary fire-suppression standpipe service according to requirements indicated:

## PART 2 - PRODUCTS

### 2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

### 2.2 STEEL PIPE AND FITTINGS

- A. Standard Weight, **Galvanized and Black** Steel Pipe: ASTM A 53/A 53M, **type**. Pipe ends may be factory or field formed to match joining method.
- B. Schedule 30, **Galvanized and Black** Steel Pipe: ASTM A 135; ASTM A 795/A 795M, ; or ASME B36.10M, wrought steel; with wall thickness not less than Schedule 30 and not more than Schedule 40. Pipe ends may be factory or field formed to match joining method.
- C. Thinwall **Galvanized and Black** Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, threadable, with wall thickness less than Schedule 30 and equal to or greater than Schedule 10. Pipe ends may be factory or field formed to match joining method.
- D. Schedule 10, Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, Schedule 10 in **NPS 5 (DN 125)** and smaller; and NFPA 13-specified wall thickness in **NPS 6 to NPS 10 (DN 150 to DN 250)**, plain end.
- E. Nonstandard OD, Thinwall Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, thinwall, with plain ends and wall thickness less than Schedule 10.
- F. Standard-Weight, **Galvanized and Black** Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, seamless steel pipe with threaded ends.
- G. [**Galvanized and Uncoated**, Steel Couplings: ASTM A 865, threaded.
- H. **Galvanized and Uncoated**, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- I. Malleable- or Ductile-Iron Unions: UL 860.
- J. Cast-Iron Flanges: ASME B16.1, Class 125.
- K. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
- L. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.
- M. Grooved-Joint, Steel-Pipe Appurtenances:

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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, Inc.
  - b. Corcoran Piping System Co.
  - c. National Fittings, Inc.
  - d. Shurjoint Piping Products.
  - e. Tyco Fire & Building Products LP.
  - f. Victaulic Company.
2. Pressure Rating: **175 psig (1200 kPa), 250 psig (1725 kPa), 300 psig (2070 kPa)** minimum.
3. **Galvanized and Uncoated**, Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

## 2.3 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: **ASTM B 88, Type L (ASTM B 88M, Type B) Type M** water tube, drawn temper.
- B. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.
- D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- E. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- F. Grooved-Joint, Copper-Tube Appurtenances:
  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, Inc.
    - b. Shurjoint Piping Products.
    - c. Victaulic Company.
  2. Grooved-End, Copper Fittings: **ASTM B 75 (ASTM B 75M)**, copper tube or ASTM B 584, bronze castings.

3. Grooved-End-Tube Couplings: To fit copper tube dimensions, with design similar to AWWA C606. Include ferrous housing sections, EPDM-rubber gasket suitable for hot and cold water, and bolts and nuts.

## 2.4 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: **AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free.**
  1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
  2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- D. 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.

## 2.5 LISTED FIRE-PROTECTION VALVES

- A. General Requirements:
  1. Valves shall be UL listed or FM approved.
  2. Minimum Pressure Rating for Standard-Pressure Piping: **175 psig (1200 kPa).**
  3. Minimum Pressure Rating for High-Pressure Piping: **250 psig (1725 kPa), 300 psig (2070 kPa).**
- B. Ball Valves:
  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, Inc.
    - b. Victaulic Company.
  2. Standard: UL 1091 except with ball instead of disc.
  3. Valves **NPS 1-1/2 (DN 40)** and Smaller: Bronze body with threaded ends.
  4. Valves **NPS 2 and NPS 2-1/2 (DN 50 and DN 65):** Bronze body with threaded ends or ductile-iron body with grooved ends.
  5. Valves **NPS 3 (DN 80):** Ductile-iron body with grooved ends.

C. Bronze Butterfly Valves:

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:**
2. Basis-of-Design Product: Subject to compliance with requirements, provide **product indicated on Drawings** or comparable product by one of the following:
  - a. Fivalco Inc.
  - b. Global Safety Products, Inc.
  - c. Milwaukee Valve Company.
3. Standard: UL 1091.
4. Pressure Rating: **175 psig (1200 kPa)**.
5. Body Material: Bronze.
6. End Connections: Threaded.

D. Iron Butterfly Valves:

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, Inc.
  - b. Fivalco Inc.
  - c. Global Safety Products, Inc.
  - d. Kennedy Valve; a division of McWane, Inc.
  - e. Milwaukee Valve Company.
  - f. NIBCO INC.
  - g. Pratt, Henry Company.
  - h. Shurjoint Piping Products.
  - i. Tyco Fire & Building Products LP.
  - j. Victaulic Company.
2. Standard: UL 1091.
3. Pressure Rating: **175 psig (1200 kPa)**.
4. Body Material: Cast or ductile iron.
5. Style: Lug or wafer.
6. End Connections: Grooved.

E. Check Valves:

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. AFAC Inc.
  - b. American Cast Iron Pipe Company; Waterous Company Subsidiary.

- c. Anvil International, Inc.
- d. Clow Valve Company; a division of McWane, Inc.
- e. Crane Co.; Crane Valve Group; Crane Valves.
- f. Crane Co.; Crane Valve Group; Jenkins Valves.
- g. Crane Co.; Crane Valve Group; Stockham Division.
- h. Fire-End & Croker Corporation.
- i. Fire Protection Products, Inc.
- j. Fivalco Inc.
- k. Globe Fire Sprinkler Corporation.
- l. Groeniger & Company.
- m. Kennedy Valve; a division of McWane, Inc.
- n. Matco-Norca.
- o. Metraflex, Inc.
- p. Milwaukee Valve Company.
- q. Mueller Co.; Water Products Division.
- r. NIBCO INC.
- s. Potter Roemer.
- t. Reliable Automatic Sprinkler Co., Inc.
- u. Shurjoint Piping Products.
- v. Tyco Fire & Building Products LP.
- w. United Brass Works, Inc.
- x. Venus Fire Protection Ltd.
- y. Victaulic Company.
- z. Viking Corporation.
- aa. Watts Water Technologies, Inc.

- 2. Standard: UL 312.
- 3. Pressure Rating: **250 psig (1725 kPa) minimum 300 psig (2070 kPa)**.
- 4. Type: Swing check.
- 5. Body Material: Cast iron.
- 6. End Connections: Flanged or grooved.

F. Bronze OS&Y Gate Valves:

- 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. Crane Co.; Crane Valve Group; Crane Valves.
  - b. Crane Co.; Crane Valve Group; Stockham Division.
  - c. Milwaukee Valve Company.
  - d. NIBCO INC.
  - e. United Brass Works, Inc.
- 2. Standard: UL 262.
- 3. Pressure Rating: **175 psig (1200 kPa)**.
- 4. Body Material: Bronze.
- 5. End Connections: Threaded.

G. Iron OS&Y Gate Valves:

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. American Cast Iron Pipe Company; Waterous Company Subsidiary.
  - b. American Valve, Inc.
  - c. Clow Valve Company; a division of McWane, Inc.
  - d. Crane Co.; Crane Valve Group; Crane Valves.
  - e. Crane Co.; Crane Valve Group; Jenkins Valves.
  - f. Crane Co.; Crane Valve Group; Stockham Division.
  - g. Hammond Valve.
  - h. Milwaukee Valve Company.
  - i. Mueller Co.; Water Products Division.
  - j. NIBCO INC.
  - k. Shurjoint Piping Products.
  - l. Tyco Fire & Building Products LP.
  - m. United Brass Works, Inc.
  - n. Watts Water Technologies, Inc.
2. Standard: UL 262.
3. Pressure Rating: **250 psig (1725 kPa) minimum 300 psig (2070 kPa).**
4. Body Material: Cast or ductile iron.
5. End Connections: Flanged or grooved.

H. Indicating-Type Butterfly Valves:

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, Inc.
  - b. Fivalco Inc.
  - c. Global Safety Products, Inc.
  - d. Kennedy Valve; a division of McWane, Inc.
  - e. Milwaukee Valve Company.
  - f. NIBCO INC.
  - g. Shurjoint Piping Products.
  - h. Tyco Fire & Building Products LP.
  - i. Victaulic Company.
2. Standard: UL 1091.
3. Pressure Rating: **175 psig (1200 kPa) minimum.**
4. Valves **NPS 2 (DN 50)** and Smaller:
  - a. Valve Type: Ball or butterfly.
  - b. Body Material: Bronze.



- c. End Connections: Threaded.
  - 5. Valves **NPS 2-1/2 (DN 65)** and Larger:
    - a. Valve Type: Butterfly.
    - b. Body Material: Cast or ductile iron.
    - c. End Connections: Flanged, grooved, or wafer.
  - 6. Valve Operation: Integral **electrical, 115-V ac, prewired, single-circuit, supervisory switch, electrical, 115-V ac, prewired, two-circuit, supervisory switch or visual** indicating device.
- I. NRS Gate Valves:
- 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. American Cast Iron Pipe Company; Waterous Company Subsidiary.
    - b. American Valve, Inc.
    - c. Clow Valve Company; a division of McWane, Inc.
    - d. Crane Co.; Crane Valve Group; Stockham Division.
    - e. Kennedy Valve; a division of McWane, Inc.
    - f. Mueller Co.; Water Products Division.
    - g. NIBCO INC.
    - h. Tyco Fire & Building Products LP.
  - 2. Standard: UL 262.
  - 3. Pressure Rating: **[250 psig (1725 kPa) minimum 300 psig (2070 kPa)]**.
  - 4. Body Material: Cast iron with indicator post flange.
  - 5. Stem: Nonrising.
  - 6. End Connections: Flanged or grooved.

## 2.6 TRIM AND DRAIN VALVES

### A. General Requirements:

- 1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
- 2. Pressure Rating: **175 psig (1200 kPa)** minimum.

### B. Angle Valves:

- 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. Fire Protection Products, Inc.
- b. United Brass Works, Inc.

C. Ball Valves:

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. Affiliated Distributors.
- b. Anvil International, Inc.
- c. Barnett.
- d. Conbraco Industries, Inc.; Apollo Valves.
- e. Fire-End & Croker Corporation.
- f. Fire Protection Products, Inc.
- g. Flowserve.
- h. FNW.
- i. Jomar International, Ltd.
- j. Kennedy Valve; a division of McWane, Inc.
- k. Kitz Corporation.
- l. Legend Valve.
- m. Metso Automation USA Inc.
- n. Milwaukee Valve Company.
- o. NIBCO INC.
- p. Potter Roemer.
- q. Red-White Valve Corporation.
- r. Southern Manufacturing Group.
- s. Stewart, M. A. and Sons Ltd.
- t. Tyco Fire & Building Products LP.
- u. Victaulic Company.
- v. Watts Water Technologies, Inc.

D. Globe Valves:

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. Fire Protection Products, Inc.
- b. United Brass Works, Inc.

E. Plug Valves:

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. Southern Manufacturing Group.

## 2.7 SPECIALTY VALVES

### A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating:
  - a. Standard-Pressure Piping Specialty Valves: **175 psig (1200 kPa)** minimum.
  - b. High-Pressure Piping Specialty Valves: **250 psig (1725 kPa) minimum 300 psig (2070 kPa)**.
3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

### B. Alarm Valves:

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. AFAC Inc.
  - b. Globe Fire Sprinkler Corporation.
  - c. Reliable Automatic Sprinkler Co., Inc.
  - d. Tyco Fire & Building Products LP.
  - e. Venus Fire Protection Ltd.
  - f. Victaulic Company.
  - g. Viking Corporation.
2. Standard: UL 193.
3. Design: For horizontal or vertical installation.
4. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, **retarding chamber**, and fill-line attachment with strainer.
5. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
6. Drip Cup Assembly: Pipe drain with check valve to main drain piping.

### C. Dry-Pipe Valves:

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. AFAC Inc.
  - b. Globe Fire Sprinkler Corporation.
  - c. Reliable Automatic Sprinkler Co., Inc.
  - d. Tyco Fire & Building Products LP.
  - e. Venus Fire Protection Ltd.
  - f. Victaulic Company.
  - g. Viking Corporation.
2. Standard: UL 260.
3. Design: Differential-pressure type.
4. Include UL 1486, quick-opening devices, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
5. Air-Pressure Maintenance Device:
- 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) AFAC Inc.
    - 2) Globe Fire Sprinkler Corporation.
    - 3) Reliable Automatic Sprinkler Co., Inc.
    - 4) Tyco Fire & Building Products LP.
    - 5) Venus Fire Protection Ltd.
    - 6) Victaulic Company.
    - 7) Viking Corporation.
  - b. Standard: UL 260.
  - c. Type: Automatic device to maintain minimum air pressure in piping.
  - d. Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure, strainer, pressure ratings with 14- to 60-psig (95- to 410-kPa) adjustable range, and 175-psig (1200-kPa) 300-psig (2070-kPa) outlet pressure.
6. Air Compressor:
- 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) Gast Manufacturing Inc.
    - 2) General Air Products, Inc.
    - 3) Viking Corporation.
  - b. Standard: UL's "Fire Protection Equipment Directory" listing.
  - c. Motor Horsepower: Fractional.
  - d. Power: 120-V ac, 60 Hz, single phase.

e. .

D. Automatic (Ball Drip) Drain Valves:

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. AFAC Inc.
  - b. Reliable Automatic Sprinkler Co., Inc.
  - c. Tyco Fire & Building Products LP.
2. Standard: UL 1726.
3. Pressure Rating: **175 psig (1200 kPa)** minimum.
4. Type: Automatic draining, ball check.
5. Size: **NPS 3/4 (DN 20)**.
6. End Connections: Threaded.

2.8 HOSE CONNECTIONS

A. Adjustable-Valve Hose Connections:

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. AFAC Inc.
  - b. Elkhart Brass Mfg. Company, Inc.
  - c. Fire-End & Croker Corporation.
  - d. Fire Protection Products, Inc.
  - e. GMR International Equipment Corporation.
  - f. Guardian Fire Equipment, Inc.
  - g. Potter Roemer.
  - h. Tyco Fire & Building Products LP.
  - i. Wilson & Cousins Inc.
  - j. Zurn Plumbing Products Group; Wilkins Water Control Products Division.
2. department threads.

2.9 FIRE-DEPARTMENT CONNECTIONS

A. Exposed-Type, Fire-Department Connection:

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. AFAC Inc.
  - b. Elkhart Brass Mfg. Company, Inc.
  - c. Fire-End & Croker Corporation.
  - d. Fire Protection Products, Inc.
  - e. GMR International Equipment Corporation.
  - f. Guardian Fire Equipment, Inc.
  - g. Tyco Fire & Building Products LP.
  - h. Wilson & Cousins Inc.
2. Standard: UL 405.
  3. Type: Exposed, projecting, for wall mounting.
  4. Pressure Rating: **175 psig (1200 kPa)** minimum.
  5. Body Material: Corrosion-resistant metal.
  6. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
  7. Caps: Brass, lugged type, with gasket and chain.
  8. Escutcheon Plate: Round, brass, wall type.
  9. Outlet: Back, with pipe threads.
  10. Number of Inlets: **Two or Three.**
  11. Escutcheon Plate Marking: Similar to "**AUTO SPKR & STANDPIPE, STANDPIPE.**"
  12. Finish: **Polished chrome plated** Outlet Size: **NPS 4 (DN 100)**

## 2.10 ALARM DEVICES

- A. Alarm-device types shall match piping and equipment connections.
- B. Water-Motor-Operated Alarm:
  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. Globe Fire Sprinkler Corporation.
    - b. Tyco Fire & Building Products LP.
    - c. Victaulic Company.
    - d. Viking Corporation.
  2. Standard: UL 753.
  3. Type: Mechanically operated, with Pelton wheel.
  4. Alarm Gong: Cast aluminum with red-enamel factory finish.
  5. Size: **10-inch (250-mm)** diameter.
  6. Components: Shaft length, bearings, and sleeve to suit wall construction.
  7. Inlet: **NPS 3/4 (DN 20).**
  8. Outlet: **NPS 1 (DN 25)** drain connection.

C. Electrically Operated Alarm Bell:

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. Fire-Lite Alarms, Inc.; a Honeywell company.
  - b. Notifier; a Honeywell company.
  - c. Potter Electric Signal Company.
2. Standard: UL 464.
3. Type: Vibrating, metal alarm bell.
4. Size: **6-inch (150-mm) minimum, 8-inch (200-mm) minimum, or 10-inch (250-mm) diameter.**
5. Finish: Red-enamel factory finish, suitable for outdoor use.

D. Water-Flow Indicators:

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. ADT Security Services, Inc.
  - b. McDonnell & Miller; ITT Industries.
  - c. Potter Electric Signal Company.
  - d. System Sensor; a Honeywell company.
  - e. Viking Corporation.
  - f. Watts Industries (Canada) Inc.
2. Standard: UL 346.
3. Water-Flow Detector: Electrically supervised.
4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
5. Type: Paddle operated.
6. Pressure Rating: **250 psig (1725 kPa).**
7. Design Installation: Horizontal or vertical.

E. Pressure Switches:

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. AFAC Inc.
  - b. Barksdale, Inc.
  - c. Detroit Switch, Inc.

- d. Potter Electric Signal Company.
  - e. System Sensor; a Honeywell company.
  - f. Tyco Fire & Building Products LP.
  - g. United Electric Controls Co.
  - h. Viking Corporation.
2. Standard: UL 346.
  3. Type: Electrically supervised water-flow switch with retard feature.
  4. Components: Single-pole, double-throw switch with normally closed contacts.
  5. Design Operation: Rising pressure signals water flow.

F. Valve Supervisory Switches:

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. Fire-Lite Alarms, Inc.; a Honeywell company.
  - b. Kennedy Valve; a division of McWane, Inc.
  - c. Potter Electric Signal Company.
  - d. System Sensor; a Honeywell company.
2. Standard: UL 346.
3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled valve is in other than fully open position.

## 2.11 MANUAL CONTROL STATIONS

- A. Description: UL listed or FM approved, hydraulic operation, with union, **NPS 1/2 (DN 15)** pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

## 2.12 CONTROL PANELS

- A. Description: Single-area, two-area, or single-area cross-zoned control panel as indicated, including NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves. Panels contain power supply; battery charger; standby batteries; field-wiring terminal strip; electrically supervised solenoid valves and polarized fire-alarm bell; lamp test facility; single-pole, double-throw auxiliary alarm contacts; and rectifier.
  1. Panels: UL listed and FM approved when used with thermal detectors and Class A detector circuit wiring. Electrical characteristics are 120-V ac, 60 Hz, with 24-V dc rechargeable batteries.



2. Manual Control Stations: Electric operation, metal enclosure, labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.
3. Manual Control Stations: Hydraulic operation, with union, **NPS 1/2 (DN 15)** pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

## 2.13 PRESSURE GAGES

- 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. AMETEK; U.S. Gauge Division.
  2. Ashcroft Inc.
  3. Brecco Corporation.
  4. WIKA Instrument Corporation.
- B. Standard: UL 393.
- C. Dial Size: **3-1/2- to 4-1/2-inch (90- to 115-mm)** diameter.
- D. Pressure Gage Range: **0 to 250 psig (0 to 1725 kPa) minimum 0 to 300 psig (0 to 2070 kPa).**
- E. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.
- F. Air System Piping Gage: Include **retard feature and** "AIR" or "AIR/WATER" label on dial face.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 14 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
- B. Report test results promptly and in writing.

### 3.2 EXAMINATION

- A. Examine roughing-in for hose connections and stations to verify actual locations of piping connections before installation.

- B. Examine walls and partitions for suitable thickness, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.3 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
  - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- B. Piping Standard: Comply with requirements in NFPA 14 for installation of fire-suppression standpipe piping.
- C. Install seismic restraints on piping. Comply with requirements in NFPA 13 for seismic-restraint device materials and installation.
- D. Install listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install drain valves on standpipes. Extend drain piping to outside of building.
- F. Install automatic (ball drip) drain valves to drain piping between fire-department connections and check valves. Drain to floor drain or outside building.
- G. Install alarm devices in piping systems.
- H. Install hangers and supports for standpipe system piping according to NFPA 14. Comply with requirements in NFPA 13 for hanger materials.
- I. Install pressure gages on riser or feed main and at top of each standpipe. Include pressure gages with connection not less than **NPS 1/4 (DN 8)** and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.
- J. Drain dry-type standpipe system piping.
- K. Pressurize and check dry-type standpipe system piping and **air-pressure maintenance devices**.
- L. Fill wet-type standpipe system piping with water.

- M. Connect compressed-air supply to dry-pipe sprinkler piping.
- N. Connect air compressor to the following piping and wiring:
  - 1. Pressure gages and controls.
  - 2. Electrical power system.
  - 3. Fire-alarm devices, including low-pressure alarm.
- O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 21 Section "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- P. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 21 Section "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 21 Section "Escutcheons for Fire-Suppression Piping."

#### 3.4 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes **NPS 2 (DN 50)** and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having **NPS 2-1/2 (DN 65)** and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. 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.

- H. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- I. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- J. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
  - 1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
- K. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Braze Joints" Chapter.
- L. Copper-Tubing Grooved Joints: Roll rounded-edge groove in end of tube according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- M. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

### 3.5 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 14 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Specialty Valves:
  - 1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
  - 2. Alarm Valves: Install bypass check valve and retarding chamber drain-line connection.
  - 3. **Dry-Pipe** Valves: Install trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
    - a. Install air compressor and compressed-air supply piping.

- b. Air-Pressure Maintenance Device: Install shutoff valves to permit servicing without shutting down sprinkler system; bypass valve for quick system filling; pressure regulator or switch to maintain system pressure; strainer; pressure ratings with **14- to 60-psig (95- to 410-kPa)** adjustable range; and **175-psig (1200-kPa)** maximum inlet pressure.
- c. Install compressed-air supply piping from building's compressed-air piping system.

### 3.6 HOSE-CONNECTION INSTALLATION

- A. Install hose connections adjacent to standpipes.
- B. Install freestanding hose connections for access and minimum passage restriction.
- C. Install **NPS 2-1/2 (DN 65)** hose connections.

### 3.7 FIRE-DEPARTMENT CONNECTION INSTALLATION

- A. Install wall-type, fire-department connections.
- B. Install automatic (ball drip) drain valve at each check valve for fire-department connection.

### 3.8 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 14.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

### 3.9 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
  - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - 3. Flush, test, and inspect standpipe systems according to NFPA 14, "System Acceptance" Chapter.
  - 4. Energize circuits to electrical equipment and devices.

5. Start and run air compressors.
  6. Coordinate with fire-alarm tests. Operate as required.
  7. Coordinate with fire-pump tests. Operate as required.
  8. Verify that equipment hose threads are same as local fire-department equipment.
- C. Fire-suppression standpipe system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

### 3.10 DEMONSTRATION

- A. **Train** Owner's maintenance personnel to adjust, operate, and maintain specialty valves. PIPING SCHEDULE
- B. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with **threaded ends**;

END OF SECTION 211200

## SECTION 211313

### WET-PIPE SPRINKLER SYSTEMS

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

###### A. Section Includes:

1. Pipes, fittings, and specialties.
2. Fire-protection valves.
3. Fire-department connections.
4. Sprinklers.
5. Alarm devices.
6. Manual control stations.
7. Control panels.
8. Pressure gages.

###### B. Related Sections:

1. Division 21 Section "Fire-Suppression Standpipes" for standpipe piping.
2. Division 21 Section "Dry-Pipe Sprinkler Systems" for dry-pipe sprinkler piping.
3. Division 21 Section "**Electric-Drive, Centrifugal Fire Pumps**

##### 1.3 DEFINITIONS

- A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175 psig (1200 kPa) maximum.

##### 1.4 SYSTEM DESCRIPTIONS

- A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges

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immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

## 1.5 PERFORMANCE REQUIREMENTS

- A. Standard-Pressure Piping System Component: Listed for **175-psig (1200-kPa)** minimum working pressure.
- B. Sprinkler system design shall be approved by authorities having jurisdiction.
  - 1. Sprinkler Occupancy Hazard Classifications:
    - a. Automobile Parking Areas: **Ordinary Hazard, Group 1**
    - b. Building Service Areas: **Ordinary Hazard, Group 1**
    - c. Electrical Equipment Rooms: **Ordinary Hazard, Group 1**
    - d. General Storage Areas: **Ordinary Hazard, Group 1**
    - e. Office and Public Areas: **Light Hazard.**
    - f. Residential Living Areas: **Light Hazard.**
    - g. Restaurant Service Areas: **Ordinary Hazard, Group 1**
  - 2. Minimum Density for Automatic-Sprinkler Piping Design:
    - a. Light-Hazard Occupancy: **0.10 gpm over 1500-sq. ft. (4.1 mm/min. over 139-sq. m)** area.
    - b. Ordinary-Hazard, Group 1 Occupancy: **0.15 gpm over 1500-sq. ft. (6.1 mm/min. over 139-sq. m)** area.
    - c. Ordinary-Hazard, Group 2 Occupancy: **0.20 gpm over 1500-sq. ft. (8.1 mm/min. over 139-sq. m)** area.
  - 3. Maximum Protection Area per Sprinkler: Per UL listing.
  - 4. Maximum Protection Area per Sprinkler:
    - a. Residential Areas: **400 sq. ft. (37 sq. m)**
    - b. Office Spaces: **120 sq. ft. (11.1 sq. m) or 225 sq. ft. (20.9 sq. m)** Storage Areas: **[130 sq. ft. (12.1 sq. m)**
    - c. Mechanical Equipment Rooms: **130 sq. ft. (12.1 sq. m)** Electrical Equipment Rooms: **130 sq. ft. (12.1 sq. m)**
    - d. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.
  - 5. Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated:
    - a. Ordinary-Hazard Occupancies: **250 gpm (15.75 L/s) for 60 to 90 minutes.**



## 1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. **Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.**
- B. Shop Drawings: For wet-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Wiring Diagrams: For power, signal, and control wiring.
- C. Delegated-Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

## 1.7 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Domestic water piping.
  - 2. Sanitary, Waste and Vent piping
  - 3. HVAC hydronic piping.
  - 4. Items penetrating finished ceiling include the following:
    - a. Lighting fixtures.
    - b. Air outlets and inlets.
- B. Qualification Data: For qualified Installer
- C. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- D. Welding certificates.
- E. Fire-hydrant flow test report.
- F. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
- G. Field quality-control reports.

## 1.8 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For sprinkler specialties to include in emergency, operation, and maintenance manuals.

## 1.9 QUALITY ASSURANCE

### A. Installer Qualifications:

- 1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
  - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

- B. 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.

- D. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:

- 1. NFPA 13, "Installation of Sprinkler Systems."
- 2. NFPA 13R, "Installation of Sprinkler Systems in Residential Occupancies up to and Including Four Stories in Height."
- 3. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."

## 1.10 PROJECT CONDITIONS

- A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:

- 1. Notify **Construction Manager** no fewer than **two** days in advance of proposed interruption of sprinkler service.
- 2. Do not proceed with interruption of sprinkler service without **Construction Manager's** written permission.

## 1.11 COORDINATION

- A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

## 1.12 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

## PART 2 - PRODUCTS

### 2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

### 2.2 STEEL PIPE AND FITTINGS

- A. Standard Weight, **Galvanized and Black** Steel Pipe: ASTM A 53/A 53M, **type>**,. Pipe ends may be factory or field formed to match joining method.
- B. Schedule 30, **Galvanized and Black** Steel Pipe: ASTM A 135; ASTM A 795/A 795M, [**Type E**] ; or ASME B36.10M, wrought steel; with wall thickness not less than Schedule 30 and not more than Schedule 40. Pipe ends may be factory or field formed to match joining method.
- C. Thinwall **Galvanized and Black** Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, threadable, with wall thickness less than Schedule 30 and equal to or greater than Schedule 10. Pipe ends may be factory or field formed to match joining method.
- D. Schedule 10, Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, Schedule 10 in **NPS 5 (DN 125)** and smaller; and NFPA 13-specified wall thickness in **NPS 6 to NPS 10 (DN 150 to DN 250)**, plain end.

- E. Nonstandard OD, Thinwall Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, thinwall, with plain ends and wall thickness less than Schedule 10.
- F. Schedule 5 Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, lightwall, with plain ends.
- G. **Galvanized and Black Steel Pipe Nipples:** ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.
- H. **Galvanized and Uncoated,** Steel Couplings: ASTM A 865, threaded.
- I. **Galvanized and Uncoated,** Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- J. Malleable- or Ductile-Iron Unions: UL 860.
- K. Cast-Iron Flanges: ASME 16.1, Class 125.
- L. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
- M. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.
- N. Grooved-Joint, Steel-Pipe Appurtenances:
  - 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, Inc.
    - b. Corcoran Piping System Co.
    - c. National Fittings, Inc.
    - d. Shurjoint Piping Products.
    - e. Tyco Fire & Building Products LP.
    - f. Victaulic Company.
  - 2. Pressure Rating: **175 psig (1200 kPa) 250 psig (1725 kPa) 300 psig (2070 kPa)** minimum.
  - 3. **Galvanized and Uncoated,** Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
  - 4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

- O. Steel Pressure-Seal Fittings: UL 213, FM-approved, **175-psig (1200-kPa)** pressure rating with steel housing, rubber O-rings, and pipe stop; for use with fitting manufacturers' pressure-seal tools.
  - 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. Victaulic Company.

## 2.3 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: **ASTM B 88, Type L (ASTM B 88M, Type B)**
- B. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.
- D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- E. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- F. Copper Pressure-Seal Fittings:
  - 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. Viega; Plumbing & Heating Systems.
  - 2. Standard: UL 213.
- G. Grooved-Joint, Copper-Tube Appurtenances:
  - 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, Inc.
    - b. Shurjoint Piping Products.
    - c. Victaulic Company.

2. Grooved-End, Copper Fittings: **ASTM B 75 (ASTM B 75M)**, copper tube or ASTM B 584, bronze castings.
3. Grooved-End-Tube Couplings: To fit copper-tube dimensions, with design similar to AWWA C606. Include ferrous housing sections, EPDM-rubber gasket suitable for hot and cold water, and bolts and nuts.

## 2.4 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: **AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free.**
  1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
  2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- D. 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.
- E. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493, solvent cement recommended by pipe and fitting manufacturer, and made for joining CPVC sprinkler pipe and fittings. Include cleaner or primer recommended by pipe and fitting manufacturer.
  1. Use solvent cement that has a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  2. Use adhesive primer that has a VOC content of 650 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- F. Plastic, Pipe-Flange Gasket, and Bolts and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

## 2.5 LISTED FIRE-PROTECTION VALVES

- A. General Requirements:
  1. Valves shall be UL listed or FM approved.

2. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig (1200 kPa).
3. Minimum Pressure Rating for High-Pressure Piping: 250 psig (1725 kPa) 300 psig (2070 kPa).

B. Ball Valves:

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, Inc.
  - b. Victaulic Company.
2. Standard: UL 1091 except with ball instead of disc.
3. Valves NPS 1-1/2 (DN 40) and Smaller: Bronze body with threaded ends.
4. Valves NPS 2 and NPS 2-1/2 (DN 50 and DN 65): Bronze body with threaded ends or ductile-iron body with grooved ends.
5. Valves NPS 3 (DN 80): Ductile-iron body with grooved ends.

C. Bronze Butterfly Valves:

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. Fivalco Inc.
  - b. Global Safety Products, Inc.
  - c. Milwaukee Valve Company.
2. Standard: UL 1091.
3. Pressure Rating: 175 psig (1200 kPa).
4. Body Material: Bronze.
5. End Connections: Threaded.

D. Iron Butterfly Valves:

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, Inc.
  - b. Fivalco Inc.
  - c. Global Safety Products, Inc.
  - d. Kennedy Valve; a division of McWane, Inc.
  - e. Milwaukee Valve Company.

- f. NIBCO INC.
  - g. Pratt, Henry Company.
  - h. Shurjoint Piping Products.
  - i. Tyco Fire & Building Products LP.
  - j. Victaulic Company.
2. Standard: UL 1091.
  3. Pressure Rating: 175 psig (1200 kPa).
  4. Body Material: Cast or ductile iron.
  5. Style: Lug or wafer.
  6. End Connections: Grooved.

E. Check Valves:

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. AFAC Inc.
  - b. American Cast Iron Pipe Company; Waterous Company Subsidiary.
  - c. Anvil International, Inc.
  - d. Clow Valve Company; a division of McWane, Inc.
  - e. Crane Co.; Crane Valve Group; Crane Valves.
  - f. Crane Co.; Crane Valve Group; Jenkins Valves.
  - g. Crane Co.; Crane Valve Group; Stockham Division.
  - h. Fire-End & Croker Corporation.
  - i. Fire Protection Products, Inc.
  - j. Fivalco Inc.
  - k. Globe Fire Sprinkler Corporation.
  - l. Groeniger & Company.
  - m. Kennedy Valve; a division of McWane, Inc.
  - n. Matco-Norca.
  - o. Metraflex, Inc.
  - p. Milwaukee Valve Company.
  - q. Mueller Co.; Water Products Division.
  - r. NIBCO INC.
  - s. Potter Roemer.
  - t. Reliable Automatic Sprinkler Co., Inc.
  - u. Shurjoint Piping Products.
  - v. Tyco Fire & Building Products LP.
  - w. United Brass Works, Inc.
  - x. Venus Fire Protection Ltd.
  - y. Victaulic Company.
  - z. Viking Corporation.
  - aa. Watts Water Technologies, Inc.



2. Standard: UL 312.
3. Pressure Rating: **250 psig (1725 kPa) minimum 300 psig (2070 kPa)**.
4. Type: Swing check.
5. Body Material: Cast iron.
6. End Connections: Flanged or grooved.

F. Bronze OS&Y Gate Valves:

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. Crane Co.; Crane Valve Group; Crane Valves.
  - b. Crane Co.; Crane Valve Group; Stockham Division.
  - c. Milwaukee Valve Company.
  - d. NIBCO INC.
  - e. United Brass Works, Inc.
2. Standard: UL 262.
3. Pressure Rating: **175 psig (1200 kPa)**.
4. Body Material: Bronze.
5. End Connections: Threaded.

G. Iron OS&Y Gate Valves:

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. American Cast Iron Pipe Company; Waterous Company Subsidiary.
  - b. American Valve, Inc.
  - c. Clow Valve Company; a division of McWane, Inc.
  - d. Crane Co.; Crane Valve Group; Crane Valves.
  - e. Crane Co.; Crane Valve Group; Jenkins Valves.
  - f. Crane Co.; Crane Valve Group; Stockham Division.
  - g. Hammond Valve.
  - h. Milwaukee Valve Company.
  - i. Mueller Co.; Water Products Division.
  - j. NIBCO INC.
  - k. Shurjoint Piping Products.
  - l. Tyco Fire & Building Products LP.
  - m. United Brass Works, Inc.
  - n. Watts Water Technologies, Inc.
2. Standard: UL 262.

3. Pressure Rating: **250 psig (1725 kPa) minimum 300 psig (2070 kPa).**
4. Body Material: Cast or ductile iron.
5. End Connections: Flanged or grooved.

H. Indicating-Type Butterfly Valves:

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, Inc.
  - b. Fivalco Inc.
  - c. Global Safety Products, Inc.
  - d. Kennedy Valve; a division of McWane, Inc.
  - e. Milwaukee Valve Company.
  - f. NIBCO INC.
  - g. Shurjoint Piping Products.
  - h. Tyco Fire & Building Products LP.
  - i. Victaulic Company.
2. Standard: UL 1091.
3. Pressure Rating: **175 psig (1200 kPa) minimum.**
4. Valves **NPS 2 (DN 50)** and Smaller:
  - a. Valve Type: Ball or butterfly.
  - b. Body Material: Bronze.
  - c. End Connections: Threaded.
5. Valves **NPS 2-1/2 (DN 65)** and Larger:
  - a. Valve Type: Butterfly.
  - b. Body Material: Cast or ductile iron.
  - c. End Connections: Flanged, grooved, or wafer.
6. Valve Operation: Integral **electrical, 115-V ac, prewired, single-circuit, supervisory switch, electrical, 115-V ac, prewired, two-circuit, supervisory switch, or visual** indicating device.

I. NRS Gate Valves:

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. American Cast Iron Pipe Company; Waterous Company Subsidiary.

- b. American Valve, Inc.
  - c. Clow Valve Company; a division of McWane, Inc.
  - d. Crane Co.; Crane Valve Group; Stockham Division.
  - e. Kennedy Valve; a division of McWane, Inc.
  - f. Mueller Co.; Water Products Division.
  - g. NIBCO INC.
  - h. Tyco Fire & Building Products LP.
- 2. Standard: UL 262.
  - 3. Pressure Rating: **250 psig (1725 kPa) minimum 300 psig (2070 kPa)**.
  - 4. Body Material: Cast iron with indicator post flange.
  - 5. Stem: Nonrising.
  - 6. End Connections: Flanged or grooved.

## 2.6 TRIM AND DRAIN VALVES

### A. General Requirements:

- 1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
- 2. Pressure Rating: **175 psig (1200 kPa) minimum**.

### B. Angle Valves:

- 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. Fire Protection Products, Inc.
  - b. United Brass Works, Inc.

### C. Ball Valves:

- 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. Affiliated Distributors.
  - b. Anvil International, Inc.
  - c. Barnett.
  - d. Conbraco Industries, Inc.; Apollo Valves.
  - e. Fire-End & Croker Corporation.
  - f. Fire Protection Products, Inc.
  - g. Flowserve.

- h. FNW.
- i. Jomar International, Ltd.
- j. Kennedy Valve; a division of McWane, Inc.
- k. Kitz Corporation.
- l. Legend Valve.
- m. Metso Automation USA Inc.
- n. Milwaukee Valve Company.
- o. NIBCO INC.
- p. Potter Roemer.
- q. Red-White Valve Corporation.
- r. Southern Manufacturing Group.
- s. Stewart, M. A. and Sons Ltd.
- t. Tyco Fire & Building Products LP.
- u. Victaulic Company.
- v. Watts Water Technologies, Inc.

D. Globe Valves:

- 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. Fire Protection Products, Inc.
  - b. United Brass Works, Inc.

E. Plug Valves:

- 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. Southern Manufacturing Group.

## 2.7 SPECIALTY VALVES

A. General Requirements:

- 1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
- 2. Pressure Rating:
  - a. Standard-Pressure Piping Specialty Valves: **175 psig (1200 kPa)** minimum.

- b. High-Pressure Piping Specialty Valves: **250 psig (1725 kPa) minimum 300 psig (2070 kPa)**.
  3. Body Material: Cast or ductile iron.
  4. Size: Same as connected piping.
  5. End Connections: Flanged or grooved.
- B. Alarm Valves:
  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. AFAC Inc.
    - b. Globe Fire Sprinkler Corporation.
    - c. Reliable Automatic Sprinkler Co., Inc.
    - d. Tyco Fire & Building Products LP.
    - e. Venus Fire Protection Ltd.
    - f. Victaulic Company.
    - g. Viking Corporation.
  2. Standard: UL 193.
  3. Design: For horizontal or vertical installation.
  4. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, **retarding chamber**, and fill-line attachment with strainer.
  5. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
  6. Drip Cup Assembly: Pipe drain with check valve to main drain piping.
- C. Automatic (Ball Drip) Drain Valves:
  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. AFAC Inc.
    - b. Reliable Automatic Sprinkler Co., Inc.
    - c. Tyco Fire & Building Products LP.
  2. Standard: UL 1726.
  3. Pressure Rating: **175 psig (1200 kPa) minimum**.
  4. Type: Automatic draining, ball check.
  5. Size: **NPS 3/4 (DN 20)**.
  6. End Connections: Threaded.

## 2.8 FIRE-DEPARTMENT CONNECTIONS

### A. Exposed-Type, Fire-Department Connection:

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. AFAC Inc.
  - b. Elkhart Brass Mfg. Company, Inc.
  - c. Fire-End & Croker Corporation.
  - d. Fire Protection Products, Inc.
  - e. GMR International Equipment Corporation.
  - f. Guardian Fire Equipment, Inc.
  - g. Tyco Fire & Building Products LP.
  - h. Wilson & Cousins Inc.
2. Standard: UL 405.
3. Type: Exposed, projecting, for wall mounting.
4. Pressure Rating: **175 psig (1200 kPa)** minimum.
5. Body Material: Corrosion-resistant metal.
6. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
7. Caps: Brass, lugged type, with gasket and chain.
8. Escutcheon Plate: Round, brass, wall type.
9. Outlet: Back, with pipe threads.
10. Number of Inlets: **Two**.
11. Escutcheon Plate Marking: Similar to "**AUTO SPKR & STANDPIPE], AUTO SPKR.**"
12. Finish: **Polished chrome plated** Outlet Size: [**NPS 4 (DN 100**

## 2.9 SPRINKLER SPECIALTY PIPE FITTINGS

### A. Branch Outlet Fittings:

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, Inc.
  - b. National Fittings, Inc.
  - c. Shurjoint Piping Products.
  - d. Tyco Fire & Building Products LP.

- e. Victaulic Company.
  - 2. Standard: UL 213.
  - 3. Pressure Rating: **175 psig (1200 kPa) minimum 300 psig (2070 kPa)**.
  - 4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
  - 5. Type: Mechanical-T and -cross fittings.
  - 6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
  - 7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
  - 8. Branch Outlets: Grooved, plain-end pipe, or threaded.
  
- B. Flow Detection and Test Assemblies:
  - 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. AGF Manufacturing Inc.
    - b. Reliable Automatic Sprinkler Co., Inc.
    - c. Tyco Fire & Building Products LP.
    - d. Victaulic Company.
  
  - 2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
  - 3. Pressure Rating: **175 psig (1200 kPa) minimum 300 psig (2070 kPa)**.
  - 4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
  - 5. Size: Same as connected piping.
  - 6. Inlet and Outlet: Threaded.
  
- C. Branch Line Testers:
  - 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. Elkhart Brass Mfg. Company, Inc.
    - b. Fire-End & Croker Corporation.
    - c. Potter Roemer.
  
  - 2. Standard: UL 199.
  - 3. Pressure Rating: **175 psig (1200 kPa)**.
  - 4. Body Material: Brass.
  - 5. Size: Same as connected piping.
  - 6. Inlet: Threaded.

7. Drain Outlet: Threaded and capped.
8. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector's Test Fittings:

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. AGF Manufacturing Inc.
  - b. Triple R Specialty.
  - c. Tyco Fire & Building Products LP.
  - d. Victaulic Company.
  - e. Viking Corporation.
2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
3. Pressure Rating: **175 psig (1200 kPa) minimum 300 psig (2070 kPa).**
4. Body Material: Cast- or ductile-iron housing with sight glass.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

E. Adjustable Drop Nipples:

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. CECA, LLC.
  - b. Corcoran Piping System Co.
  - c. Merit Manufacturing; a division of Anvil International, Inc.
2. Standard: UL 1474.
3. Pressure Rating: **250 psig (1725 kPa) minimum 300 psig (2070 kPa).**
4. Body Material: Steel pipe with EPDM-rubber O-ring seals.
5. Size: Same as connected piping.
6. Length: Adjustable.
7. Inlet and Outlet: Threaded.

## 2.10 SPRINKLERS

- 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. AFAC Inc.
2. Globe Fire Sprinkler Corporation.
3. Reliable Automatic Sprinkler Co., Inc.
4. Tyco Fire & Building Products LP.
5. Venus Fire Protection Ltd.
6. Victaulic Company.
7. Viking Corporation.

B. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating for Residential Sprinklers: **175 psig (1200 kPa)** maximum.
3. Pressure Rating for Automatic Sprinklers: **175 psig (1200 kPa)** minimum.

C. Automatic Sprinklers with Heat-Responsive Element:

1. Early-Suppression, Fast-Response Applications: **UL 1767**
2. Nonresidential Applications: **UL 199** Residential Applications: **UL 1626**  
Characteristics: Nominal **1/2-inch (12.7-mm)** orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

D. Sprinkler Finishes:

1. Chrome plated.
2. Bronze.

E. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

1. Ceiling Mounting: **Chrome-plated steel, one piece, flat, Chrome-plated steel, two piece, with 1-inch (25-mm) vertical adjustment**
2. Sidewall Mounting: **Chrome-plated steel**

F. Sprinkler Guards:

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. Reliable Automatic Sprinkler Co., Inc.
  - b. Tyco Fire & Building Products LP.
  - c. Victaulic Company.

- d. Viking Corporation.
2. Standard: UL 199.
3. Type: Wire cage with fastening device for attaching to sprinkler.

## 2.11 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Electrically Operated Alarm Bell:

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. Fire-Lite Alarms, Inc.; a Honeywell company.
  - b. Notifier; a Honeywell company.
  - c. Potter Electric Signal Company.
2. Standard: UL 464.
3. Type: Vibrating, metal alarm bell.
4. Size: **10-inch (250-mm)** diameter.
5. Finish: Red-enamel factory finish, suitable for outdoor use.

C. Water-Flow Indicators:

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. ADT Security Services, Inc.
  - b. McDonnell & Miller; ITT Industries.
  - c. Potter Electric Signal Company.
  - d. System Sensor; a Honeywell company.
  - e. Viking Corporation.
  - f. Watts Industries (Canada) Inc.
2. Standard: UL 346.
3. Water-Flow Detector: Electrically supervised.
4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
5. Type: Paddle operated.

6. Pressure Rating: 250 psig (1725 kPa).
7. Design Installation: Horizontal or vertical.

D. Pressure Switches:

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. AFAC Inc.
  - b. Barksdale, Inc.
  - c. Detroit Switch, Inc.
  - d. Potter Electric Signal Company.
  - e. System Sensor; a Honeywell company.
  - f. Tyco Fire & Building Products LP.
  - g. United Electric Controls Co.
  - h. Viking Corporation.
2. Standard: UL 346.
3. Type: Electrically supervised water-flow switch with retard feature.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design Operation: Rising pressure signals water flow.

E. Valve Supervisory Switches:

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. Fire-Lite Alarms, Inc.; a Honeywell company.
  - b. Kennedy Valve; a division of McWane, Inc.
  - c. Potter Electric Signal Company.
  - d. System Sensor; a Honeywell company.
2. Standard: UL 346.
3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled valve is in other than fully open position.

## 2.12 PRESSURE GAGES

- 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. AMETEK; U.S. Gauge Division.
  2. Ashcroft, Inc.
  3. Brecco Corporation.
  4. WIKA Instrument Corporation.
- B. Standard: UL 393.
- C. Dial Size: 3-1/2- to 4-1/2-inch (90- to 115-mm) diameter.
- D. Pressure Gage Range: 0 to 250 psig (0 to 1725 kPa) minimum 0 to 300 psig (0 to 2070 kPa).
- E. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.
- F. Air System Piping Gage: Include **retard feature and** "AIR" or "AIR/WATER" label on dial face.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
- B. Report test results promptly and in writing.

### 3.2 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
  1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.
- C. Install seismic restraints on piping. Comply with requirements for seismic-restraint device materials and installation in NFPA 13.

- D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install unions adjacent to each valve in pipes **NPS 2 (DN 50)** and smaller.
- F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having **NPS 2-1/2 (DN 65)** and larger end connections.
- G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- H. Install sprinkler piping with drains for complete system drainage.
- I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- J. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.
- K. Install alarm devices in piping systems.
- L. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
- M. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than **NPS 1/4 (DN 8)** and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.
- N. Fill sprinkler system piping with water.
- O. Suppression Systems Insulation."
- P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 21 Section "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- Q. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 21 Section "Sleeves and Sleeve Seals for Fire-Suppression Piping."

- R. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 21 Section "Escutcheons for Fire-Suppression Piping."

### 3.3 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes **NPS 2 (DN 50)** and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having **NPS 2-1/2 (DN 65)** and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. 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.
- H. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.
- I. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
- J. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
  - 1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

- K. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- L. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- M. Steel-Piping, Pressure-Sealed Joints: Join Schedule 5 steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
- N. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Braze Joints" Chapter.
- O. Copper-Tubing Grooved Joints: Roll rounded-edge groove in end of tube according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- P. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.
- Q. Plastic-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. Apply primer.
  - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

### 3.4 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Specialty Valves:

1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
2. Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.
3. Deluge Valves: Install in vertical position, in proper direction of flow, and in main supply to deluge system. Install trim sets for drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

### 3.5 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of **narrow dimension of** acoustical ceiling panels.
- B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.

### 3.6 FIRE-DEPARTMENT CONNECTION INSTALLATION

- A. Install wall-type, fire-department connections.
- B. Install automatic (ball drip) drain valve at each check valve for fire-department connection.

### 3.7 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

### 3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
  1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.



2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
  4. Energize circuits to electrical equipment and devices.
  5. Coordinate with fire-alarm tests. Operate as required.
  6. Coordinate with fire-pump tests. Operate as required.
  7. Verify that equipment hose threads are same as local fire-department equipment.
- C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

### 3.9 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.

### 3.10 DEMONSTRATION

- A. **Train** Owner's maintenance personnel to adjust, operate, and maintain **specialty valves and pressure-maintenance pumps**.

### 3.11 PIPING SCHEDULE

- A. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with **threaded ends**; Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
- B. Copper-tube, extruded-tee connections may be used for tee branches in copper tubing instead of specified copper fittings. Branch-connection joints must be brazed.
- C. CPVC pipe; **Schedule 40 or [Schedule 80** CPVC fittings; and solvent-cemented joints may be used for light-hazard and residential occupancies.

### 3.12 SPRINKLER SCHEDULE

- A. Use sprinkler types in subparagraphs below for the following applications:

1. Rooms without Ceilings: **Upright sprinklers**
2. Rooms with Suspended Ceilings: **Pendent sprinklers, Recessed sprinklers, Flush sprinklers, Concealed sprinklers, Pendent, recessed, flush, and concealed sprinklers.**
3. Wall Mounting: Sidewall sprinklers.
4. Spaces Subject to Freezing: **dry sprinklers**

B. Provide sprinkler types in subparagraphs below with finishes indicated.

1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
2. Flush Sprinklers: Bright chrome, with painted white escutcheon.
3. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
4. Residential Sprinklers: Dull chrome.
5. **Upright, Pendent and Sidewall** Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view;

END OF SECTION 211313

## SECTION 213113

### ELECTRIC-DRIVE, CENTRIFUGAL FIRE PUMPS

#### 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. **Horizontal mounted, split case** pumps.
  - 2. Fire-pump accessories and specialties.

##### 1.3 PERFORMANCE REQUIREMENTS

- A. Pump Equipment, Accessory, and Specialty Pressure Rating: **250 psig (1200 kPa)** minimum unless higher pressure rating is indicated.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, performance curves, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For fire pumps, motor drivers, and fire-pump accessories and specialties. 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.

##### 1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each fire pump, from manufacturer.
- B. Source quality-control reports.

- C. Field quality-control reports.

## 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire pumps to include in operation and maintenance manuals.

## 1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 20, "Installation of Stationary Pumps for Fire Protection."

## 1.8 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS FOR CENTRIFUGAL FIRE PUMPS

- A. Description: Factory-assembled and -tested fire-pump and driver unit.
- B. Base: Fabricated and attached to fire-pump and driver unit with reinforcement to resist movement of pump during seismic events when base is anchored to building substrate.
- C. Finish: Red paint applied to factory-assembled and -tested unit before shipping.

### 2.2 HORIZONTALLY MOUNTED, SINGLE-STAGE, SPLIT-CASE FIRE 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. A-C Fire Pump Systems; a business of ITT Industries.
  2. Patterson Pump Company; a subsidiary of the Gorman-Rupp Company.
  3. PACO Pumps; Grundfos Pumps Corporation, U.S.A.
  4. Peerless Pump, Inc.
  5. Pentair Pump Group; Aurora Pump.
  6. S.A. Armstrong Limited.

B. Pump:

1. Standard: **UL 448** , for split-case pumps for fire service.
2. Casing: Axially split case, cast iron with ASME B16.1 pipe-flange connections.
3. Impeller: Cast bronze, statically and dynamically balanced, and keyed to shaft.
4. Wear Rings: Replaceable bronze.
5. Shaft and Sleeve: Steel shaft with bronze sleeve.
  - a. Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
  - b. Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.
6. Mounting: Pump and driver shafts are horizontal, with pump and driver on same base.

C. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.

D. Driver:

1. Standard: **UL 1004A**
2. Type: Electric motor; NEMA MG 1, polyphase Design B.

E. Capacities and Characteristics:

1. As listed on Drawings
2. Inlet Flange: **Class 125 or Class 250.**
3. Outlet Flange: **Class 125 or Class 250.**

## 2.3 FIRE-PUMP ACCESSORIES AND SPECIALTIES

A. Automatic Air-Release Valves: Comply with NFPA 20 for installation in fire-pump casing.

B. Circulation Relief Valves: UL 1478, brass, spring loaded; for installation in pump discharge piping.

C. Relief Valves:

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:**
2. Basis-of-Design Product: Subject to compliance with requirements, provide **product indicated on Drawings** or comparable product by one of the following:
  - a. CLA-VAL Automatic Control Valves.
  - b. Kunkle Valve; a part of Tyco International Ltd.
  - c. OCV Control Valves.
  - d. Watts Regulator Company; a division of Watts Water Technologies, Inc.
  - e. Zurn Plumbing Products Group; Wilkins Water Control Products.

3. Description: UL 1478, bronze or cast iron, spring loaded; for installation in fire-suppression water-supply piping.
- D. Inlet Fitting: Eccentric tapered reducer at pump suction inlet.
  - E. Outlet Fitting: Concentric tapered reducer at pump discharge outlet.
  - F. Discharge Cone: **Closed or open** type.
  - G. Hose Valve Manifold Assembly:
    1. Standard: Comply with requirements in NFPA 20.
    2. Header Pipe: ASTM A 53/A 53M, Schedule 40, galvanized steel with ends threaded according to ASME B1.20.1.
    3. Header Pipe Fittings: ASME B16.4, galvanized cast-iron threaded fittings.
    4. Automatic Drain Valve: UL 1726.
    5. Manifold:
      - a. Test Connections: Comply with UL 405 except provide outlets without clappers instead of inlets.
      - b. Body: Flush type, brass or ductile iron, with number of outlets required by NFPA 20.
      - c. Nipples: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with ends threaded according to ASME B1.20.1.
      - d. Adapters and Caps with Chain: Brass or bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
      - e. Escutcheon Plate: Brass or bronze; rectangular.
      - f. Hose Valves: UL 668, bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
      - g. Exposed Parts Finish: **Polished, Rough, brass, chrome plated.**
      - h. Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."
    6. Manifold:
      - a. Test Connections: Comply with UL 405 except provide outlets without clappers instead of inlets.
      - b. Body: Exposed type, brass, with number of outlets required by NFPA 20.
      - c. Escutcheon Plate: Brass or bronze; round.
      - d. Hose Valves: UL 668, bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads. Include caps and chains.
      - e. Exposed Parts Finish **Rough brass** Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."

## 2.4 GROUT

- A. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

- B. Characteristics: Nonshrink and recommended for interior and exterior applications.
- C. Design Mix: 5000-psi (34-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

## 2.5 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect fire pumps according to UL 448 requirements for "Operation Test" and "Manufacturing and Production Tests."
  - 1. Verification of Performance: Rate fire pumps according to UL 448.
- B. Fire pumps will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine equipment bases and anchorage provisions, with Installer present, for compliance with requirements and for conditions affecting performance of fire pumps.
- B. Examine roughing-in for fire-suppression piping systems to verify actual locations of piping connections before fire-pump installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Fire-Pump Installation Standard: Comply with NFPA 20 for installation of fire pumps, relief valves, and related components.
- B. Equipment Mounting: Install fire pumps on concrete bases. Comply with requirements for concrete bases specified in Division 03 Section **Miscellaneous Cast-in-Place Concrete.**
  - 1. 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 concrete base.
  - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- C. Install fire-pump suction and discharge piping equal to or larger than sizes required by NFPA 20.
- D. Support piping and pumps separately so weight of piping does not rest on pumps.
- E. Install valves that are same size as connecting piping. Comply with requirements for fire-protection valves specified in **Division 21 Section "Fire-Suppression Standpipes." Division 21 Section "Wet-Pipe Sprinkler Systems."**
- F. Install pressure gages on fire-pump suction and discharge flange pressure-gage tapplings. Comply with requirements for pressure gages specified in **Division 21 Section "Fire-Suppression Standpipes." Division 21 Section "Wet-Pipe Sprinkler Systems."**
- G. Install piping hangers and supports, anchors, valves, gages, and equipment supports according to NFPA 20.
- H. Install flowmeters and sensors. Install flowmeter-system components and make connections according to NFPA 20 and manufacturer's written instructions.
- I. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical Installer.
- J. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

### 3.3 ALIGNMENT

- A. Align **end-suction and split-case** pump and driver shafts after complete unit has been leveled on concrete base, grout has set, and anchor bolts have been tightened.
- B. After alignment is correct, tighten anchor bolts evenly. Fill baseplate completely with grout, with metal blocks and shims or wedges in place. Tighten anchor bolts after grout has hardened. Check alignment and make required corrections.
- C. Align piping connections.
- D. Align pump and driver shafts for angular and parallel alignment according to HI 1.4 and to tolerances specified by manufacturer.



### 3.4 CONNECTIONS

- A. Comply with requirements for piping and valves specified in **Division 21 Section "Fire-Suppression Standpipes."** **Division 21 Section "Wet-Pipe Sprinkler Systems."** Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to pumps and equipment to allow service and maintenance.
- C. Connect relief-valve discharge to drainage piping or point of discharge.
- D. Connect flowmeter-system meters, sensors, and valves to tubing.
- E. Connect fire pumps to their controllers.

### 3.5 IDENTIFICATION

- A. Identify system components. Comply with requirements for fire-pump marking according to NFPA 20.

### 3.6 FIELD QUALITY CONTROL

- A. Test each fire pump with its controller as a unit. Comply with requirements for electric-motor-driver fire-pump controllers specified in Division 21 Section "Controllers for Fire-Pump Drivers."
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
  - 1. After installing components, assemblies, and equipment including controller, test for compliance with requirements.
  - 2. Test according to NFPA 20 for acceptance and performance testing.
  - 3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 4. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

- E. Components, assemblies, and equipment will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.
- G. Furnish fire hoses in number, size, and length required to reach storm drain or other acceptable location to dispose of fire-pump test water. Hoses are for tests only and do not convey to Owner.

### 3.7 STARTUP SERVICE

- A. **Engage a factory-authorized service representative to perform** startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.

### 3.8 DEMONSTRATION

- A. **Engage a factory-authorized service representative to train** Owner's maintenance personnel to adjust, operate, and maintain fire pumps.

END OF SECTION 213113

## SECTION 213400

### PRESSURE-MAINTENANCE PUMPS

#### 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. Multistage, pressure-maintenance pumps.

- B. Related Section:

- 1. Division 21 Section "Controllers For Fire-Pump Drivers" for pressure-maintenance-pump controllers.

##### 1.3 PERFORMANCE REQUIREMENTS

- A. Pump Equipment, Accessory, and Specialty Pressure Rating: 250 psig (1200 kPa) minimum unless higher pressure rating is indicated.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, performance curves, electrical characteristics, and furnished specialties and accessories.

- B. Shop Drawings: For pumps, accessories, and specialties. 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.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

## 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pumps to include in operation and maintenance manuals.

## 1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## 1.8 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

## PART 2 - PRODUCTS

### 2.1 MULTISTAGE, PRESSURE-MAINTENANCE 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. A-C Fire Pump Systems; a business of ITT Industries.
2. Grundfos Management A/S; Grundfos Pumps Corporation U.S.A.
3. PACO Pumps; Grundfos Pumps Corporation U.S.A.
4. TACO Incorporated.

- B. Description: Factory-assembled and -tested, multistage, barrel-type vertical pump as defined in HI 2.1-2.2 and HI 2.3; designed for surface installation with pump and motor direct coupled and mounted vertically.

- C. Pump Construction:

1. Barrel: Stainless steel.
2. Suction and Discharge Chamber: Cast iron with flanged inlet and outlet.
3. Pump Head/Motor Mount: Cast iron.
4. Impellers: Stainless steel, balanced, and keyed to shaft.
5. Pump Shaft: Stainless steel.
6. Seal: Mechanical type with carbon rotating face and silicon-carbide stationary seat.

7. Intermediate Chamber Bearings: Aluminum-oxide ceramic or bronze.
  8. Chamber-Base Bearing: Tungsten carbide.
  9. O-Rings: EPDM or NBR.
- D. Motor: Single speed with permanently lubricated ball bearings and rigidly mounted to pump head. Comply with requirements in Division 21 Section "Common Motor Requirements for Fire Suppression Equipment."
1. Power Cord: Factory-connected to motor for field connection to controller and at least **10 feet (3 m)** long.
- E. Nameplate: Permanently attached to pump and indicating capacity and characteristics.
- F. Capacities and Characteristics:
1. Rated Capacity: As listed on Drawings

## 2.2 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 21 Section "Common Motor Requirements for Fire Suppression 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. Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

## PART 3 - EXECUTION

### 3.1 EQUIPMENT INSTALLATION

- A. NFPA Standard: Comply with NFPA 20 for installation of pressure-maintenance pumps.
- B. Base-Mounted Pump Mounting: Install pumps on concrete bases. Comply with requirements for concrete bases specified in Division 03 Section **Miscellaneous Cast-in-Place Concrete.**
1. 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 concrete base.
  2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to supported equipment.
  5. Attach pumps to equipment base using anchor bolts.
- C. Install **multistage** pressure-maintenance pumps according to HI 1.4.

### 3.2 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Pressure-maintenance pumps will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

### 3.3 ADJUSTING

- A. Lubricate pumps as recommended by manufacturer.
- B. Set field-adjustable pressure-switch ranges as indicated.

END OF SECTION 213400

## SECTION 213900

### CONTROLLERS FOR FIRE-PUMP DRIVERS

#### 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. Full-service, **reduced**-voltage controllers rated 600 V and less.
  - 2. Controllers for pressure-maintenance pumps.
  - 3. Remote alarm panels.

##### 1.3 DEFINITIONS

- A. ATS: Automatic transfer switch(es).
- B. ECM: Electronic control module.
- C. MCCB: Molded-case circuit breaker.
- D. N.O.: Normally open.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For each type of product indicated. Include dimensioned plans, elevations, sections, details, and attachments to other work, including required clearances and service spaces around controller enclosures.
  - 1. Show tabulations of the following:
    - a. Each installed unit's type and details.
    - b. Enclosure types and details for types other than NEMA 250, Type 2.

- c. Factory-installed devices.
  - d. Nameplate legends.
  - e. Short-circuit current (withstand) rating of integrated unit.
  - f. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices.
  - g. Specified modifications.
- 2. Detail equipment assemblies and indicate dimensions, weights, loads, method of field assembly, components, and location and size of each field connection.
  - 3. Schematic and Connection Diagrams: For power, signal, alarm, and control wiring and for pressure-sensing tubing.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Product Certificates: For each type of product indicated, from manufacturer.
- C. Manufacturer's factory test reports of fully assembled and tested equipment.
- D. Source quality-control reports.
- E. Field quality-control reports.

## 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product indicated to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
  - 1. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
  - 2. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor-based logic controls.

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Indicating Lights: **Two** of each type and color of lens installed; **two** of each type and size of lamp installed.
  - 2. Auxiliary Contacts: **One** for each size and type of magnetic contactor installed.
  - 3. Power Contacts: **Three** for each size and type of magnetic contactor installed.
  - 4. Contactor Coils: **One** for each size and type of magnetic controller installed.



5. Relay Boards: **One** for each size and type of relay board installed.
6. Operator Interface: **One** microprocessor board(s), complete with display and membrane keypad.

## 1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of an NRTL.
- B. Source Limitations: Obtain fire-pump controllers and all associated equipment from single source or producer.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with standards of authorities having jurisdiction pertaining to materials and installation.
- E. Comply with NFPA 20 and NFPA 70.
- F. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Store controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- B. If stored in areas subject to weather, protect controllers from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; **install temporary electric heating, with at least 250 W per controller** and **connect factory-installed space heaters to temporary electrical service**.

## 1.10 PROJECT CONDITIONS

- A. Environmental Limitations:
  1. Ambient Temperature Rating: Not less than **40 deg F (5 deg C)** and not exceeding **122 deg F (50 deg C)** unless otherwise indicated.
  2. Altitude Rating: Not exceeding **6600 feet (2010 m)** unless otherwise indicated.

## 1.11 COORDINATION

- A. Coordinate layout and installation of controllers with other construction including conduit, piping, fire-pump equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels. Ensure that controllers are within sight of fire-pump drivers.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided.

## PART 2 - PRODUCTS

### 2.1 FULL-SERVICE CONTROLLERS

- 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. Aquarius Fluid Products, Inc.
  - 2. ASCO Power Technologies, LP; Firetrol Products.
  - 3. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  - 4. Hubbell Incorporated; Hubbell Industrial Controls.
  - 5. Master Control Systems, Inc.
  - 6. Metron, Inc.
- B. General Requirements for Full-Service Controllers:
  - 1. Comply with NFPA 20 and **UL 218**
  - 2. Listed by an NRTL for electric-motor driver for fire-pump service.
  - 3. **Combined automatic and nonautomatic** operation.
  - 4. Factory assembled, wired, and tested; continuous-duty rated.
  - 5. Service Equipment Label: NRTL labeled for use as service equipment.
- C. Method of Starting:
  - 1. **[Pressure** -switch actuated.
    - a. Water-pressure-actuated switch and pressure transducer with independent high- and low-calibrated adjustments responsive to water pressure in fire-suppression piping.
    - b. System pressure recorder, electric ac driven, with spring backup.
    - c. Programmable minimum-run-time relay to prevent short cycling.
    - d. Programmable timer for weekly tests.
  - 2. Magnetic Controller: **Wye-delta (open transition)** type.
  - 3. Solid-State Controller: **Reduced-voltage** type.

4. Emergency Start: Mechanically operated start handle that closes and retains the motor RUN contactor independent of all electric or pressure actuators.
- D. Method of Stopping: **Automatic and nonautomatic shutdown after automatic starting** .
- E. Capacity: Rated for fire-pump-driver horsepower and short-circuit-current (withstand) rating equal to or greater than short-circuit current available at controller location.
- F. Method of Isolation and Overcurrent Protection: Interlocked isolating switch and nonthermal MCCB; with a common, externally mounted operating handle, and providing locked-rotor protection.
- G. Door-Mounted Operator Interface and Controls:
1. Monitor, display, and control the devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used.
  2. Method of Control and Indication:
    - a. **Microprocessor-based logic** controller, with multiline digital readout.
    - b. **Membrane** keypad.
    - c. **LED** alarm and status indicating lights.
  3. Local **and Remote** Alarm and Status Indications:
    - a. Controller power on.
    - b. Motor running condition.
    - c. Loss-of-line power.
    - d. Line-power phase reversal.
    - e. Line-power single-phase condition.
  4. Audible alarm, with silence push button.
  5. Nonautomatic START and STOP push buttons or switches.
  - 6.
- H. Optional Features:
1. Extra Output Contacts:
    - a. **One** N.O. contact(s) for motor running condition.
    - b. **One** set(s) of contacts for loss-of-line power.
    - c. **One** each, Form C contacts for high and low reservoir level.
  2. Local alarm bell.
  3. Door-mounted thermal or impact printer for alarm and status logs.
  4. Operator Interface Communications Ports: USB, Ethernet, and RS485.
- I. ATS:

1. Complies with NFPA 20, **UL 218** and **UL 1008**
2. Integral with controller as a listed combination fire-pump controller and power transfer switch.
3. Automatically transfers fire-pump controller from normal power supply to alternate power supply in event of power failure.
4. Allows manual transfer from one source to the other.
5. Alternate-Source Isolating and Disconnecting Means: Integral molded-case switch, with an externally mounted operating handle.
6. Alternate-Source Isolating and Disconnecting Means: Mechanically interlocked isolation switch and circuit breaker rated at a minimum of 115 percent of rated motor full-load current, with an externally mounted operating handle; circuit breaker shall be provided with nonthermal sensing, instantaneous-only short-circuit overcurrent protection to comply with available fault currents.
7. Local **and Remote** Alarm and Status Indications:
  - a. Normal source available.
  - b. Alternate source available.
  - c. In normal position.
  - d. In alternate position.
  - e. Isolating means open.
8. Audible alarm, with silence push button.
9. Nonautomatic (manual, nonelectric) means of transfer.
10. Engine test push button.
11. Start generator output contacts.
12. Timer for weekly generator tests.

## 2.2 CONTROLLERS FOR PRESSURE-MAINTENANCE 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. Aquarius Fluid Products, Inc.
  2. ASCO Power Technologies, LP; Firetrol Products.
  3. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  4. Hubbell Incorporated; Hubbell Industrial Controls.
  5. Master Control Systems, Inc.
  6. Metron, Inc.
- B. General Requirements for Pressure-Maintenance-Pump Controllers:
  1. Type: UL 508 factory assembled, -wired, and tested, across-the-line; for combined automatic and manual operation.
  2. Enclosure: UL 508 and NEMA 250, Type 2 for wall-mounting.
  3. Factory assembled, wired, and tested.
  4. Finish: Manufacturer's standard color paint.

C. Rate controller for scheduled horsepower and include the following:

1. Fusible disconnect switch.
2. Pressure switch.
3. Hand-off-auto selector switch.
4. Pilot light.
5. Running period timer.

### 2.3 REMOTE ALARM PANELS

A. General Requirements for Remote Alarm Panels: Comply with NFPA 20 and **UL 218** ; listed by an NRTL for fire-pump service.

B. Manufacturers: Subject to compliance with requirements, **available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:**

1. Aquarius Fluid Products, Inc.
2. ASCO Power Technologies, LP; Firetrol Products.
3. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
4. Hubbell Incorporated; Hubbell Industrial Controls.
5. Master Control Systems, Inc.
6. Metron, Inc.

C. General Requirements for Remote Alarm Panels: Factory assembled, wired, and tested.

D. Supervisory **and Normal** Control Voltage: **120-V ac** source.

E. Audible and Visual Alarm and Status Indications:

1. Driver running.
2. Loss of phase.
3. Phase reversal.
4. Supervised power on.
5. **Separate** trouble on the controller.
6. Controller connected to alternate power source.

F. Audible and Visual Alarm and Status Indications: Manufacturer's standard indicating lights; **push-to-test**

1. Engine running.
2. Controller main switch turned to the off or manual position.
3. Supervised power on.
4. **Separate** trouble on the controller or engine.

5. Common pump room trouble.
  6. Controller connected to alternate power source.
- G. Audible alarm, with silence push button.
- H. Pump REMOTE START push button.

## 2.4 ENCLOSURES

- A. Fire-Pump Controllers, ATS, Remote Alarm Panels, and Low-Suction-Shutdown Panels: NEMA 250, to comply with environmental conditions at installed locations and NFPA 20.
1. Other Wet or Damp, Indoor Locations: **Type 4 (IEC IP56)** Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12 (IEC IP12).
- B. Enclosure Color: **Manufacturer's standard "fire-pump-controller red"** Nameplates: Comply with NFPA 20; complete with capacity, characteristics, approvals, listings, and other pertinent data.
- C. Optional Features:
1. Floor stands, **12 inches (305 mm)** high, for floor-mounted controllers.

## 2.5 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect fire-pump controllers according to requirements in NFPA 20 and **UL 218**
1. Verification of Performance: Rate controllers according to operation of functions and features specified.
- B. Fire-pump controllers will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and surfaces to receive equipment, with Installer present, for compliance with requirements and other conditions affecting performance.

- B. Examine equipment before installation. Reject equipment that is wet or damaged by moisture or mold.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 CONTROLLER INSTALLATION

- A. Install controllers within sight of their respective drivers.
- B. Connect controllers to their dedicated pressure-sensing lines.
- C. Wall-Mounting Controllers: Install controllers on walls with disconnect operating handles not higher than **79 inches (2006 mm)** above finished floor, and bottom of enclosure not less than **12 inches (305 mm)** above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."
- D. Floor-Mounting Controllers: Install controllers on **4-inch (100-mm)** nominal-thickness concrete bases, using floor stands high enough so that the bottom of enclosure cabinet is not less than **12 inches (305 mm)** above finished floor. Comply with requirements for concrete bases specified in Division 03 Section **Miscellaneous Cast-in-Place Concrete.**
  - 1. 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 concrete base.
  - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
  - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- F. Comply with NEMA ICS 15.

### 3.3 REMOTE ALARM PANEL INSTALLATION

- A. Install panels on walls with tops not higher than **60 inches (1829 mm)** above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For ATS not on walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

### 3.4 POWER WIRING INSTALLATION

- A. Install power wiring between controllers and their services or sources, and between controllers and their drivers. Comply with requirements in NFPA 20, NFPA 70, and Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

### 3.5 CONTROL AND ALARM WIRING INSTALLATION

- A. Install wiring between controllers and remote devices **and facility's central monitoring system**. Comply with requirements in NFPA 20, NFPA 70, and Division 26 Section "Control-Voltage Electrical Power Cables."
- B. Install wiring between remote alarm **and low-suction-shutdown** panels and controllers. Comply with requirements in NFPA 20, NFPA 70, and Division 26 Section "Control-Voltage Electrical Power Cables."
- C. Install wiring between controllers and the building's fire-alarm system. Comply with requirements specified in Division 28 Section "Digital, Addressable Fire-Alarm System."
- D. Bundle, train, and support wiring in enclosures.
- E. Connect remote manual and automatic activation devices where applicable.

### 3.6 IDENTIFICATION

- A. Comply with requirements in NFPA 20 for marking fire-pump controllers.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification in NFPA 20 and as specified in Division 26 Section "Identification for Electrical Systems."

### 3.7 FIELD QUALITY CONTROL

- A. Testing Agency: **Engage** a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Acceptance Testing Preparation:



1. Inspect and Test Each Component:
  - a. Inspect wiring, components, connections, and equipment installations. Test and adjust components and equipment.
  - b. Test insulation resistance for each element, component, connecting supply, feeder, and control circuits.
  - c. Test continuity of each circuit.
2. Verify and Test Each Electric-Driver Controller:
  - a. Verify that voltages at controller locations are within plus 10 or minus 1 percent of motor nameplate rated voltages, with motors off. If outside this range for any motor, notify **Construction Manager** before starting the motor(s).
  - b. Test each motor for proper phase rotation.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Field Acceptance Tests:

1. Do not begin field acceptance testing until suction piping has been flushed and hydrostatically tested and the certificate for flushing and testing has been submitted to **Construction Manager** and authorities having jurisdiction.
2. Prior to starting, notify authorities having jurisdiction of the time and place of the acceptance testing.
3. Engage manufacturer's factory-authorized service representative to be present during the testing.
4. Perform field acceptance tests as outlined in NFPA 20.

F. Controllers will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

### 3.8 STARTUP SERVICE

A. **Engage a factory-authorized service representative to perform** startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

### 3.9 ADJUSTING

- A. Adjust controllers **and battery charger systems** to function smoothly and as recommended by manufacturer.
- B. Set field-adjustable switches, auxiliary relays, time-delay relays, and timers.
- C. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
- D. Set field-adjustable pressure switches.

### 3.10 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.
- B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

### 3.11 DEMONSTRATION

- A. **Engage a factory-authorized service representative to train** Owner's maintenance personnel to adjust, operate, and maintain controllers, **remote alarm panels, and to use and reprogram microprocessor-based controls within this equipment.**

END OF SECTION 213900

## SECTION 220513

### COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

#### 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 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.

##### 1.3 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
  - 1. Motor controllers.
  - 2. Torque, speed, and horsepower requirements of the load.
  - 3. Ratings and characteristics of supply circuit and required control sequence.
  - 4. Ambient and environmental conditions of installation location.

#### PART 2 - PRODUCTS

##### 2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with requirements in this Section except when stricter requirements are specified in plumbing equipment schedules or Sections.
- B. Comply with NEMA MG 1 unless otherwise indicated.
- C. Comply with IEEE 841 for severe-duty motors.

## 2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of **3300 feet (1000 m)** 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. Multispeed Motors: Separate winding for each speed.
- F. Rotor: Random-wound, squirrel cage.
- G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- H. Temperature Rise: Match insulation rating.
- I. Insulation: **Class F**
- J. Code Letter Designation:
  - 1. Motors **15** HP and Larger: NEMA starting Code F or Code G.
  - 2. Motors Smaller than **15** HP: Manufacturer's standard starting characteristic.
- K. Enclosure Material: Cast iron for motor frame sizes **324T** and larger; rolled steel for motor frame sizes smaller than **324T**.

## 2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

- B. **Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.**
  - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
  - 2. 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.
- C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

## 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 220513

## SECTION 220516

### EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- A. Section Includes:
  1. Grooved-joint expansion joints.
  2. Pipe loops and swing connections.
  3. Alignment guides and anchors.

##### 1.3 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.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Delegated-Design Submittal: For each anchor and alignment guide 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. 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.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Product Certificates: For each type of expansion joint, from manufacturer.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For expansion joints to include in maintenance manuals.

#### 1.7 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
  1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
  2. ASME Boiler and Pressure Vessel Code: Section IX.

### PART 2 - PRODUCTS

#### 2.1 GROOVED-JOINT EXPANSION JOINTS

- 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. Anvil International, Inc.
  2. Shurjoint Piping Products.
  3. Victaulic Company.
- B. Description: Factory-assembled expansion joint made of several grooved-end pipe nipples, couplings, and grooved joints.
- C. Standard: AWWA C606, for grooved joints.
- D. Nipples: **Galvanized**, ASTM A 53/A 53M, Schedule 40, Type E or S, steel pipe with grooved ends.

## 2.2 ALIGNMENT GUIDES AND ANCHORS

### A. Alignment Guides:

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. Flex-Hose Co., Inc.
  - d. Flexicraft Industries.
  - e. Flex-Weld, Inc.
  - f. Hyspan Precision Products, Inc.
  - g. Metraflex, Inc.
  - h. Senior Flexonics Pathway.
  - i. Unisource Manufacturing, Inc.
  - j. U.S. Bellows, Inc.
2. **Description:** Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding spider for bolting to pipe.

### B. Anchor Materials:

1. **Steel Shapes and Plates:** ASTM A 36/A 36M.
2. **Bolts and Nuts:** ASME B18.10 or ASTM A 183, steel hex head.
3. **Washers:** ASTM F 844, 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 C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
  - b. **Stud:** ASTM A 307, zinc-coated carbon steel with continuous thread on stud unless otherwise indicated.
  - c. **Washer and Nut:** Zinc-coated steel.



## PART 3 - EXECUTION

### 3.1 EXPANSION-JOINT INSTALLATION

- A. Install expansion joints of sizes matching sizes of piping in which they are installed.
- B. Install grooved-joint expansion joints to grooved-end steel piping

### 3.2 PIPE LOOP AND SWING CONNECTION INSTALLATION

- 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 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

- 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 Black-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 Galvanized-Steel Pipe: Attach with pipe hangers. Use MSS SP-69, Type 42, riser clamp welded to anchor.
  - 3. 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 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. Sleeves.
  - 2. Stack-sleeve fittings.
  - 3. Sleeve-seal systems.
  - 4. Sleeve-seal fittings.
  - 5. Grout.

##### 1.3 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 (0.6-mm)** minimum thickness; round tube closed with welded longitudinal joint.
- F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- G. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

## 2.2 STACK-SLEEVE 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. Smith, Jay R. Mfg. Co.
  - 2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
  - 3. **<Insert manufacturer's name>**.
- B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
  - 1. Underdeck Clamp: Clamping ring with setscrews.

## 2.3 SLEEVE-SEAL SYSTEMS

- 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. Advance Products & Systems, Inc.
  - 2. CALPICO, Inc.
  - 3. Metraflex Company (The).
  - 4. Pipeline Seal and Insulator, Inc.
  - 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: **Carbon steel** Connecting Bolts and Nuts: **Carbon steel, with corrosion-resistant coating**, of length required to secure pressure plates to sealing elements.

## 2.4 SLEEVE-SEAL 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. Presealed Systems.
- B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

## 2.5 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 (34.5-MPa)**, 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 (25-mm)** 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. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
  - 2. 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 (50 mm)** above finished floor level.

3. 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 (6.4-mm)** 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 Division 07 Section "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 Division 07 Section "Penetration Firestopping."

### 3.2 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
1. Install fittings that are large enough to provide **1/4-inch (6.4-mm)** annular clear space between sleeve and pipe or pipe insulation.
  2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Division 07 Section "Sheet Metal Flashing and Trim."
  3. Install section of cast-iron soil pipe to extend sleeve to **2 inches (50 mm)** above finished floor level.
  4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
  5. Using grout, seal the space around outside of stack-sleeve fittings.
- B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

### 3.3 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.

### 3.4 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

### 3.5 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 (DN 150)**: **Cast-iron wall sleeves**
    - b. Piping **NPS 6 (DN 150)** and Larger: **Cast-iron wall sleeves**
  - 2. Exterior Concrete Walls below Grade:
    - a. Piping Smaller Than **NPS 6 (DN 150)**: **Cast-iron wall sleeves with sleeve-seal system**
      - 1) Select sleeve size to allow for **1-inch (25-mm)** annular clear space between piping and sleeve for installing sleeve-seal system.
    - b. Piping **NPS 6 (DN 150)** and Larger: **Cast-iron wall sleeves with sleeve-seal system**
      - 1) Select sleeve size to allow for **1-inch (25-mm)** annular clear space between piping and sleeve for installing sleeve-seal system.
  - 3. Concrete Slabs-on-Grade:
    - a. Piping Smaller Than **NPS 6 (DN 150)**: **Cast-iron wall sleeves with sleeve-seal system**
      - 1) Select sleeve size to allow for **1-inch (25-mm)** annular clear space between piping and sleeve for installing sleeve-seal system.
    - b. Piping **NPS 6 (DN 150)** and Larger: **Cast-iron wall sleeves with sleeve-seal system**
      - 1) Select sleeve size to allow for **1-inch (25-mm)** annular clear space between piping and sleeve for installing sleeve-seal system.
  - 4. Concrete Slabs above Grade:

- a. Piping Smaller Than **NPS 6 (DN 150)**: **Galvanized-steel-pipe sleeves, PVC-pipe sleeves,**
  - b. Piping **NPS 6 (DN 150)** and Larger: **Galvanized-steel-pipe sleeves, PVC-pipe sleeves**
5. Interior Partitions:
- a. Piping Smaller Than **NPS 6 (DN 150)**: **Galvanized-steel-pipe sleeves, PVC-pipe sleeves .**
  - b. Piping **NPS 6 (DN 150)** and Larger: Galvanized-steel-sheet sleeves

END OF SECTION 220517



## SECTION 220518

### ESCUTCHEONS FOR PLUMBING PIPING

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- A. Section Includes:
  - 1. Escutcheons.
  - 2. Floor plates.

##### 1.3 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 and rough-brass** 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.
- D. Split-Casting Brass Type: With **polished, chrome-plated and rough-brass** finish and with concealed hinge and setscrew.
- E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, **concealed and exposed-rivet]** hinge, and spring-clip fasteners.

## 2.2 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange **with holes for fasteners**.
- B. Split-Casting Floor Plates: Cast brass with concealed hinge.

## 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 insulated 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 Retain one of first two subparagraphs below.
    - 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 Retain one of first two subparagraphs below.
    - h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass **or split-casting brass** type with **rough-brass** finish.
    - i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type **or split-plate, stamped-steel type with concealed hinge or split-plate, stamped-steel type with exposed-rivet hinge**.
    - j. Bare Piping in Equipment Rooms: One-piece, cast-brass **or split-casting brass** type with **rough-brass** finish.
    - k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type **or split-plate, stamped-steel type with concealed hinge or split-plate, stamped-steel type with exposed-rivet hinge**.
- 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 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. Bimetallic-actuated thermometers.
2. Filled-system thermometers.
3. Liquid-in-glass thermometers.
4. Dial-type pressure gages.
5. Gage attachments.
6. Test plugs.
7. Test-plug kits.

- B. Related Sections:

1. Division 22 Section " Domestic Water Piping" for water meters inside the building.

##### 1.3 ACTION SUBMITTALS

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

##### 1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of meter and gage, from manufacturer.

##### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

## PART 2 - PRODUCTS

### 2.1 BIMETALLIC-ACTUATED THERMOMETERS

- 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. 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. Terrice, H. O. Co.
  11. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
  12. Weiss Instruments, Inc.
  13. WIKA Instrument Corporation - USA.
  14. Winters Instruments - U.S.
- B. Standard: ASME B40.200.
- C. Case: **Liquid-filled and sealed** type(s); stainless steel with **5-inch (127-mm)** nominal diameter.
- D. Dial: **Nonreflective aluminum** with permanently etched scale markings and scales in **deg F (deg C)**.
- E. Connector Type(s): Union joint, **adjustable angle** , with unified-inch screw threads.
- F. Connector Size: [**1/2 inch (13 mm)**] , with ASME B1.1 screw threads.
- G. Stem: **0.25 or 0.375 inch (6.4 or 9.4 mm)** in diameter; stainless steel.
- H. Window: **Plain glass or plastic** .
- I. Ring: Stainless steel.
- J. Element: Bimetal coil.
- K. Pointer: Dark-colored metal.
- L. Accuracy: Plus or minus **1.5** percent of scale range.

## 2.2 FILLED-SYSTEM THERMOMETERS

### A. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:

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. Ashcroft Inc.
  - b. Marsh Bellofram.
  - c. Miljoco Corporation.
  - d. Palmer Wahl Instrumentation Group.
  - e. REOTEMP Instrument Corporation.
  - f. Trerice, H. O. Co.
  - g. Weiss Instruments, Inc.
2. Standard: ASME B40.200.
3. Case: Sealed type, **cast aluminum or drawn steel ; 5-inch (127-mm)** nominal diameter.
4. Element: Bourdon tube or other type of pressure element.
5. Movement: Mechanical,] with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in **deg F (deg C)**.
7. Pointer: Dark-colored metal.
8. Window: **Glass or plastic** .
9. Ring: **Stainless steel**.
10. Connector Type(s): Union joint, **adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device** ; with ASME B1.1 screw threads.
11. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
  - a. Design for Thermowell Installation: Bare stem.
12. Accuracy: Plus or minus **1** percent of scale range.

### B. Direct-Mounted, Plastic-Case, Vapor-Actuated Thermometers:

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. Ashcroft Inc.
  - b. Miljoco Corporation.
  - c. REOTEMP Instrument Corporation.
2. Standard: ASME B40.200.

3. Case: Sealed type, **plastic** ; **5-inch (127-mm)** nominal diameter.
4. Element: Bourdon tube or other type of pressure element.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in **deg F (deg C)**.
7. Pointer: Dark-colored metal.
8. Window: **Glass or plastic**
9. Ring: **Metal or plastic**
10. Connector Type(s): Union joint, **adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device**; with ASME B1.1 screw threads.
11. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
  - a. Design for Thermowell Installation: Bare stem.
12. Accuracy: Plus or minus **1** percent of scale range.

## 2.3 LIQUID-IN-GLASS THERMOMETERS

### A. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:

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. Trerice, H. O. Co.
2. Standard: ASME B40.200.
3. Case: **Cast aluminum**; **6-inch (152-mm)** nominal size.
4. Case Form: **Back 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 and deg C**.
7. Window: Glass or plastic.
8. Stem: Aluminum or brass and of length to suit installation.
  - a. Design for Thermowell Installation: Bare stem.
9. Connector: **3/4 inch (19 mm)**, 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.

## 2.4 PRESSURE GAGES

### A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

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. AMETEK, Inc.; 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. Terice, H. O. Co.
  - l. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
  - m. Weiss Instruments, Inc.
  - n. WIKA Instrument Corporation - USA.
  - o. Winters Instruments - U.S.
2. Standard: ASME B40.100.
3. Case: **Liquid-filled Sealed** type(s); **cast aluminum or drawn steel; 6-inch (152-mm)** nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with **NPS 1/4 (DN** , 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 (kPa)**
8. Pointer: Dark-colored metal.
9. Window: **Glass or plastic.**
10. Ring: **Metal, Brass**
11. Accuracy: **Grade A, plus or minus 1 percent of middle half of scale range.**
12. ange.

## 2.5 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with **NPS 1/4 or NPS 1/2 (DN 8 or DN 15) (DN 15)**, 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 (DN 8 or DN 15)**, ASME B1.20.1 pipe threads.

## 2.6 TEST PLUGS

- A. Manufacturers: Subject to compliance with requirements, **available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:**

1. Flow Design, Inc.
2. Miljoco Corporation.
3. National Meter, Inc.
4. Peterson Equipment Co., Inc.
5. Sisco Manufacturing Company, Inc.
6. Terrice, H. O. Co.
7. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
8. Weiss Instruments, Inc.

- B. Description: Test-station fitting made for insertion into piping tee fitting.

- C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

- D. Thread Size: **[NPS 1/4 (DN 8) or NPS 1/2 (DN 15)**, ASME B1.20.1 pipe thread.

- E. Minimum Pressure and Temperature Rating: **[500 psig at 200 deg F (3450 kPa at 93 deg C)**.

- F. Core Inserts: **Chlorosulfonated polyethylene synthetic and EPDM** self-sealing rubber.

## 2.7 TEST-PLUG KITS

- 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. Flow Design, Inc.
2. Miljoco Corporation.
3. National Meter, Inc.
4. Peterson Equipment Co., Inc.
5. Sisco Manufacturing Company, Inc.
6. Terrice, H. O. Co.
7. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
8. Weiss Instruments, Inc.

- B. Furnish **one** test-plug kit(s) containing **one** thermometer, one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.
- C. Low-Range Thermometer: Small, bimetallic insertion type with **1- to 2-inch- (25- to 51-mm-)** diameter dial and tapered-end sensing element. Dial range shall be at least **25 to 125 deg F (minus 4 to plus 52 deg C)**.
- D. High-Range Thermometer: Small, bimetallic insertion type with **1- to 2-inch- (25- to 51-mm-)** diameter dial and tapered-end sensing element. Dial range shall be at least **0 to 220 deg F (minus 18 to plus 104 deg C)**.
- E. Pressure Gage: Small, Bourdon-tube insertion type with **2- to 3-inch- (51- to 76-mm-)** diameter dial and probe. Dial range shall be at least **0 to 200 psig (0 to 1380 kPa)**  
Carrying Case: Metal or plastic, with formed instrument padding.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install thermowells with socket extending **a minimum of 2 inches (51 mm) into fluid 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 test plugs in piping tees.

- K. Install thermometers in the following locations:
  - 1. Inlet and outlet of each water heater.
  - 2. Inlet and outlet of each domestic hot-water storage tank.
  
- L. 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.

### 3.2 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

### 3.3 ADJUSTING

- A. Adjust faces of meters and gages to proper angle for best visibility.

END OF SECTION 220519

## SECTION 220523

### GENERAL-DUTY VALVES FOR PLUMBING PIPING

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

###### A. Section Includes:

1. Bronze angle valves.
2. Brass ball valves.
3. Bronze ball valves.
4. Bronze lift check valves.
5. Bronze swing check valves.
6. Bronze gate valves.
7. Bronze globe valves.
8. Lubricated plug valves.

###### B. Related Sections:

1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
2. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
3. Division 33 water distribution piping Sections for general-duty and specialty valves for site construction piping.

##### 1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.

- E. OS&Y: Outside screw and yoke.
- F. RS: Rising stem.
- G. SWP: Steam working pressure.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of valve indicated.

#### 1.5 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
  - 1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
  - 2. ASME B31.1 for power piping valves.
  - 3. ASME B31.9 for building services piping valves.
- C. NSF Compliance: NSF 61 for valve materials for potable-water service.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
  - 1. Protect internal parts against rust and corrosion.
  - 2. Protect threads, flange faces, grooves, and weld ends.
  - 3. Set angle, gate, and globe valves closed to prevent rattling.
  - 4. Set ball and plug valves open to minimize exposure of functional surfaces.
  - 5. Set butterfly valves closed or slightly open.
  - 6. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
  - 1. Maintain valve end protection.
  - 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to valve schedule articles for applications of valves.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. Valve Sizes: Same as upstream piping unless otherwise indicated.
- D. Valve Actuator Types:
  - 1. Handwheel: For valves other than quarter-turn types.
  - 2. Handlever: For quarter-turn valves **NPS 6 (DN 150)** and smaller **except plug valves**.
  - 3. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every **5** plug valves, for each size square plug-valve head.
- E. Valves in Insulated Piping: With **2-inch (50-mm)** stem extensions and the following features:
  - 1. Gate Valves: With rising stem.
  - 2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
  - 3. Butterfly Valves: With extended neck.
- F. Valve-End Connections:
  - 1. Flanged: With flanges according to ASME B16.1 for iron valves.
  - 2. Grooved: With grooves according to AWWA C606.
  - 3. Solder Joint: With sockets according to ASME B16.18.
  - 4. Threaded: With threads according to ASME B1.20.1.
- G. Valve Bypass and Drain Connections: MSS SP-45.

### 2.2 BRONZE ANGLE VALVES

- A. Class 125, Bronze Angle Valves with Bronze Disc:
  - 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. Hammond Valve.
    - b. Milwaukee Valve Company.

2. Description:
  - a. Standard: MSS SP-80, Type 1.
  - b. CWP Rating: 200 psig (1380 kPa).
  - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
  - d. Ends: Threaded.
  - e. Stem and Disc: Bronze.
  - f. Packing: Asbestos free.
  - g. Handwheel: Malleable iron[, **bronze, or aluminum**].

B. Class 125, Bronze Angle Valves with Nonmetallic Disc:

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. American Valve, Inc.
- b. NIBCO INC.

2. Description:

- a. Standard: MSS SP-80, Type 2.
- b. CWP Rating: 200 psig (1380 kPa).
- c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
- d. Ends: Threaded.
- e. Stem: Bronze.
- f. Disc: PTFE or TFE.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron[, **bronze, or aluminum**].

C. Class 150, Bronze Angle Valves with Bronze Disc:

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. Crane Co.; Crane Valve Group; Stockham Division.
- b. Kitz Corporation.

2. Description:

- a. Standard: MSS SP-80, Type 1.
- b. CWP Rating: 300 psig (2070 kPa).
- c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
- d. Ends: Threaded.
- e. Stem and Disc: Bronze.
- f. Packing: Asbestos free.

g. Handwheel: Malleable iron or **bronze**,

D. Class 150, Bronze Angle Valves with Nonmetallic Disc:

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. Crane Co.; Crane Valve Group; Crane Valves.
- b. Crane Co.; Crane Valve Group; Jenkins Valves.
- c. Crane Co.; Crane Valve Group; Stockham Division.
- d. Hammond Valve.
- e. Milwaukee Valve Company.
- f. NIBCO INC.
- g. Powell Valves.

2. Description:

- a. Standard: MSS SP-80, Type 2.
- b. CWP Rating: **300 psig (2070 kPa)**.
- c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
- d. Ends: Threaded.
- e. Stem: Bronze.
- f. Disc: PTFE or TFE.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron or **bronze**

## 2.3 BRASS BALL VALVES

A. One-Piece, Reduced-Port, Brass Ball Valves with Brass Trim:

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. Kitz Corporation.
- b. **<Insert manufacturer's name>**.

2. Description:

- a. Standard: MSS SP-110.
- b. CWP Rating: **400 psig (2760 kPa)**.
- c. Body Design: One piece.
- d. Body Material: Forged brass.
- e. Ends: Threaded.
- f. Seats: PTFE or TFE.



- g. Stem: Brass.
- h. Ball: Chrome-plated brass.
- i. Port: Reduced.

B. Two-Piece, Full-Port, Brass Ball Valves with Brass Trim:

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. Crane Co.; Crane Valve Group; Crane Valves.
- b. Crane Co.; Crane Valve Group; Jenkins Valves.
- c. DynaQuip Controls.
- d. Flow-Tek, Inc.; a subsidiary of Bray International, Inc.
- e. Hammond Valve.
- f. Jamesbury; a subsidiary of Metso Automation.
- g. Jomar International, LTD.
- h. Kitz Corporation.
- i. Legend Valve.
- j. Marwin Valve; a division of Richards Industries.
- k. Milwaukee Valve Company.
- l. NIBCO INC.

2. Description:

- a. Standard: MSS SP-110.
- b. SWP Rating: 150 psig (1035 kPa).
- c. CWP Rating: 600 psig (4140 kPa).
- d. Body Design: Two piece.
- e. Body Material: Forged brass.
- f. Ends: Threaded.
- g. Seats: PTFE or TFE.
- h. Stem: Brass.
- i. Ball: Chrome-plated brass.
- j. Port: Full.

C. Two-Piece, Full-Port, Brass Ball Valves with Stainless-Steel Trim:

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. Crane Co.; Crane Valve Group; Crane Valves.
- b. Crane Co.; Crane Valve Group; Jenkins Valves.
- c. Flow-Tek, Inc.; a subsidiary of Bray International, Inc.
- d. Hammond Valve.
- e. Jamesbury; a subsidiary of Metso Automation.
- f. Kitz Corporation.

- g. Marwin Valve; a division of Richards Industries.
- h. Milwaukee Valve Company.

2. Description:

- a. Standard: MSS SP-110.
- b. SWP Rating: 150 psig (1035 kPa).
- c. CWP Rating: 600 psig (4140 kPa).
- d. Body Design: Two piece.
- e. Body Material: Forged brass.
- f. Ends: Threaded.
- g. Seats: PTFE or TFE.
- h. Stem: Stainless steel.
- i. Ball: Stainless steel, vented.
- j. Port: Full.

D. Two-Piece, Regular-Port, Brass Ball Valves with Brass Trim:

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. Hammond Valve.
- b. Jamesbury; a subsidiary of Metso Automation.
- c. Legend Valve.
- d. Marwin Valve; a division of Richards Industries.
- e. Milwaukee Valve Company.

2. Description:

- a. Standard: MSS SP-110.
- b. SWP Rating: 150 psig (1035 kPa).
- c. CWP Rating: 600 psig (4140 kPa).
- d. Body Design: Two piece.
- e. Body Material: Forged brass.
- f. Ends: Threaded.
- g. Seats: PTFE or TFE.
- h. Stem: Brass.
- i. Ball: Chrome-plated brass.
- j. Port: Regular.

E. Two-Piece, Regular-Port, Brass Ball Valves with Stainless-Steel Trim:

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. Jamesbury; a subsidiary of Metso Automation.

b. Marwin Valve; a division of Richards Industries.

2. Description:

- a. Standard: MSS SP-110.
- b. SWP Rating: 150 psig (1035 kPa).
- c. CWP Rating: 600 psig (4140 kPa).
- d. Body Design: Two piece.
- e. Body Material: Brass or bronze.
- f. Ends: Threaded.
- g. Seats: PTFE or TFE.
- h. Stem: Stainless steel.
- i. Ball: Stainless steel, vented.
- j. Port: Regular.

F. Three-Piece, Full-Port, Brass Ball Valves with Brass Trim:

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. Jomar International, LTD.
- b. Kitz Corporation.
- c. Red-White Valve Corporation.
- d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-110.
- b. SWP Rating: 150 psig (1035 kPa).
- c. CWP Rating: 600 psig (4140 kPa).
- d. Body Design: Three piece.
- e. Body Material: Forged brass.
- f. Ends: Threaded.
- g. Seats: PTFE or TFE.
- h. Stem: Brass.
- i. Ball: Chrome-plated brass.
- j. Port: Full.

G. Three-Piece, Full-Port, Brass Ball Valves with Stainless-Steel Trim:

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. Jomar International, LTD.
- b. Kitz Corporation.
- c. Marwin Valve; a division of Richards Industries.

d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-110.
- b. SWP Rating: 150 psig (1035 kPa).
- c. CWP Rating: 600 psig (4140 kPa).
- d. Body Design: Three piece.
- e. Body Material: Forged brass.
- f. Ends: Threaded.
- g. Seats: PTFE or TFE.
- h. Stem: Stainless steel.
- i. Ball: Stainless steel, vented.
- j. Port: Full.

2.4 BRONZE BALL VALVES

A. One-Piece, Reduced-Port, Bronze Ball Valves with Bronze Trim:

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. American Valve, Inc.
- b. Conbraco Industries, Inc.; Apollo Valves.
- c. NIBCO INC.

2. Description:

- a. Standard: MSS SP-110.
- b. CWP Rating: 400 psig (2760 kPa).
- c. Body Design: One piece.
- d. Body Material: Bronze.
- e. Ends: Threaded.
- f. Seats: PTFE or TFE.
- g. Stem: Bronze.
- h. Ball: Chrome-plated brass.
- i. Port: Reduced.

B. One-Piece, Reduced-Port, Bronze Ball Valves with Stainless-Steel Trim:

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. Conbraco Industries, Inc.; Apollo Valves.
- b. NIBCO INC.

2. Description:
  - a. Standard: MSS SP-110.
  - b. CWP Rating: 600 psig (4140 kPa).
  - c. Body Design: One piece.
  - d. Body Material: Bronze.
  - e. Ends: Threaded.
  - f. Seats: PTFE or TFE.
  - g. Stem: Stainless steel.
  - h. Ball: Stainless steel, vented.
  - i. Port: Reduced.

C. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

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. American Valve, Inc.
  - b. Conbraco Industries, Inc.; Apollo Valves.
  - c. Crane Co.; Crane Valve Group; Crane Valves.
  - d. Hammond Valve.
  - e. Lance Valves; a division of Advanced Thermal Systems, Inc.
  - f. Legend Valve.
  - g. Milwaukee Valve Company.
  - h. NIBCO INC.
  - i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
  - a. Standard: MSS SP-110.
  - b. SWP Rating: 150 psig (1035 kPa).
  - c. CWP Rating: 600 psig (4140 kPa).
  - d. Body Design: Two piece.
  - e. Body Material: Bronze.
  - f. Ends: Threaded.
  - g. Seats: PTFE or TFE.
  - h. Stem: Bronze.
  - i. Ball: Chrome-plated brass.
  - j. Port: Full.

D. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

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. Conbraco Industries, Inc.; Apollo Valves.

- b. Crane Co.; Crane Valve Group; Crane Valves.
- c. Hammond Valve.
- d. Lance Valves; a division of Advanced Thermal Systems, Inc.
- e. Milwaukee Valve Company.
- f. NIBCO INC.
- g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-110.
- b. SWP Rating: 150 psig (1035 kPa).
- c. CWP Rating: 600 psig (4140 kPa).
- d. Body Design: Two piece.
- e. Body Material: Bronze.
- f. Ends: Threaded.
- g. Seats: PTFE or TFE.
- h. Stem: Stainless steel.
- i. Ball: Stainless steel, vented.
- j. Port: Full.

E. Two-Piece, Regular-Port, Bronze Ball Valves with Bronze Trim:

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. American Valve, Inc.
- b. Conbraco Industries, Inc.; Apollo Valves.
- c. Crane Co.; Crane Valve Group; Jenkins Valves.
- d. Crane Co.; Crane Valve Group; Stockham Division.
- e. DynaQuip Controls.
- f. Hammond Valve.
- g. Lance Valves; a division of Advanced Thermal Systems, Inc.
- h. Milwaukee Valve Company.
- i. NIBCO INC.

2. Description:

- a. Standard: MSS SP-110.
- b. SWP Rating: 150 psig (1035 kPa).
- c. CWP Rating: 600 psig (4140 kPa).
- d. Body Design: Two piece.
- e. Body Material: Bronze.
- f. Ends: Threaded.
- g. Seats: PTFE or TFE.
- h. Stem: Bronze.
- i. Ball: Chrome-plated brass.
- j. Port: Regular.

F. Two-Piece, Regular-Port, Bronze Ball Valves with Stainless-Steel Trim:

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. Conbraco Industries, Inc.; Apollo Valves.
  - b. Crane Co.; Crane Valve Group; Jenkins Valves.
  - c. Hammond Valve.
  - d. Milwaukee Valve Company.
2. Description:
  - a. Standard: MSS SP-110.
  - b. SWP Rating: **150 psig (1035 kPa)**.
  - c. CWP Rating: **600 psig (4140 kPa)**.
  - d. Body Design: Two piece.
  - e. Body Material: Bronze.
  - f. Ends: Threaded.
  - g. Seats: PTFE or TFE.
  - h. Stem: Stainless steel.
  - i. Ball: Stainless steel, vented.
  - j. Port: Regular.

G. Three-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

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. Conbraco Industries, Inc.; Apollo Valves.
  - b. DynaQuip Controls.
  - c. Hammond Valve.
  - d. Milwaukee Valve Company.
  - e. NIBCO INC.
2. Description:
  - a. Standard: MSS SP-110.
  - b. SWP Rating: **150 psig (1035 kPa)**.
  - c. CWP Rating: **600 psig (4140 kPa)**.
  - d. Body Design: Three piece.
  - e. Body Material: Bronze.
  - f. Ends: Threaded.
  - g. Seats: PTFE or TFE.
  - h. Stem: Bronze.
  - i. Ball: Chrome-plated brass.
  - j. Port: Full.

H. Three-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

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. Conbraco Industries, Inc.; Apollo Valves.
  - b. Hammond Valve.
  - c. Milwaukee Valve Company.
  - d. NIBCO INC.
2. Description:
  - a. Standard: MSS SP-110.
  - b. SWP Rating: **150 psig (1035 kPa)**.
  - c. CWP Rating: **600 psig (4140 kPa)**.
  - d. Body Design: Three piece.
  - e. Body Material: Bronze.
  - f. Ends: Threaded.
  - g. Seats: PTFE or TFE.
  - h. Stem: Stainless steel.
  - i. Ball: Stainless steel, vented.
  - j. Port: Full.

2.5 BRONZE LIFT CHECK VALVES

A. Class 125, Lift Check Valves with Bronze Disc:

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. Crane Co.; Crane Valve Group; Crane Valves.
  - b. Crane Co.; Crane Valve Group; Jenkins Valves.
  - c. Crane Co.; Crane Valve Group; Stockham Division.
2. Description:
  - a. Standard: MSS SP-80, Type 1.
  - b. CWP Rating: **200 psig (1380 kPa)**.
  - c. Body Design: Vertical flow.
  - d. Body Material: ASTM B 61 or ASTM B 62, bronze.
  - e. Ends: Threaded.
  - f. Disc: Bronze.

B. Class 125, Lift Check Valves with Nonmetallic Disc:



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. Flo Fab Inc.
  - b. Hammond Valve.
  - c. Kitz Corporation.
  - d. Milwaukee Valve Company.
  - e. Mueller Steam Specialty; a division of SPX Corporation.
  - f. NIBCO INC.
  - g. Red-White Valve Corporation.
  - h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - i. **<Insert manufacturer's name>**.
2. Description:
  - a. Standard: MSS SP-80, Type 2.
  - b. CWP Rating: **200 psig (1380 kPa)**.
  - c. Body Design: Vertical flow.
  - d. Body Material: ASTM B 61 or ASTM B 62, bronze.
  - e. Ends: Threaded.
  - f. Disc: NBR, PTFE, or TFE.

## 2.6 BRONZE SWING CHECK VALVES

### A. Class 125, Bronze Swing Check Valves with Bronze Disc:

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. American Valve, Inc.
  - b. Crane Co.; Crane Valve Group; Crane Valves.
  - c. Crane Co.; Crane Valve Group; Jenkins Valves.
  - d. Crane Co.; Crane Valve Group; Stockham Division.
  - e. Hammond Valve.
  - f. Kitz Corporation.
  - g. Milwaukee Valve Company.
  - h. NIBCO INC.
  - i. Powell Valves.
  - j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - k. Zy-Tech Global Industries, Inc.
2. Description:
  - a. Standard: MSS SP-80, Type 3.
  - b. CWP Rating: **200 psig (1380 kPa)**.

- c. Body Design: Horizontal flow.
- d. Body Material: ASTM B 62, bronze.
- e. Ends: Threaded.
- f. Disc: Bronze.

B. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:

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. Crane Co.; Crane Valve Group; Crane Valves.
- b. Crane Co.; Crane Valve Group; Jenkins Valves.
- c. Crane Co.; Crane Valve Group; Stockham Division.
- d. Hammond Valve.
- e. Kitz Corporation.
- f. Milwaukee Valve Company.
- g. NIBCO INC.
- h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-80, Type 4.
- b. CWP Rating: 200 psig (1380 kPa).
- c. Body Design: Horizontal flow.
- d. Body Material: ASTM B 62, bronze.
- e. Ends: Threaded.
- f. Disc: PTFE or TFE.

## 2.7 BRONZE GATE VALVES

A. Class 125, NRS Bronze Gate Valves:

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. American Valve, Inc.
- b. Crane Co.; Crane Valve Group; Crane Valves.
- c. Crane Co.; Crane Valve Group; Jenkins Valves.
- d. Crane Co.; Crane Valve Group; Stockham Division.
- e. Hammond Valve.
- f. Kitz Corporation.
- g. Milwaukee Valve Company.
- h. NIBCO INC.
- i. Powell Valves.
- j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

k. Zy-Tech Global Industries, Inc.

2. Description:

- a. Standard: MSS SP-80, Type 1.
- b. CWP Rating: 200 psig (1380 kPa).
- c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
- d. Ends: Threaded[ or solder joint].
- e. Stem: Bronze.
- f. Disc: Solid wedge; bronze.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron or **bronze**.

B. Class 125, RS Bronze Gate Valves:

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. American Valve, Inc.
- b. Crane Co.; Crane Valve Group; Crane Valves.
- c. Crane Co.; Crane Valve Group; Jenkins Valves.
- d. Crane Co.; Crane Valve Group; Stockham Division.
- e. Hammond Valve.
- f. Kitz Corporation.
- g. Milwaukee Valve Company.
- h. NIBCO INC.
- i. Powell Valves.
- j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- k. Zy-Tech Global Industries, Inc.

2. Description:

- a. Standard: MSS SP-80, Type 2.
- b. CWP Rating: 200 psig (1380 kPa).
- c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
- d. Ends: Threaded[ or solder joint].
- e. Stem: Bronze.
- f. Disc: Solid wedge; bronze.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron or **bronze**.

C. Class 150, NRS Bronze Gate Valves:

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. Hammond Valve.
- b. Kitz Corporation.
- c. Milwaukee Valve Company.
- d. NIBCO INC.
- e. Powell Valves.
- f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-80, Type 1.
- b. CWP Rating: **300 psig (2070 kPa)**.
- c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
- d. Ends: Threaded.
- e. Stem: Bronze.
- f. Disc: Solid wedge; bronze.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron or **bronze**.

## 2.8 BRONZE GLOBE VALVES

A. Class 125, Bronze Globe Valves with Bronze Disc:

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. Crane Co.; Crane Valve Group; Crane Valves.
- b. Crane Co.; Crane Valve Group; Stockham Division.
- c. Hammond Valve.
- d. Kitz Corporation.
- e. Milwaukee Valve Company.
- f. NIBCO INC.
- g. Powell Valves.
- h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- i. Zy-Tech Global Industries, Inc.

2. Description:

- a. Standard: MSS SP-80, Type 1.
- b. CWP Rating: **200 psig (1380 kPa)**.
- c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
- d. Ends: Threaded[ **or solder joint**].
- e. Stem and Disc: Bronze.
- f. Packing: Asbestos free.
- g. Handwheel: Malleable iron or **bronze**

B. Class 125, Bronze Globe Valves with Nonmetallic Disc:

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. Crane Co.; Crane Valve Group; Crane Valves.
  - b. Crane Co.; Crane Valve Group; Stockham Division.
  - c. NIBCO INC.
2. Description:
  - a. Standard: MSS SP-80, Type 2.
  - b. CWP Rating: **200 psig (1380 kPa)**.
  - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
  - d. Ends: Threaded **or solder joint**].
  - e. Stem: Bronze.
  - f. Disc: PTFE or TFE.
  - g. Packing: Asbestos free.
  - h. Handwheel: Malleable iron or **bronze**

C. Class 150, Bronze Globe Valves with Nonmetallic Disc:

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. Crane Co.; Crane Valve Group; Crane Valves.
  - b. Hammond Valve.
  - c. Kitz Corporation.
  - d. Milwaukee Valve Company.
  - e. NIBCO INC.
  - f. Powell Valves.
  - g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - h. Zy-Tech Global Industries, Inc.
2. Description:
  - a. Standard: MSS SP-80, Type 2.
  - b. CWP Rating: **300 psig (2070 kPa)**.
  - c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
  - d. Ends: Threaded.
  - e. Stem: Bronze.
  - f. Disc: PTFE or TFE.
  - g. Packing: Asbestos free.
  - h. Handwheel: Malleable iron or **bronze**

## 2.9 LUBRICATED PLUG VALVES

### A. Class 125, Regular-Gland, Lubricated Plug Valves with Threaded Ends:

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. Nordstrom Valves, Inc.
2. Description:
  - a. Standard: MSS SP-78, Type II.
  - b. CWP Rating: 200 psig (1380 kPa).
  - c. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
  - d. Pattern: **Regular**
  - e. Plug: Cast iron or bronze with sealant groove.

### B. Class 125, Regular-Gland, Lubricated Plug Valves with Flanged Ends:

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. Nordstrom Valves, Inc.
2. Description:
  - a. Standard: MSS SP-78, Type II.
  - b. CWP Rating: 200 psig (1380 kPa).
  - c. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
  - d. Pattern: **Regular**
  - e. Plug: Cast iron or bronze with sealant groove.

### C. Class 125, Cylindrical, Lubricated Plug Valves with Threaded Ends:

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. Homestead Valve; a division of Olson Technologies, Inc.
  - b. Milliken Valve Company.
  - c. R & M Energy Systems; a unit of Robbins & Myers, Inc.

2. Description:

- a. Standard: MSS SP-78, Type IV.
- b. CWP Rating: 200 psig (1380 kPa).
- c. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
- d. Pattern: **Regular**
- e. Plug: Cast iron or bronze with sealant groove.

D. Class 125, Cylindrical, Lubricated Plug Valves with Flanged Ends:

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. Homestead Valve; a division of Olson Technologies, Inc.
- b. Milliken Valve Company.
- c. R & M Energy Systems; a unit of Robbins & Myers, Inc.

2. Description:

- a. Standard: MSS SP-78, Type IV.
- b. CWP Rating: 200 psig (1380 kPa).
- c. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
- d. Pattern: **Regular**
- e. Plug: Cast iron or bronze with sealant groove.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

- E. Do not attempt to repair defective valves; replace with new valves.

### 3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install check valves for proper direction of flow and as follows:
  - 1. Swing Check Valves: In horizontal position with hinge pin level.
  - 2. Lift Check Valves: With stem upright and plumb.

### 3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

### 3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
  - 1. Shutoff Service: Ball, butterfly **or gate** valves.
  - 2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
  - 3. Throttling Service: **Globe** valves.
  - 4. Pump-Discharge Check Valves:
    - a. **NPS 2 (DN 50)** and Smaller: Bronze swing check valves with **bronze or nonmetallic** disc.
    - b. **NPS 2-1/2 (DN 65)** and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring or iron, center-guided, **metal or resilient**-seat check valves.
    - c. **NPS 2-1/2 (DN 65)** and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:



1. For Copper Tubing, **NPS 2 (DN 50)** and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, **NPS 2-1/2 to NPS 4 (DN 65 to DN 100)**: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, **NPS 5 (DN 125)** and Larger: Flanged ends.
4. For Grooved-End [**Copper Tubing**] [**and**] [**Steel Piping**]: Valve ends may be grooved.

### 3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

#### A. Pipe **NPS 2 (DN 50)** and Smaller:

1. Bronze **and Brass** Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Angle Valves: **Class 150, bronze** disc.
3. Ball Valves: **One or Two piece, full port, brass or bronze** with **bronze** trim.
4. Bronze Swing Check Valves: **Class 150 bronze or nonmetallic** disc.
5. Bronze Gate Valves: **Class 150, NRS or RS**.
6. Bronze Globe Valves: **Class 150, bronze or nonmetallic** disc.

#### B. Pipe **NPS 2-1/2 (DN 65)** and Larger:

1. Iron Valves, **NPS 2-1/2 to NPS 4 (DN 65 to DN 100)**: May be provided with threaded ends instead of flanged ends.
2. Iron Ball Valves: **Class 150**.
3. Iron, Single-Flange Butterfly Valves: 200 CWP, **EPDM or NBR** seat, **aluminum-bronze or stainless-steel** disc.

END OF SECTION 220523

## SECTION 220529

### HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

#### 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. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Thermal-hanger shield inserts.
4. Fastener systems.
5. Pipe stands.
6. Pipe positioning systems.
7. Equipment supports.

- B. Related Sections:

1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Division 22 Section "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.

##### 1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

##### 1.4 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 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, including pipe stands, 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 **and obtain approval from authorities having jurisdiction**].

#### 1.5 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. Metal framing systems.
  3. Pipe stands.
  4. 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. Detail fabrication and assembly of trapeze hangers.
  2. Design Calculations: Calculate requirements for designing trapeze hangers.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

#### 1.7 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. 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 **copper-coated 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. 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. Carpenter & Paterson, Inc.
  2. Clement Support Services.
  3. ERICO International Corporation.
  4. National Pipe Hanger Corporation.
  5. PHS Industries, Inc.
  6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
  7. Piping Technology & Products, Inc.
  8. Rilco Manufacturing Co., Inc.
  9. Value Engineered Products, Inc.
- B. Insulation-Insert Material for Cold Piping: **ASTM C 552, Type II cellular glass with 100-psig (688-kPa)** minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: **Water-repellent treated, [ASTM C 552, Type II cellular glass with 100-psig (688-kPa)]** minimum compressive strength.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

- F. Insert Length: Extend **2 inches (50 mm)** 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, [**zinc-coated**] [**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 STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
- C. Low-Type, Single-Pipe Stand: One-piece **plastic or stainless-steel** base unit with plastic roller, for roof installation without membrane penetration.
- D. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

## 2.6 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.

## 2.7 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

## 2.8 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 (34.5-MPa), 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. Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.
- D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- E. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled fiberglass struts.
- F. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- G. Fastener System Installation:
  1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) 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.
- H. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
  2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Division 07 Section "Roof Accessories" for curbs.
- I. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. See Division 22 plumbing fixture Sections for requirements for pipe positioning systems for plumbing fixtures.
  - J. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
  - K. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
  - L. 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.
  - M. Install lateral bracing with pipe hangers and supports to prevent swaying.
  - N. 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 (DN 65)** 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.
  - O. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
  - P. 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.
  - Q. 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 (DN 100)** 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 (DN 100)** 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 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.**
  - b. **NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.**
  - c. **NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.**
  - d. **NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.**
- 5. Pipes **NPS 8 (DN 200)** 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 (40 mm)**.

### 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 (0.05 mm)**.
- 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** attachments for general service applications.

- F. Use copper-plated pipe hangers and **copper or stainless-steel** attachments for copper piping and tubing.
- G. Use padded hangers for piping that is subject to scratching.
- H. Use thermal-hanger shield inserts for insulated piping and tubing.
- I. 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 (DN 15 to DN 750)**.
  2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to **1050 deg F (566 deg C)**, pipes **NPS 4 to NPS 24 (DN 100 to DN 600)**, requiring up to **4 inches (100 mm)** of insulation.
  3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes **NPS 3/4 to NPS 36 (DN 20 to DN 900)**, requiring clamp flexibility and up to **4 inches (100 mm)** of insulation.
  4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes **NPS 1/2 to NPS 24 (DN 15 to DN 600)** if little or no insulation is required.
  5. Pipe Hangers (MSS Type 5): For suspension of pipes **NPS 1/2 to NPS 4 (DN 15 to DN 100)**, to allow off-center closure for hanger installation before pipe erection.
  6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes **NPS 3/4 to NPS 8 (DN 20 to DN 200)**.
  7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes **NPS 1/2 to NPS 8 (DN 15 to DN 200)**.
  8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes **NPS 1/2 to NPS 8 (DN 15 to DN 200)**.
  9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes **NPS 1/2 to NPS 8 (DN 15 to DN 200)**.
  10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes **NPS 3/8 to NPS 8 (DN 10 to DN 200)**.
  11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes **NPS 3/8 to NPS 3 (DN 10 to DN 80)**.
  12. U-Bolts (MSS Type 24): For support of heavy pipes **NPS 1/2 to NPS 30 (DN 15 to DN 750)**.
  13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
  14. Pipe Saddle Supports (MSS Type 36): For support of pipes **NPS 4 to NPS 36 (DN 100 to DN 900)**, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
  15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes **NPS 4 to NPS 36 (DN 100 to DN 900)**, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.

16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes **NPS 2-1/2 to NPS 36 (DN 65 to DN 900)** if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
  17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes **NPS 1 to NPS 30 (DN 25 to DN 750)**, from two rods if longitudinal movement caused by expansion and contraction might occur.
  18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes **NPS 2-1/2 to NPS 24 (DN 65 to DN 600)**, from single rod if horizontal movement caused by expansion and contraction might occur.
  19. Complete Pipe Rolls (MSS Type 44): For support of pipes **NPS 2 to NPS 42 (DN 50 to DN 1050)** if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
  20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes **NPS 2 to NPS 24 (DN 50 to DN 600)** if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
  21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes **NPS 2 to NPS 30 (DN 50 to DN 750)** if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- J. 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 (DN 24 to DN 600)**.
  2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers **NPS 3/4 to NPS 24 (DN 20 to DN 600)** if longer ends are required for riser clamps.
- K. 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 (150 mm)** for heavy loads.
  2. Steel Clevises (MSS Type 14): For **120 to 450 deg F (49 to 232 deg C)** piping installations.
  3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
  4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
  5. Steel Weldless Eye Nuts (MSS Type 17): For **120 to 450 deg F (49 to 232 deg C)** piping installations.
- L. 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. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
  8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
  9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
  10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
  11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
  12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    - a. Light (MSS Type 31): 750 lb (340 kg).
    - b. Medium (MSS Type 32): 1500 lb (680 kg).
    - c. Heavy (MSS Type 33): 3000 lb (1360 kg).
  13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
  14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
  15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- M. 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.
- N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
  2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
  3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
  4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.

5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
  6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
  7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
  8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
    - a. Horizontal (MSS Type 54): Mounted horizontally.
    - b. Vertical (MSS Type 55): Mounted vertically.
    - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- P. Comply with MFMA-103 for metal framing system 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 220553

### IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

#### 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. Equipment labels.
  - 2. Warning signs and labels.
  - 3. Pipe labels.
  - 4. Valve tags.
  - 5. Warning tags.

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

##### 1.4 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.

- C. Install identifying devices before installing acoustical ceilings and similar concealment.

## PART 2 - PRODUCTS

### 2.1 EQUIPMENT LABELS

#### A. Metal Labels for Equipment:

1. Material and Thickness: **Brass, 0.032-inch (0.8-mm) or anodized aluminum, 0.032-inch (0.8-mm)**] minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than **2-1/2 by 3/4 inch (64 by 19 mm)**.
3. Minimum Letter Size: **1/4 inch (6.4 mm)** for name of units if viewing distance is less than **24 inches (600 mm)**, **1/2 inch (13 mm)** for viewing distances up to **72 inches (1830 mm)**, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel **rivets or self-tapping screws**.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

#### B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, **1/8 inch (3.2 mm)** thick, and having predrilled holes for attachment hardware.
2. Letter Color: **Black**.
3. Background Color: **White**.
4. Maximum Temperature: Able to withstand temperatures up to **160 deg F (71 deg C)**.
5. Minimum Label Size: Length and width vary for required label content, but not less than **2-1/2 by 3/4 inch (64 by 19 mm)**.
6. Minimum Letter Size: **1/4 inch (6.4 mm)** for name of units if viewing distance is less than **24 inches (600 mm)**, **1/2 inch (13 mm)** for viewing distances up to **72 inches (1830 mm)**, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel **rivets or self-tapping screws**.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

- D. Equipment Label Schedule: For each item of equipment to be labeled, on **8-1/2-by-11-inch (A4)** bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

## 2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, **1/8 inch (3.2 mm)** thick, and having predrilled holes for attachment hardware.
- B. Letter Color: **Black or Red.**
- C. Background Color: **White.**
- D. Maximum Temperature: Able to withstand temperatures up to **160 deg F (71 deg C).**
- E. Minimum Label Size: Length and width vary for required label content, but not less than **2-1/2 by 3/4 inch (64 by 19 mm).**
- F. Minimum Letter Size: **1/4 inch (6.4 mm)** for name of units if viewing distance is less than **24 inches (600 mm)**, **1/2 inch (13 mm)** for viewing distances up to **72 inches (1830 mm)**, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel **rivets or self-tapping screws.**
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

## 2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
  - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.



2. Lettering Size: At least **1-1/2 inches (38 mm)** high.

## 2.4 VALVE TAGS

- A. Valve Tags: Stamped or engraved with **1/4-inch (6.4-mm)** letters for piping system abbreviation and **1/2-inch (13-mm)** numbers.
  1. Tag Material: **Brass, 0.032-inch (0.8-mm) or anodized aluminum, 0.032-inch (0.8-mm)**] minimum thickness, and having predrilled or stamped holes for attachment hardware.
  2. Fasteners: Brass **wire-link or beaded chain**.
- B. Valve Schedules: For each piping system, on **8-1/2-by-11-inch (A4)** bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
  1. Valve-tag schedule shall be included in operation and maintenance data.

## 2.5 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
  1. Size: **Approximately 4 by 7 inches (100 by 178 mm)**.
  2. Fasteners: **Brass grommet and wire**.
  3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
  4. Color: Yellow background with black lettering.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

### 3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

### 3.3 PIPE LABEL INSTALLATION

- A. Piping Color-Coding: Painting of piping is specified in Division 09 Section "**Interior Painting.**"
- B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
  - 1. Near each valve and control device.
  - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
  - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
  - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
  - 5. Near major equipment items and other points of origination and termination.
  - 6. Spaced at maximum intervals of **50 feet (15 m)** along each run. Reduce intervals to **25 feet (7.6 m)** in areas of congested piping and equipment.
  - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- C. Pipe Label Color Schedule: Black on white or approved readable of other colors at Contractor's option.

### 3.4 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
  - 1. Valve-Tag Size and Shape (or approved satisfactory):
    - a. Cold Water: **1-1/2 inches round.**
    - b. Hot Water: **1-1/2 inches (38 mm) round.**
    - c. Low-Pressure Compressed Air: **1-1/2 inches (38 mm) round**
    - d. High-Pressure Compressed Air: **1-1/2 inches (38 mm) round.**
  - 2. Valve-Tag Color: Contractor's option – submit sample for approval
  - 3. Letter Color: Contractor's option – submit sample for approval

### 3.5 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 220553

## SECTION 220716

### PLUMBING EQUIPMENT INSULATION

#### 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 insulating the following plumbing equipment:
  - 1. Domestic water, **hot-water, hot water return, and cold-water.**
- B. Related Sections:
  - 1. Division 22 Section "Plumbing Piping Insulation."

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied, if any).
- 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 equipment connections and access panels.
  - 3. Detail application of field-applied jackets.
  - 4. Detail application at linkages of control devices.
  - 5. Detail field application for each equipment type.
- C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:
  - 1. Sheet Form Insulation Materials: **12 inches (300 mm)** square.
  - 2. Sheet Jacket Materials: **12 inches (300 mm)** square.
  - 3. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. 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.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

#### 1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with equipment Installer for equipment insulation application.
- C. Coordinate installation and testing of heat tracing.

## 1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

## PART 2 - PRODUCTS

### 2.1 INSULATION MATERIALS

- A. Comply with requirements in "Domestic Water Boiler Breeching Insulation Schedule" and "Equipment 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. Products: Subject to compliance with requirements **available products that may be incorporated into the Work include, but are not limited to, the following:**
    - a. Pittsburgh Corning Corporation; Foamglas.
  - 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** or **ASJ-SSL**: Comply with ASTM C 552, Type II, Class 2.
  - 7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

- G. 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.
1. Products: Subject to compliance with requirements, **available products that may be incorporated into the Work include, but are not limited to, the following:**
    - a. CertainTeed Corp.; SoftTouch Duct Wrap.
    - b. Johns Manville; Microlite.
    - c. Knauf Insulation; Friendly Feel Duct Wrap.
    - d. Manson Insulation Inc.; Alley Wrap.
    - e. Owens Corning; SOFTR All-Service Duct Wrap.
- H. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For equipment applications, provide insulation **with factory-applied ASJ** Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Products: Subject to compliance with requirements, **available products that may be incorporated into the Work include, but are not limited to, the following:**
    - a. CertainTeed Corp.; CertaPro Commercial Board.
    - b. Fibrex Insulations Inc.; FBX.
    - c. Johns Manville; 800 Series Spin-Glas.
    - d. Knauf Insulation; Insulation Board.
    - e. Manson Insulation Inc.; AK Board.
    - f. Owens Corning; Fiberglas 700 Series.
- I. Mineral-Fiber, Preformed Pipe Insulation:
1. Products: Subject to compliance with requirements, **available products that may be incorporated into the Work include, but are not limited to, the following:**
    - a. Fibrex Insulations Inc.; Coreplus 1200.
    - b. Johns Manville; Micro-Lok.
    - c. Knauf Insulation; 1000-Degree Pipe Insulation.
    - d. Manson Insulation Inc.; Alley-K.
    - e. Owens Corning; Fiberglas Pipe Insulation.
  2. Type I, **850 Deg F (454 Deg C)** Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, **with factory-applied ASJ** Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- J. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied **[ASJ]** complying

with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. (40 kg/cu. m) or more. Thermal conductivity (k-value) at 100 deg F (55 deg C) is 0.29 Btu x in./h x sq. ft. x deg F (0.042 W/m x K) or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, **available products that may be incorporated into the Work include, but are not limited to, the following:**
  - a. CertainTeed Corp.; CrimpWrap.
  - b. Johns Manville; MicroFlex.
  - c. Knauf Insulation; Pipe and Tank Insulation.
  - d. Manson Insulation Inc.; AK Flex.
  - e. Owens Corning; Fiberglas Pipe and Tank Insulation.

## 2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, **available products that may be incorporated into the Work include, but are not limited to, the following:**
  - a. Ramco Insulation, Inc.; Super-Stik.

- B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

1. Products: Subject to compliance with requirements **available products that may be incorporated into the Work include, but are not limited to, the following:**
  - a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

## 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. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F (10 to 427 deg C).

1. Products: Subject to compliance with requirements, **available products that may be incorporated into the Work include, but are not limited to, the following:**



- a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-97.
  - b. Eagle Bridges - Marathon Industries; 290.
  - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-27.
  - d. Mon-Eco Industries, Inc.; 22-30.
  - e. Vimasco Corporation; 760.
- 2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
- 1. Products: Subject to compliance with requirements **available products that may be incorporated into the Work include, but are not limited to, the following:**
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
    - b. Eagle Bridges - Marathon Industries; 225.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
    - d. Mon-Eco Industries, Inc.; 22-25.
  - 2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- D. 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. Products: Subject to compliance with requirements, **available products that may be incorporated into the Work include, but are not limited to, the following:**
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
    - b. Eagle Bridges - Marathon Industries; 225.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
    - d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements **available products that may be incorporated into the Work include, but are not limited to, the following:**
  - a. Dow Corning Corporation; 739, Dow Silicone.
  - b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
  - c. P.I.C. Plastics, Inc.; Welding Adhesive.
  - d. Speedline Corporation; Polyco VP Adhesive.
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."

## 2.4 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. Products: Subject to compliance with requirements, **available products that may be incorporated into the Work include, but are not limited to, the following:**
    - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
    - b. Vimasco Corporation; 749.
  2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, **0.013 perm (0.009 metric perm)** at **43-mil (1.09-mm)** dry film thickness.
  3. Service Temperature Range: **Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C)**.

4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

## 2.5 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.
1. For indoor applications, use lagging adhesives that have a VOC content of **<Insert value>** g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  2. Products: Subject to compliance with requirements **available products that may be incorporated into the Work include, but are not limited to, the following:**
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
    - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
    - c. Vimasco Corporation; 713 and 714.
  3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over insulation.
  4. Service Temperature Range: **0 to plus 180 deg F (Minus 18 to plus 82 deg C)**.
  5. Color: White.

## 2.6 SEALANTS

- A. Joint Sealants:
1. Joint Sealants for Cellular-Glass Products: Subject to compliance with requirements, **available products that may be incorporated into the Work include, but are not limited to, the following:**
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
    - b. Eagle Bridges - Marathon Industries; 405.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
    - d. Mon-Eco Industries, Inc.; 44-05.
    - e. Pittsburgh Corning Corporation; Pittseal 444.
  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 (Minus 73 to plus 149 deg C)**.
  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. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements **available products that may be incorporated into the Work include, but are not limited to, the following:**
  - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: **Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).**
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."

## 2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. PVDC Jacket for Indoor Applications: **4-mil- (0.10-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm (0.013 metric 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. Products: Subject to compliance with requirements **available products that may be incorporated into the Work include, but are not limited to, the following:**

- 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
5. PVDC Jacket for Outdoor Applications: **6-mil- (0.15-mm-)** thick, white PVDC biaxially oriented barrier film with a permeance at **0.01 perm (0.007 metric 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. Products: Subject to compliance with requirements, **available products that may be incorporated into the Work include, but are not limited to, the following**]:
      - 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
      - 2) **<Insert manufacturer's name; product name or designation>**.
  6. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
    - a. Products: Subject to compliance with requirements, **available products that may be incorporated into the Work include, but are not limited to, the following**:
      - 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

## 2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Fabric: Approximately **6 oz./sq. yd. (203 g/sq. m)** with a thread count of **5 strands by 5 strands/sq. in. (2 strands by 2 strands/sq. mm)** for covering equipment.
  1. Products: Subject to compliance with requirements, **available products that may be incorporated into the Work include, but are not limited to, the following**:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Chil-Glas No. 5.

## 2.9 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements **available products that may be incorporated into the Work include, but are not limited to, the following:**
  - a. Johns Manville; Zeston.
  - b. P.I.C. Plastics, Inc.; FG Series.
  - c. Proto Corporation; LoSmoke.
  - d. Speedline Corporation; SmokeSafe.
2. Adhesive: As recommended by jacket material manufacturer.
3. Color: **White** Factory-fabricated tank heads and tank side panels.

## 2.10 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
  1. Products: Subject to compliance with requirements, **available products that may be incorporated into the Work include, but are not limited to, the following]**:
    - a. ABI, Ideal Tape Division; 428 AWF ASJ.
    - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
    - c. Compac Corporation; 104 and 105.
    - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
  2. Width: **3 inches (75 mm)**.
  3. Thickness: **11.5 mils (0.29 mm)**.
  4. Adhesion: **90 ounces force/inch (1.0 N/mm)** in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: **40 lbf/inch (7.2 N/mm)** in width.
  7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

## 2.11 SECUREMENTS

- A. Bands:
  1. Products: Subject to compliance with requirements **available products that may be incorporated into the Work include, but are not limited to, the following:**
    - a. ITW Insulation Systems; Gerrard Strapping and Seals.
    - b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
  2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, **Type 304 or Type 316; 0.015 inch (0.38 mm)** thick, **1/2 inch (13 mm)** wide with **wing seal or closed seal**.

3. Aluminum: **ASTM B 209 (ASTM B 209M)**, Alloy 3003, 3005, 3105, or 5005; Temper H-14, **0.020 inch (0.51 mm)** thick, **1/2 inch (13 mm)** wide with **wing seal or closed seal**.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
  1. Verify that systems and equipment to be insulated have been tested and are free of defects.
  2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
  1. Carbon Steel: Coat carbon steel operating at a service temperature between **32 and 300 deg F (0 and 149 deg C)** with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

### 3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item 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.
  - 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.
- 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- (75-mm-)** wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced **4 inches (100 mm)** o.c.
  - 3. Overlap jacket longitudinal seams at least **1-1/2 inches (38 mm)**. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at **2 inches (50 mm)** 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.
- 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 (100 mm)** beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- O. 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.

### 3.4 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
  1. Draw jacket smooth and tight to surface with **2-inch (50-mm)** overlap at seams and joints.
  2. Embed glass cloth between two **0.062-inch- (1.6-mm-)** thick coats of lagging adhesive.
  3. Completely encapsulate insulation with coating, leaving no exposed insulation.

### 3.5 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
  1. Flat Acrylic Finish: **Two** finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
    - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

### 3.6 FIELD QUALITY CONTROL

- A. Testing Agency: **Engage** a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
  - 1. Inspect field-insulated equipment, 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]** **<Insert number>** location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
- D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

### 3.7 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.

### 3.8 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. Equipment, Concealed:
  - 1. None.
  - 2. **PVC: 20 mils (0.5 mm) thick.**
- D. Equipment, Exposed, up to **48 Inches (1200 mm)** in Diameter or with Flat Surfaces up to **72 Inches (1800 mm)**:
  - 1. **Painted Aluminum, Smooth: 0.020 inch (0.51 mm) thick.**
  - 2. **Stainless Steel, Type 304 or Type 316, Smooth 2B Finish: 0.020 inch (0.51 mm) thick..**

END OF SECTION 220716

PLUMBING EQUIPMENT INSULATION

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02 March 2018

## SECTION 220719

### PLUMBING PIPING INSULATION

#### 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 insulating the following plumbing piping services:
  - 1. Domestic cold-water piping.
  - 2. Domestic hot-water piping.
  - 3. Roof drains and rainwater leaders.
  - 4. Supplies and drains for handicap-accessible lavatories and sinks.
- B. Related Sections:
  - 1. Division 22 Section "Plumbing Equipment Insulation."

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).
- 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 pipe expansion joints for each type of insulation.
  - 3. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
  - 4. Detail removable insulation at piping specialties, equipment connections, and access panels.
  - 5. Detail application of field-applied jackets.
- C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:

1. Preformed Pipe Insulation Materials: 12 inches (300 mm) long by NPS 2 (DN 50).
2. Jacket Materials for Pipe: 12 inches (300 mm) long by NPS 2 (DN 50).
3. Sheet Jacket Materials: 12 inches (300 mm) square.
4. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. 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.
- C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

## 1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

## 1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

## PART 2 - PRODUCTS

### 2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Mineral-Fiber 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.

1. Products: Subject to compliance with requirements **available products that may be incorporated into the Work include, but are not limited to, the following:**
  - a. CertainTeed Corp.; SoftTouch Duct Wrap.
  - b. Johns Manville; Microlite.
  - c. Knauf Insulation; Friendly Feel Duct Wrap.
  - d. Manson Insulation Inc.; Alley Wrap.
  - e. Owens Corning; SOFTR All-Service Duct Wrap.

G. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:**
  - a. Fibrex Insulations Inc.; Coreplus 1200.
  - b. Johns Manville; Micro-Lok.
  - c. Knauf Insulation; 1000-Degree Pipe Insulation.
  - d. Manson Insulation Inc.; Alley-K.
  - e. Owens Corning; Fiberglas Pipe Insulation.
  - f. **<Insert manufacturer's name; product name or designation>**.
2. Type I, **850 Deg F (454 Deg C)** Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, **[without factory-applied jacket] [with factory-applied ASJ] [with factory-applied ASJ-SSL]**. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

## 2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, **available products that may be incorporated into the Work include, but are not limited to, the following:**
  - a. Ramco Insulation, Inc.; Super-Stik.
  - b. >.

## 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. Products: Subject to compliance with requirements **available products that may be incorporated into the Work include, but are not limited to, the following:**
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
    - b. Eagle Bridges - Marathon Industries; 225.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
    - d. Mon-Eco Industries, Inc.; 22-25.
    - e.
  2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. Products: Subject to compliance with requirements, **available products that may be incorporated into the Work include, but are not limited to, the following:**
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
    - b. Eagle Bridges - Marathon Industries; 225.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-20.
    - d. Mon-Eco Industries, Inc.; 22-25.
  2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- D. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Products: Subject to compliance with requirements. **available products that may be incorporated into the Work include, but are not limited to, the following]:**
    - a. Dow Corning Corporation; 739, Dow Silicone.
    - b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
    - c. P.I.C. Plastics, Inc.; Welding Adhesive.



- d. Speedline Corporation; Polyco VP Adhesive.
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."

## 2.4 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. Products: Subject to compliance with requirements **available products that may be incorporated into the Work include, but are not limited to, the following:**
    - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
    - b. Vimasco Corporation; 749.
  2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, **0.013 perm (0.009 metric perm)** at **43-mil (1.09-mm)** dry film thickness.
  3. Service Temperature Range: **Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C)**.
  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. Products: Subject to compliance with requirements, **available products that may be incorporated into the Work include, but are not limited to, the following:**
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
    - b. Eagle Bridges - Marathon Industries; 550.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
    - d. Mon-Eco Industries, Inc.; 55-50.
    - e. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms (1.2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

## 2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Products: Subject to compliance with requirements, **available products that may be incorporated into the Work include, but are not limited to, the following:**
  - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
  - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
  - c. Vimasco Corporation; 713 and 714.
3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
4. Service Temperature Range: 0 to plus 180 deg F (Minus 18 to plus 82 deg C).
5. Color: White.

B. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, **available products that may be incorporated into the Work include, but are not limited to, the following]:**
  - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
  - b. Eagle Bridges - Marathon Industries; 405.
  - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
  - d. Mon-Eco Industries, Inc.; 44-05.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
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. Products: Subject to compliance with requirements **available products that may be incorporated into the Work include, but are not limited to, the following:**
  - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: **Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).**
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."

## 2.6 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.
    - a.

## 2.7 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. Products: Subject to compliance with requirements **available products that may be incorporated into the Work include, but are not limited to, the following**]:
    - a. Johns Manville; Zeston.
    - b. P.I.C. Plastics, Inc.; FG Series.
    - c. Proto Corporation; LoSmoke.
    - d. Speedline Corporation; SmokeSafe.
  2. Adhesive: As recommended by jacket material manufacturer.
  3. Color: **White** Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
    - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

## 2.8 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Products: Subject to compliance with requirements **available products that may be incorporated into the Work include, but are not limited to, the following**]:
    - a. ABI, Ideal Tape Division; 428 AWF ASJ.
    - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
    - c. Compac Corporation; 104 and 105.
    - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
  2. Width: **3 inches (75 mm)**.
  3. Thickness: **11.5 mils (0.29 mm)**.
  4. Adhesion: **90 ounces force/inch (1.0 N/mm)** in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: **40 lbf/inch (7.2 N/mm)** in width.
  7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Products: Subject to compliance with requirements, **available products that may be incorporated into the Work include, but are not limited to, the following**:

- a. ABI, Ideal Tape Division; 491 AWF FSK.
  - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
  - c. Compac Corporation; 110 and 111.
  - d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
2. Width: **3 inches (75 mm)**.
  3. Thickness: **6.5 mils (0.16 mm)**.
  4. Adhesion: **90 ounces force/inch (1.0 N/mm)** in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: **40 lbf/inch (7.2 N/mm)** in width.
  7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

## 2.9 SECUREMENTS

### A. Bands:

1. Products: Subject to compliance with requirements, **available products that may be incorporated into the Work include, but are not limited to, the following:**
  - a. ITW Insulation Systems; Gerrard Strapping and Seals.
  - b. RPR Products, Inc.; Insul-Mate Strapping and Seals.
2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, **Type 304 or Type 316; 0.015 inch (0.38 mm) thick, 1/2 inch (13 mm) wide with wing seal or closed seal.**
3. Aluminum: **ASTM B 209 (ASTM B 209M)**, Alloy 3003, 3005, 3105, or 5005; Temper H-14, **0.020 inch (0.51 mm) thick, 1/2 inch (13 mm) wide with wing seal or closed seal.**

### B. Staples: Outward-clinching insulation staples, nominal **3/4-inch- (19-mm-)** wide, stainless steel or Monel.

### C. Wire: **0.080-inch (2.0-mm) nickel-copper alloy soft-annealed, stainless steel 0.062-inch (1.6-mm) soft-annealed, galvanized steel.**

1. Manufacturers: Subject to compliance with requirements, **available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:**
  - a. C & F Wire.

## 2.10 PROTECTIVE SHIELDING GUARDS

### A. Protective Shielding Pipe Covers,

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. Engineered Brass Company.
  - b. Insul-Tect Products Co.; a subsidiary of MVG Molded Products.
  - c. McGuire Manufacturing.
  - d. Plumberex.
  - e. Truebro; a brand of IPS Corporation.
  - f. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.
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.

B. Protective Shielding Piping Enclosures,

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. Truebro; a brand of IPS Corporation.
  - b. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.
2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
  1. Verify that systems to be insulated have been tested and are free of defects.
  2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
  - 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils (0.127 mm) thick and an epoxy finish 5 mils (0.127 mm) thick if operating in a temperature range between 140 and 300 deg F (60 and 149 deg C). Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
  - 2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F (0 and 149 deg C) with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

### 3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of 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- (75-mm-)** wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced **4 inches (100 mm)** o.c.
  3. Overlap jacket longitudinal seams at least **1-1/2 inches (38 mm)**. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at **[2 inches (50 mm)] [4 inches (100 mm)]** 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 (100 mm)** beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
  2. Testing agency labels and stamps.
  3. Nameplates and data plates.
  4. Cleanouts.



### 3.4 PENETRATIONS

- A. Insulation Installation at 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 (50 mm)** 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 (50 mm)**.
  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 Division 07 Section "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 Division 07 Section "Penetration Firestopping."

### 3.5 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 (50 mm)** 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.

### 3.6 INSTALLATION OF MINERAL-FIBER 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 (150 mm)** 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 (25 mm)**, 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.

### 3.7 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with **2-inch (50-mm)** overlap at seams and joints.
2. Embed glass cloth between two **0.062-inch- (1.6-mm-)** thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. 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 (38-mm)** laps at longitudinal seams and **3-inch- (75-mm-)** wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

- C. Where PVC jackets are indicated, install with **1-inch (25-mm)** 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.
- D. Where metal jackets are indicated, install with **2-inch (50-mm)** 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 (300 mm)** o.c. and at end joints.

### 3.8 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
  - 1. Flat Acrylic Finish: [**Two**] <Insert number> 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.

### 3.9 FIELD QUALITY CONTROL

- A. Testing Agency: **Engage** a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
  - 1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to **three** locations of straight pipe, **three** locations of threaded fittings, **three** locations of welded fittings, **two** locations of threaded strainers, **two** locations of welded strainers, **three** locations of threaded valves, and **three** locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

- D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

### 3.10 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.

### 3.11 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Cold Water:
  - 1. **NPS 1 (DN 25)** and Smaller: Insulation shall be:
    - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: **1/2 inch (13 mm)** thick.
  - 2. **NPS 1-1/4 (DN 32)** and Larger: Insulation shall be:
    - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: **1 inch (25 mm)** thick.
- B. Domestic Hot Water:
  - 1. **NPS 1-1/4 (DN 32)** and Smaller: Insulation shall be:
    - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: **1 inch (25 mm)** thick.
  - 2. **NPS 1-1/2 (DN 40)** and Larger: Insulation shall be:
    - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: **1 inch (25 mm)** thick.
- C. Roof Drain Bodies:
  - 1. All Pipe Sizes: Insulation shall be:
    - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: **1 inch (25 mm)** thick.
- D. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
  - 1. All Pipe Sizes: Insulation shall be **one of** the following:

- a. Flexible Elastomeric: **1/2 inch (13 mm)** thick.
- b. Mineral-Fiber, Preformed Pipe Insulation, Type I: **1/2 inch (13 mm)** thick.

END OF SECTION 220719

**SECTION 22 1113  
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 and related components outside the building for combined water service and fire-service mains.

1.3 DEFINITIONS

- A. DIP: Ductile Iron Pipe

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
  - 1. Piping specialties.
  - 2. Valves and accessories.
  - 3. Fire hydrants.
- B. Field quality-control test reports.
- C. Operation and Maintenance Data: For water valves and specialties to include in emergency, operation, and maintenance manuals.

1.5 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. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.



## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:
  - 1. Ensure that valves are dry and internally protected against rust and corrosion.
  - 2. Protect valves against damage to threaded ends and flange faces.
  - 3. Set valves in best position for handling. Set valves closed to prevent rattling.
- B. During Storage: Use precautions for valves, including fire hydrants, according to the following:
  - 1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
  - 2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.
- C. Handling: Use sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.
- D. Deliver piping 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.
- E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.
- F. Protect flanges, fittings, and specialties from moisture and dirt.

## 1.7 COORDINATION

- A. Coordinate connection to water main with utility purveyor.

## **PART 2 - PRODUCTS**

### 2.1 DUCTILE-IRON PIPE AND FITTINGS

- A. 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.

### 2.2 GATE VALVES

- A. AWWA, Cast-Iron Gate Valves:

1. 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/C515.
    - 2) Minimum Pressure Rating: 200 psig.
    - 3) End Connections: Mechanical joint.
    - 4) Interior Coating: Complying with AWWA C550.

## 2.3 GATE VALVE ACCESSORIES AND SPECIALTIES

### A. Tapping-Sleeve Assemblies:

1. Description: Sleeve and valve compatible with drilling machine.
  - a. Standard: MSS SP-60.
  - b. Tapping Sleeve: 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, resilient-seated gate valve with one raised face flange mating tapping-sleeve flange.

## 2.4 CONCRETE VAULTS

- A. Description: Precast, reinforced-concrete vault, designed for A-16 load designation according to ASTM C 857 and made according to ASTM C 858.
  1. Ladder: ASTM A 36/A 36M, steel or polyethylene-encased steel steps.
  2. Manhole: ASTM A 48, Class 35 gray-iron heavy duty traffic frame and cover.

## 2.5 FIRE HYDRANTS

### A. Dry-Barrel Fire Hydrants:

1. Description: Freestanding, with one 4-1/2-inches and two 2-1/2-inch outlets, 5-1/4-inch main valve, drain valve, and NPS 6 mechanical-joint inlet. Hydrant shall have cast-iron body, compression-type valve opening against pressure and closing with pressure.
  - a. Standards: UL 246, FMG approved.
  - b. Pressure Rating: 150 psig minimum.
  - c. Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
  - d. Operating and Cap Nuts: Pentagon, 1-1/2 inches point to flat.
  - e. Direction of Opening: Open hydrant valve by turning operating nut to left or counterclockwise.

- f. Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.

### **PART 3 - EXECUTION**

#### **3.1 EARTHWORK**

- A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

#### **3.2 VALVE APPLICATIONS**

- A. General Application: Use mechanical-joint-end valves for 3-inch 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 2-inch and smaller installation.

#### **3.3 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. Pressure Tap Connections: Make connections larger than 2-inches 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. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.
- E. 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.
- F. 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.

### 3.4 JOINT CONSTRUCTION

- A. Make pipe joints according to the following:
  - 1. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
  - 2. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure.

### 3.5 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.

### 3.6 CONCRETE VAULT INSTALLATION

- A. Install precast concrete vaults according to ASTM C 891.

### 3.7 FIRE HYDRANT INSTALLATION

- A. General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.
- B. AWWA Fire Hydrants: Comply with AWWAM17.

### 3.8 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.
  - 1. Increase pressure in 50-psig increments and inspect each joint between increments. Hold at test pressure for 2 hours; 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.

### 3.9 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 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 22 1113**

**SECTION 221116**  
**DOMESTIC WATER PIPING**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
2. Water meters furnished by utility company for installation by Contractor.

B. Related Section:

1. Division 22 Section "Facility Water Distribution Piping" for water-service piping **and water meters** outside the building from source to the point where water-service piping enters the building.

1.3 PERFORMANCE REQUIREMENTS

1.4 ACTION SUBMITTALS

A. Product Data: For the following products:

1. Transition fittings.
2. Dielectric fittings.
3. Water meters.
4. **Vacuum breakers**
5. Water penetration systems.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.

2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products 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."

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Water Samples: Specified in "Cleaning" Article.
- B. Coordination Drawings: For piping in equipment rooms and other congested areas, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
  1. Fire-suppression-water piping.
  2. Domestic water piping.
  3. Sanitary, Waste and Vent piping
- C. Field quality-control reports.

#### 1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic, potable domestic water piping and components Comply with NSF 61 for potable domestic water piping and components.

#### 1.7 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

### PART 2 - PRODUCTS

#### 2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

#### 2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: **ASTM B 88, Type L (ASTM B 88M,**

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1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
  - 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) Elkhart Products Corporation; Industrial Division.
    - 2) NIBCO INC.
    - 3) Viega; Plumbing and Heating Systems.
  - b. **NPS 2 (DN 50)** and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
  - c. **NPS 2-1/2 to NPS 4 (DN 65 to DN 100)**: Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.

## 2.3 DUCTILE-IRON PIPE AND FITTINGS

- A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
  1. Standard-Pattern, Mechanical-Joint Fittings: AWWA C110, ductile or gray iron.
  2. Compact-Pattern, Mechanical-Joint Fittings: AWWA C153, ductile iron.
    - a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- B. 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. Standard-Pattern, Push-on-Joint Fittings: AWWA C110, ductile or gray iron.
    - a. Gaskets: AWWA C111, rubber.
  2. Compact-Pattern, Push-on-Joint Fittings: AWWA C153, ductile iron.
    - a. Gaskets: AWWA C111, rubber.
- C. Plain-End, Ductile-Iron Pipe: AWWA C151.
  1. Grooved-Joint, Ductile-Iron-Pipe Appurtenances:



- 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) Anvil International.
  - 2) Shurjoint Piping Products.
  - 3) Star Pipe Products.
  - 4) Victaulic Company.
- b. Grooved-End, Ductile-Iron Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.
- c. Grooved-End, Ductile-Iron-Pipe Couplings: AWWA C606 for ductile-iron-pipe dimensions. Include ferrous housing sections, EPDM-rubber gaskets suitable for hot and cold water, and bolts and nuts.

## 2.4 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, **1/8 inch (3.2 mm)** thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; full-face or ring type unless otherwise indicated.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

## 2.5 SPECIALTY VALVES

- A. Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty metal valves.
- B. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.

## 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. Capitol Manufacturing Company.
  - b. Central Plastics Company.
  - c. Hart Industries International, Inc.
  - d. Jomar International Ltd.
  - e. Matco-Norca, Inc.
  - f. McDonald, A. Y. Mfg. Co.
  - g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - h. Wilkins; a Zurn company.
2. Description:
  - a. Standard: ASSE 1079.
  - b. Pressure Rating: **150 psig (1035 kPa) minimum at 180 deg F (82 deg C).**
  - c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, **available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:**
  - a. Capitol Manufacturing Company.
  - b. Central Plastics Company.
  - c. Matco-Norca, Inc.
  - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - e. Wilkins; a Zurn company.
2. Description:
  - a. Standard: ASSE 1079.
  - b. Factory-fabricated, bolted, companion-flange assembly.
  - c. Pressure Rating: **150 psig (1035 kPa) minimum at 180 deg F (82 deg C).**
  - d. 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, **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. Central Plastics Company.
- d. Pipeline Seal and Insulator, Inc.

2. Description:

- a. Nonconducting materials for field assembly of companion flanges.
- b. Pressure Rating: **150 psig (1035 kPa)**.
- c. Gasket: Neoprene or phenolic.
- d. Bolt Sleeves: Phenolic or polyethylene.
- e. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

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. Elster Perfection.
- b. Grinnell Mechanical Products.
- c. Matco-Norca, Inc.
- d. Precision Plumbing Products, Inc.
- e. Victaulic Company.

2. Description:

- a. Standard: IAPMO PS 66
- b. Electroplated steel nipple. complying with ASTM F 1545.
- c. Pressure Rating: **300 psig (2070 kPa) at 225 deg F (107 deg C)**.
- d. End Connections: Male threaded or grooved.
- e. Lining: Inert and noncorrosive, propylene.

## PART 3 - EXECUTION

### 3.1 EARTHWORK

- A. Comply with requirements in Division 31 Section "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 in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.
- E. Install shutoff valve immediately upstream of each dielectric fitting.
- F. Install domestic water piping level **without pitch** and plumb.
- G. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- H. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- I. 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.
- J. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- K. Install piping adjacent to equipment and specialties to allow service and maintenance.
- L. Install piping to permit valve servicing.
- M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.
- N. Install piping free of sags and bends.
- O. Install fittings for changes in direction and branch connections.
- P. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

- Q. Install pressure gages on suction and discharge piping from each plumbing pump and packaged booster pump. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages.
- R. Install thermometers on **inlet and** outlet piping from each water heater. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.
- S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."
- T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."
- U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "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. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Braze Joints" Chapter.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- E. Copper-Tubing Grooved Joints: Roll groove end of tube. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for roll-grooved joints.
- F. Ductile-Iron-Piping Grooved Joints: Cut groove end of pipe. Assemble coupling with housing, gasket, lubricant, and bolts. Join ductile-iron pipe and grooved-end fittings according to AWWA C606 for ductile-iron-pipe, cut-grooved joints.
- 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.

### 3.4 VALVE INSTALLATION

- A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for valve installations.
- B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball or gate valves for piping **NPS 2 (DN 50)** and smaller. Use butterfly or gate valves for piping **NPS 2-1/2 (DN 65)** and larger.
- C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."
  - 1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
  - 2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.
- D. Install balancing valve in each hot-water circulation return branch and discharge side of each pump and circulator. Set balancing valves partly open to restrict but not stop flow. Use ball valves for piping **NPS 2 (DN 50)** and smaller and butterfly valves for piping **NPS 2-1/2 (DN 65)** and larger. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves.
- E. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for calibrated balancing valves.

### 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 (DN 50)** and Smaller: Use dielectric **couplings or unions**.
- C. Dielectric Fittings for **NPS 2-1/2 to NPS 4 (DN 65 to DN 100)**: Use dielectric **flange kits**.
- D. Dielectric Fittings for **NPS 5 (DN 125)** and Larger: Use dielectric flange kits.

### 3.6 WATER METER INSTALLATION

- A. Rough-in domestic water piping **and install water meters** according to utility company's requirements.

- B. Water meters will be furnished by utility company.

### 3.7 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.
- B. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.
  - 1. Vertical Piping: MSS Type 8 or 42, clamps.
  - 2. Individual, Straight, Horizontal Piping Runs:
    - a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
    - b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
    - c. Longer Than 100 Feet (30 m) If Indicated: MSS Type 49, spring cushion rolls.
  - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) 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 (10 mm).
- E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 3/4 (DN 20) and Smaller: 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
  - 2. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
  - 3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
  - 4. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
  - 5. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
  - 6. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.
  - 7. NPS 8 (DN 200): 10 feet (3 m) with 3/4-inch (19-mm) rod.
- F. Install supports for vertical copper tubing every 10 feet (3 m).
- G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 (DN 32) and Smaller: 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
2. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
3. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
4. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
5. NPS 3 and NPS 3-1/2 (DN 80 and DN 90): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
6. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.
7. NPS 6 (DN 150): 12 feet (3.7 m) with 3/4-inch (19-mm) rod.
8. NPS 8 to NPS 12 (DN 200 to DN 300): 12 feet (3.7 m) with 7/8-inch (22-mm) rod.

H. Install supports for vertical steel piping every 15 feet (4.5 m).

### 3.8 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow 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 required by plumbing code. Comply with requirements in Division 22 plumbing fixture Sections for connection sizes.
  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 (DN 65) and larger.

### 3.9 IDENTIFICATION

- A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.
- B. Label pressure piping with system operating pressure.



### 3.10 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Piping Inspections:

1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
  - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
  - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

C. Piping Tests:

1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
4. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and for corrective action required.

D. Domestic water piping will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

### 3.11 ADJUSTING

- A. Perform the following adjustments before operation:
1. Close drain valves, hydrants, and hose bibbs.
  2. Open shutoff valves to fully open position.
  3. Open throttling valves to proper setting.
  4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
    - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
    - b. Adjust calibrated balancing valves to flows indicated.
  5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
  6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
  7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
  8. Check plumbing specialties and verify proper settings, adjustments, and operation.

### 3.12 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 (50 mg/L)** 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 (200 mg/L)** of chlorine. Isolate and allow to stand for three hours.
    - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.

- d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- B. Prepare and submit reports of purging and disinfecting activities.
- C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

### 3.13 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.

END OF SECTION 221116

## SECTION 221313 - FACILITY 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. Section Includes:
  - 1. Pipe and fittings.
  - 2. Nonpressure couplings
  - 3. Manholes.

#### 1.3 DEFINITIONS

- A. **DIP: Ductile Iron Pipe**
- B. PVC: Polyvinyl chloride plastic pipe

#### 1.4 SUBMITTALS

- A. Shop Drawings:
  - 1. Pipe materials: include product certificates for all sizes of pipe materials required.
- B. Field quality-control reports.

#### 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.
- C. Handle manholes according to manufacturer's written rigging instructions.

#### 1.6 PROJECT CONDITIONS

- A. Site Information: Perform site survey, research public utility records, and verify existing utility locations.
- B. Locate existing structures and piping to be closed and abandoned.
- C. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
  - 1. Notify Architect no fewer than two days in advance of proposed interruption of service.

2. Do not proceed with interruption of service without Architect's written permission.

## PART 2 - PRODUCTS

### 2.1 DUCTILE-IRON PIPE AND FITTINGS

#### A. Push-on-Joint Piping:

1. **Pipe:** AWWA C151 ANSI A21.51, cement lined with bituminous coating per AWWA C104 ANSI 21.4 thickness class 52 per AWWA C150 ANSI A 21.50.
2. **Standard Fittings:** AWWA C110, ductile or gray iron.
3. **Gaskets:** AWWA C111 ANSI 21.11, rubber, of shape matching pipe and fittings.

### 2.2 PVC PIPE AND FITTINGS

#### A. PVC Pressure Piping:

1. **Pipe:** AWWA C900, Class 150 PVC pipe with bell-and-spigot ends for gasketed joints.
2. **Fittings:** AWWA C900, Class 150 PVC pipe with bell ends.
3. **Gaskets:** ASTM F 477, elastomeric seals.

### 2.3 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 corrosion-resistant-metal tension band and tightening mechanism on each end.

##### 1. Sleeve Materials:

- a. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 926, PVC.
- b. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

#### B. Shielded, Flexible Couplings:

1. **Description:** ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant stainless steel outer shield and corrosion-resistant stainless steel tension band and tightening mechanism on each end.

### 2.4 MANHOLES

#### A. Standard Precast Concrete Manholes:

1. **Description:** ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. **Ballast:** Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
3. **Riser Sections:** Of length to provide depth indicated.
4. **Section Joint Sealant:** ASTM C 443 rubber gasket.
5. **Resilient Pipe Connectors:** ASTM C 923 rubber boot, cast or fitted into manhole walls, for each pipe connection. Boot shall result in a water tight connection conforming to the performance requirements of ASTM C 443.

6. Steps: Cast Iron steps conforming to the performance standards of ASTM C 478. Omit steps if total depth from floor of manhole to finished grade is less than 48. Cast or anchor steps into sidewalls at 16-inch intervals inches.
7. Grade (Adjusting) Rings: Reinforced-concrete rings, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Maximum per Drawings.

B. Manhole Frames and Covers:

1. Description: Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."
2. Material: ASTM A 48, Class 35 gray iron ASTM A 536 unless otherwise indicated.

C. External Chimney Seal:

1. Description: Rubber sleeves shall be extruded from a high grade rubber compound meeting the applicable requirements of ASTM C923. Sleeves shall be double or triple pleated with a minimum unexpanded vertical height of 8 inches, a minimum thickness of 3/16 inch, capable of expanding not less than 2 inches vertically when installed.
2. Screws, bolts and nuts: Stainless steel, ASTM F-593 and 594 Type 304
3. Expansion Bands shall be 16 gauge thickness, 1 3/4 inches wide and made of stainless steel meeting the requirements of ASTM A240, Type 304.

## 2.5 CONCRETE

A. General: Cast-in-place concrete complying with ACI 318, and the following:

1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum.

1. Reinforcing Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615, Grade 60, deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum. Include channels and benches in manholes.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
  - a. Invert Slope: 1 percent through manhole.
2. Benches: Concrete, sloped to drain into channel.
  - a. Slope: 8 percent.

## PART 3 - EXECUTION

### 3.1 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

### 3.2 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details 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 manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
- D. 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.
- E. Install gravity-flow, nonpressure, drainage piping according to the following:
  - 1. **Install ductile-iron (DIP), gravity sewer piping according to ASTM A 746.**
  - 2. Install PVC Type PSM sewer piping according to ASTM D 2321 and ASTM F 1668.
- F. 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 ductile-iron pressure piping according to AWWA C600 for push-on joints.**
  - 2. 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.
  - 3. Join dissimilar pipe materials with nonpressure-type couplings.

### 3.4 MANHOLE INSTALLATION

- A. General: Install manholes complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants according to ASTM C 891.
- C. Form continuous concrete channels and benches between inlets and outlet.
- D. Set tops of frames and covers flush with finished surface.
- E. Install manhole-cover inserts in frame and immediately below cover.

- F. Install manhole chimney seal per manufacturer's instructions

### 3.5 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318.

### 3.6 BACKWATER VALVE INSTALLATION

- A. Install horizontal-type backwater valves in piping manholes or pits.
- B. Install combination horizontal and manual gate valves in piping and in manholes.
- C. Install terminal-type backwater valves on end of piping and in manholes. Secure units to sidewalls.

### 3.7 PIPE TAP CONNECTIONS

- A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Division 22 Section "Sanitary Waste and Vent Piping."
- B. Make connections to existing piping.
  - 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch overlap with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
  - 2. Make branch connections from side into existing piping by cutting opening into existing unit large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.
    - a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
  - 3. 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.

### 3.8 CLOSING ABANDONED SANITARY SEWER SYSTEMS

- A. Abandoned Piping: Close open ends of abandoned underground piping where to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
  - 1. Close open ends of piping with at least 24-inch thick, concrete bulkheads.
- B. Abandoned Manholes: Excavate around manhole as required and use either procedure below:
  - 1. Remove manhole and close open ends of remaining piping.



- C. Backfill to grade according to Division 31 Section "Earth Moving."

### 3.9 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches 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. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and per Exfiltration and Infiltration Method Procedures per the Standard Specifications for Water and Sewer Construction in Illinois latest edition where no separate written standards exist:
  - 6. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
    - a. Option: Test plastic gravity sewer piping according to ASTM F 1417
  - 7. Manholes: Perform hydraulic test according to ASTM C 969.
- 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.

### 3.10 CLEANING

- A. Clean dirt and superfluous material from interior of piping.

END OF SECTION 221313

## SECTION 221316

### SANITARY WASTE AND VENT PIPING

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- A. Section Includes:

- 1. Pipe, tube, and fittings.
- 2. Specialty pipe fittings.

- B. Related Sections:

- 1. Division 22 Section "Facility Sanitary Sewers" for sanitary sewerage piping and structures outside the building.
- 2. Division 22 Section "Sanitary Sewerage Pumps" for effluent and sewage pumps.

##### 1.3 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
  - 1. Soil, Waste, and Vent Piping: **10-foot head of water (30 kPa)**.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For sovent drainage system. Include plans, elevations, sections, and details.

##### 1.5 INFORMATIONAL SUBMITTALS

- 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.

## 1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

## 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 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, **Service** class.
- B. Gaskets: ASTM C 564, rubber.
- C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

### 2.3 GALVANIZED-STEEL PIPE AND FITTINGS

- A. Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Standard Weight class. Include square-cut-grooved or threaded ends matching joining method.
- B. **Galvanized**-Cast-Iron Drainage Fittings: ASME B16.12, threaded.
- C. Steel Pipe Pressure Fittings:
  1. **Galvanized**-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Schedule 40, seamless steel pipe. Include ends matching joining method.
  2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
  3. **Galvanized**-Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, standard pattern.

## 2.4 COPPER TUBE AND FITTINGS

- A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
- B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
- C. Hard Copper Tube: **ASTM B 88, Type L and Type M** (ASTM B 88M, Type B and Type C), water tube, drawn temper.
- D. Copper Pressure Fittings:
  - 1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
  - 2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- E. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
- F. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

## PART 3 - EXECUTION

### 3.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Division 31 Section "Earth Moving."

### 3.1 PIPING INSTALLATION 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).
  - 1. 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."
- B. 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).

- 8.1 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
- 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 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. 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.
  - K. 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.
  - L. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Drain: 1 percent downward in direction of flow for piping **NPS 4 (DN 100)** and smaller; **1 percent** downward in direction of flow for piping **NPS 4 (DN 100)** and larger.
  2. Horizontal Sanitary Drainage Piping: **1 percent** downward in direction of flow.
  3. Vent Piping: **1 percent** down toward vertical fixture vent or toward vent stack.
- M. 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."
1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.
- N. Install steel piping according to applicable plumbing code.
- O. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
- P. 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. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Division 22 Section "Sanitary Waste Piping Specialties."
  2. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Division 22 Section "Sanitary Waste Piping Specialties."
- Q. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."
- S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."
- T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Escutcheons for Plumbing Piping."
- 8.2 JOINT CONSTRUCTION
- A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
  - B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.

- 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 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.
- D. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

### 8.3 VALVE INSTALLATION

- A. General valve installation requirements are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- B. Shutoff Valves:
  - 1. Install shutoff valve on each sewage pump discharge.
- C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

### 8.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger and support devices and installation specified in Division 22 Section "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. Vertical Piping: MSS Type 8 or Type 42, clamps.
  - 5. Install individual, straight, horizontal piping runs:
    - a. **100 Feet (30 m)** and Less: MSS Type 1, adjustable, steel clevis hangers.
    - b. **Longer Than 100 Feet (30 m)**: MSS Type 43, adjustable roller hangers.

- c. Longer Than 100 Feet (30 m) if Indicated: MSS Type 49, spring cushion rolls.
  - 6. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
  - 7. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support horizontal piping and tubing within 12 inches (300 mm) of each fitting, valve, 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 (10-mm) 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 (DN 40 and DN 50): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
  - 2. NPS 3 (DN 80): 60 inches (1500 mm) with 1/2-inch (13-mm) rod.
  - 3. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1500 mm) with 5/8-inch (16-mm) rod.
  - 4. NPS 6 and NPS 8 (DN 150 and DN 200): 60 inches (1500 mm) with 3/4-inch (19-mm) rod.
  - 5. NPS 10 and NPS 12 (DN 250 and DN 300): 60 inches (1500 mm) with 7/8-inch (22-mm) rod.
  - 6. Spacing for 10-foot (3-m) lengths may be increased to 10 feet (3 m). Spacing for fittings is limited to 60 inches (1500 mm).
- G. Install supports for vertical cast-iron soil piping every 15 feet (4.5 m).
- H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
- 1. NPS 1-1/4 (DN 32): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
  - 2. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
  - 3. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
  - 4. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
  - 5. NPS 3 (DN 80): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
  - 6. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.
  - 7. NPS 6 and NPS 8 (DN 150 and DN 200): 12 feet (3.7 m) with 3/4-inch (19-mm) rod.
  - 8. NPS 10 and NPS 12 (DN 250 and DN 300): 12 feet (3.7 m) with 7/8-inch (22-mm) rod.
- I. Install supports for vertical steel piping every 15 feet (4.5 m).



- J. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 2 (DN 50): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
  - 2. NPS 3 (DN 80): 96 inches (2400 mm) with 1/2-inch (13-mm) rod.
  - 3. NPS 4 (DN 100): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
  - 4. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.
- K. Install supports for vertical stainless-steel piping every 10 feet (3 m).
- L. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 1-1/4 (DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
  - 2. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
  - 3. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
  - 4. NPS 3 and NPS 5 (DN 80 and DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
  - 5. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.
  - 6. NPS 8 (DN 200): 10 feet (3 m) with 3/4-inch (19-mm) rod.
- M. Install supports for vertical copper tubing every 10 feet (3 m).

## 8.5 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. 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 (DN 65) and larger.

## 8.6 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

## 8.7 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 (30 kPa)**. 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 (250 Pa)**. 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.

## 8.8 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.

## 8.9 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste piping **NPS 4 (DN 100) and smaller** shall be **any of** the following:
  - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
  - 2. Galvanized-steel pipe, drainage fittings, and threaded joints.
  - 3. .
  - 4. Copper DWV tube, copper drainage fittings, and soldered joints.
- C. Aboveground, soil and waste piping **NPS 5 (DN 125) and larger** shall be **any of** the following:
  - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
- D. Aboveground, vent piping **NPS 4 (DN 100) and smaller** shall be **any of** the following:
  - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
  - 2. .
  - 3. Galvanized-steel pipe, drainage fittings, and threaded joints.
  - 4. .
  - 5. Copper DWV tube, copper drainage fittings, and soldered joints.
  - 6. Dissimilar Pipe-Material Couplings: **Unshielded or Shielded**, nonpressure transition couplings.
- E. Aboveground, vent piping **NPS 5 (DN 125) and larger** shall be **any of** the following:
  - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
- F. Underground, soil, waste, and vent piping **NPS 4 (DN 100) and smaller** shall be **any of** the following:
  - 1. **Service** class, cast-iron soil piping; **gaskets**;
- G. Underground, soil and waste piping **NPS 5 (DN 125)** shall be the following:

1. **Service** class, cast-iron soil piping; **gaskets**;
- H. Aboveground sanitary-sewage force mains **NPS 1-1/2 and NPS 2 (DN 40 and DN 50)** shall be **any of** the following:
1. Hard copper tube, **Type L (Type B)**; copper pressure fittings; and soldered joints.
  2. Galvanized-steel pipe, pressure fittings, and threaded joints.

END OF SECTION 221316

## SECTION 221423

### STORM DRAINAGE PIPING SPECIALTIES

#### 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. Roof drains.
  - 2. Miscellaneous storm drainage piping specialties.
  - 3. Cleanouts.

##### 1.3 ACTION SUBMITTALS

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

##### 1.4 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

#### PART 2 - PRODUCTS

##### 2.1 METAL ROOF DRAINS

- A. Cast-Iron, Large-Sump, General-Purpose Roof:
  - 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. Josam Company.
    - b. MIFAB, Inc.
    - c. Smith, Jay R. Mfg. Co.

- d. Tyler Pipe.
  - e. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.6.4, for general-purpose roof drains.
  3. Body Material: **Cast iron**.
  4. Dimension of Body: Nominal **14-inch (357-mm)** diameter.
  5. Combination Flashing Ring and Gravel Stop: **Required**.
  6. Outlet: **Bottom**.
  7. Extension Collars: **Required**.
  8. Underdeck Clamp: **Required**.
  9. Dome Material: **Aluminum**.

## 2.2 CLEANOUTS

### A. Floor Cleanouts:

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. Josam Company.
  - b. Smith, Jay R. Mfg. Co.
  - c. Tyler Pipe.
  - d. Zurn Plumbing Products Group; Light Commercial Products Operation.
  - e. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M, for **adjustable housing cast-iron soil pipe with cast-iron ferrule threaded, adjustable housing** cleanouts.
3. Size: Same as connected branch.
4. Type: **Adjustable housing Cast-iron soil pipe with cast-iron ferrule duty, Threaded, adjustable housing**.
5. Body or Ferrule Material: **Cast iron**.
6. Clamping Device: **Required**.
7. Outlet Connection: **Inside calk Spigot**
8. Closure: **Brass plug with tapered threads**.
9. Adjustable Housing Material: **Cast iron with set-screws or other device**.
10. Frame and Cover Material and Finish: **Nickel-bronze, copper alloy** Frame and Cover Shape: **Round**] **Square**
11. Top-Loading Classification: **Heavy Duty**
12. Riser: ASTM A 74, **Service** class, cast-iron drainage pipe fitting and riser to cleanout.

### B. Test Tees :

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. Josam Company.
  - b. MIFAB, Inc.
  - c. Smith, Jay R. Mfg. Co.
  - d. Tyler Pipe.
  - e. Watts Water Technologies, Inc.
  - f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M and ASTM A 74, ASTM A 888, or CISPI 301, for cleanout test tees.
  3. Size: Same as connected drainage piping.
  4. Body Material: Hub-and-spigot, cast-iron soil-pipe test tee as required to match connected piping.
  5. Closure Plug: **Countersunk or raised head, brass**
  6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

C. Wall Cleanouts :

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. Josam Company.
  - b. MIFAB, Inc.
  - c. Smith, Jay R. Mfg. Co.
  - d. Tyler Pipe.
  - e. Watts Water Technologies, Inc.
  - f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M, for cleanouts. Include wall access.
3. Size: Same as connected drainage piping.
4. Body Material: **Hub-and-spigot, 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.
7. Wall Access: Round, **flat, chrome-plated brass or stainless-steel** cover plate with screw.
8. Wall Access: **Round or Square, nickel-bronze, copper-alloy, or stainless-steel** wall-installation frame and cover.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 07 Sections.
  - 1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
  - 2. Position roof drains for easy access and maintenance.
- B. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.
- C. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:
  - 1. Use cleanouts the same size as drainage piping up to **NPS 4 (DN 100)**. Use **NPS 4 (DN 100)** for larger drainage piping unless larger cleanout is indicated.
  - 2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
  - 3. Locate cleanouts at minimum intervals of **50 feet (DN 100)** and smaller and **100**
  - 4. Locate cleanouts at base of each vertical soil and waste stack.
- D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- F. Install test tees in vertical conductors and near floor.
- G. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.
- H. Assemble channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.
- I. Install through-penetration firestop assemblies in plastic conductors at concrete floor penetrations.
- J. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

### 3.2 CONNECTIONS

- A. Comply with requirements for piping specified in Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.



### 3.3 FLASHING INSTALLATION

- A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
  - 1. Lead Sheets: Burn joints of 6.0-lb/sq. ft. (30-kg/sq. m) lead sheets, 0.0938-inch (2.4-mm) thickness or thicker. Solder joints of 4.0-lb/sq. ft. (20-kg/sq. m) lead sheets, 0.0625-inch (1.6-mm) thickness or thinner.
  - 2. Copper Sheets: Solder joints of copper sheets.
- 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 the pipe size, with a minimum length of 10 inches (250 mm) and with skirt or flange extending at least 8 inches (200 mm) around pipe.
  - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around sleeve.
  - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) 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. Fabricate and install flashing and pans, sumps, and other drainage shapes.

### 3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221423

## SECTION 221429

### SUMP PUMPS

#### 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. Submersible sump pumps.

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. **Include construction details, material descriptions, dimensions of individual components and profiles. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.**
- B. Wiring Diagrams: For power, signal, and control wiring.

##### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

##### 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. UL Compliance: Comply with UL 778 for motor-operated water pumps.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Retain shipping flange protective covers and protective coatings during storage.
- B. Protect bearings and couplings against damage.
- C. Comply with pump manufacturer's written rigging instructions for handling.

## PART 2 - PRODUCTS

### 2.1 SUBMERSIBLE SUMP PUMPS

#### A. Submersible, Fixed-Position, Single-Seal Sump Pumps:

1. 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:**
  - a. Barnes; Crane Pumps & Systems.
  - b. Bell & Gossett Domestic Pump; ITT Corporation.
  - c. Flo Fab inc.
  - d. Glentronics, Inc.
  - e. Goulds Pumps; ITT Corporation.
  - f. Grundfos Pumps Corp.
  - g. Liberty Pumps.
  - h. Little Giant Pump Co.
  - i. McDonald, A. Y. Mfg. Co.
  - j. Pentair Pump Group; Hydromatic Pumps.
  - k. Pentair Pump Group; Myers.
  - l. Stancor, Inc.
  - m. Sta-Rite Industries, Inc.
  - n. Weil Pump Company, Inc.
  - o. Weinman Division; Crane Pumps & Systems.
  - p. Zoeller Company.
2. Description: Factory-assembled and -tested sump-pump unit.
3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 1.1-1.2 and HI 1.3.
4. Pump Casing: Cast iron, with strainer inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
5. Impeller: Statically and dynamically balanced, **ASTM A 48/A 48M, Class No. 25 A cast iron, ASTM A 532/A 532M, abrasion-resistant cast iron, and ASTM B 584, cast bronze, semiopen** design for clear wastewater handling, and keyed and secured to shaft.
6. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
7. Seal: Mechanical.

8. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
  - a. Motor Housing Fluid: **Air or Oil**.
9. Controls:
  - a. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with **pressure** switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
10. Control-Interface Features:
  - a. Remote Alarm Contacts: For remote alarm interface.

## 2.2 SUMP PUMP CAPACITIES AND CHARACTERISTICS

- A. Unit Capacity: As listed on drawings.

## 2.3 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22 Section "Common Motor Requirements for Plumbing 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 Division 26 Sections.
- B. Motors for submersible pumps shall be hermetically sealed.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine roughing-in for plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

### 3.2 INSTALLATION

- A. Pump Installation Standards: Comply with HI 1.4 for installation of sump pumps.

### 3.3 CONNECTIONS

- A. Comply with requirements for piping specified in Division 22 Section "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

### 3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection.
  - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Pumps and controls will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

### 3.5 STARTUP SERVICE

- 1. Complete installation and startup checks according to manufacturer's written instructions.

### 3.6 ADJUSTING

- A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.
- B. Adjust control set points.

## SECTION 22 41 00

### RESIDENTIAL PLUMBING FIXTURES

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- A. Section Includes:

1. Bathtubs.
2. Faucets.
3. Lavatories.
4. Showers.
5. Kitchen sinks.
6. Water closets.
7. Toilet seats.
8. Supply fittings.
9. Waste fittings.

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for lavatories.
  2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories. INFORMATIONAL SUBMITTALS
- B. Coordination Drawings: Counter cutout templates for mounting of counter-mounted plumbing fixtures.
- C. Sample Warranty: For special warranty.

##### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For plumbing fixtures and faucets to include in emergency, operation, and operation and maintenance manuals.

## 1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Faucet Washers and O-Rings: Equal to **10** percent of amount of each type and size installed.
  - 2. Faucet Cartridges and O-Rings: Equal to **5** percent of amount of each type and size installed.
  - 3. Flushometer-Tank Repair Kits: Equal to **5** percent of amount of each type installed, but no fewer than **two** of each type.
  - 4. Toilet Seats: Equal to **5** percent of amount of each type installed.

## PART 2 - PRODUCTS

### 2.0 PLUMBING FIXTURES

- A. See Architectural Drawing

### 2.1 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for faucet materials that will be in contact with potable water.
- B. Standard: ASME A112.18.1/CSA B125.1.
- C. Supply Fittings:
  - 1. Supply Piping: Chrome-plated-brass pipe or chrome-plated-copper tube matching water-supply piping size. Include chrome-plated wall flange.
  - 2. Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression stop with inlet connection matching water-supply piping type and size.
    - a. Operation: **Wheel handle.**
  - 3. Risers:
    - a. Size: **NPS 1/2 (DN 15).**
    - b. Material: **Chrome-plated, soft-copper flexible tube**

### 2.2 WASTE FITTINGS

- A. Standard: ASME A112.18.2/CSA B125.2.
- B. Drain: Grid type with **NPS 1-1/4 (DN 32)** offset tailpiece for accessible lavatories.

- C. Drain: Pop-up type with **NPS 1-1/4 (DN 32)** straight tailpiece as part of faucet for standard lavatories.
- D. Trap:
  - 1. Size: **NPS 1-1/4 (DN 32)** lavatories.
  - 2. Size: **NPS 1-1/2 (DN 40)** for kitchen sinks and laundry trays.
  - 3. Material: Chrome-plated, **two-piece, cast-brass trap and swivel elbow with 0.032-inch- (0.83-mm-) thick brass tube to wall**; and chrome-plated-brass or -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 plumbing-fixture installation.
- B. Examine walls, floors, cabinets, and counters for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install plumbing fixtures level and plumb according to roughing-in drawings.
- B. Install floor-mounted water closets on closet flange attachments to drainage piping.
- C. Install counter-mounting fixtures in and attached to casework.
- D. Install pedestal lavatories on pedestals and secured to wood blocking in wall.
- E. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
  - 1. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture. Comply with valve requirements specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- F. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.
- G. Install toilet seats on water closets.



- H. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- I. Install shower flow-control fittings with specified maximum flow rates in shower arms.
- J. Install traps on fixture outlets.
  - 1. Exception: Omit trap on fixtures with integral traps.
  - 2. Exception: Omit trap on indirect wastes unless otherwise indicated.
- K. Install disposer in outlet of each sink indicated to have a disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.
- L. Set **shower receptors** in leveling bed of cement grout.
- M. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible **lavatories and sinks**. Comply with requirements in Division 22 Section "Plumbing Piping Insulation."
- N. 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 Division 22 Section "Escutcheons for Plumbing Piping."
- O. Seal joints between plumbing fixtures, 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 Division 07 Section "Joint Sealants."

### 3.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Division 22 Section "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Division 22 Section "Sanitary Waste and Vent Piping."
- D. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible **lavatories and sinks**

### 3.4 ADJUSTING

- A. Operate and adjust plumbing fixtures and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

- B. Adjust water pressure at faucets to produce proper flow.

### 3.5 CLEANING AND PROTECTION

- A. After completing installation of plumbing fixtures, inspect and repair damaged finishes.
- B. Clean plumbing fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed plumbing fixtures and fittings.
- D. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224100

## SECTION 23 05 13

### COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

#### 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 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.

##### 1.3 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
  - 1. Motor controllers.
  - 2. Torque, speed, and horsepower requirements of the load.
  - 3. Ratings and characteristics of supply circuit and required control sequence.
  - 4. Ambient and environmental conditions of installation location.

#### PART 2 - PRODUCTS

##### 2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.
- B. Comply with NEMA MG 1 unless otherwise indicated.
- C. Comply with IEEE 841 for severe-duty motors.

## 2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of **3300 feet (1000 m)** 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. Multispeed Motors: Separate winding for each speed.
- F. Rotor: Random-wound, squirrel cage.
- G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- H. Temperature Rise: Match insulation rating.
- I. Insulation: **Class F**.
- J. Code Letter Designation:
  - 1. Motors **15** HP and Larger: NEMA starting Code F or Code G.
  - 2. Motors Smaller than **15** HP: Manufacturer's standard starting characteristic.
- K. Enclosure Material: Cast iron for motor frame sizes **324T** and larger; rolled steel for motor frame sizes smaller than **324T**.

## 2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers: **Ratings, characteristics, and features coordinated with and approved by controller manufacturer.**
  - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
  - 2. 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.
- C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

## 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 230517

### SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- A. Section Includes:
  - 1. Sleeves.
  - 2. Stack-sleeve fittings.
  - 3. Sleeve-seal systems.
  - 4. Sleeve-seal fittings.
  - 5. Grout.

##### 1.3 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 (0.6-mm)** minimum thickness; round tube closed with welded longitudinal joint.
- F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- G. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

## 2.2 STACK-SLEEVE FITTINGS

- 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. Smith, Jay R. Mfg. Co.
  - 2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
- B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
  - 1. Underdeck Clamp: Clamping ring with setscrews.

## 2.3 SLEEVE-SEAL SYSTEMS

- 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. Advance Products & Systems, Inc.
  - 2. CALPICO, Inc.
  - 3. Metraflex Company (The).
  - 4. Pipeline Seal and Insulator, Inc.
  - 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** or **NBR** interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  - 2. Pressure Plates: **Carbon steel** or **Stainless steel**.
  - 3. Connecting Bolts and Nuts: **Carbon steel, with corrosion-resistant coating or Stainless steel** of length required to secure pressure plates to sealing elements.



## 2.4 SLEEVE-SEAL 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. Presealed Systems.
- B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

## 2.5 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 (34.5-MPa)**, 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 (25-mm)** 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. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
  - 2. 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 (50 mm)** above finished floor level.
  - 3. 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 (6.4-mm) 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 Division 07 Section "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 Division 07 Section "Penetration Firestopping."

### 3.2 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
  - 1. Install fittings that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
  - 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Division 07 Section "Sheet Metal Flashing and Trim."
  - 3. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level.
  - 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
  - 5. Using grout, seal the space around outside of stack-sleeve fittings.
- B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

### 3.3 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.

### 3.4 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

### 3.5 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 (DN 150)**: **Cast-iron wall sleeves or Galvanized-steel wall sleeves or Galvanized-steel-pipe sleeves.**
    - b. Piping **NPS 6 (DN 150)** and Larger: **Cast-iron wall sleeves or Galvanized-steel wall sleeves or Galvanized-steel-pipe sleeves] <Insert material>.**
  - 2. Exterior Concrete Walls below Grade:
    - a. Piping Smaller Than **NPS 6 (DN 150)**: **Cast-iron wall sleeves with sleeve-seal system or Galvanized-steel wall sleeves with sleeve-seal system] [Galvanized-steel-pipe sleeves with sleeve-seal system] [Sleeve-seal fittings] <Insert material>.**
      - 1) Select sleeve size to allow for **1-inch (25-mm)** annular clear space between piping and sleeve for installing sleeve-seal system.
    - b. Piping [**NPS 6 (DN 150)**] **<Insert pipe size>** and Larger: **[Cast-iron wall sleeves with sleeve-seal system] [Galvanized-steel wall sleeves with sleeve-seal system or Galvanized-steel-pipe sleeves with sleeve-seal system.**
      - 1) Select sleeve size to allow for **1-inch (25-mm)** annular clear space between piping and sleeve for installing sleeve-seal system.
  - 3. Concrete Slabs-on-Grade:
    - a. Piping Smaller Than **NPS 6 (DN 150)**: **Cast-iron wall sleeves with sleeve-seal system or Galvanized-steel wall sleeves with sleeve-seal system or Galvanized-steel-pipe sleeves with sleeve-seal system.**

- 1) Select sleeve size to allow for **1-inch (25-mm)** annular clear space between piping and sleeve for installing sleeve-seal system.
  - b. Piping **NPS 6 (DN 150)** and Larger: **Cast-iron wall sleeves with sleeve-seal system or Galvanized-steel wall sleeves with sleeve-seal system or Galvanized-steel-pipe sleeves with sleeve-seal system.**
    - 1) Select sleeve size to allow for **1-inch (25-mm)** annular clear space between piping and sleeve for installing sleeve-seal system.
4. Concrete Slabs above Grade:
- a. Piping Smaller Than **NPS 6 (DN 150)**: **Galvanized-steel-pipe sleeves or PVC-pipe sleeve.**
  - b. Piping **NPS 6 (DN 150)** and Larger: **Galvanized-steel-pipe sleeves.**
5. Interior Partitions:
- a. Piping Smaller Than **NPS 6 (DN 150)**: **Galvanized-steel-pipe sleeves.**
  - b. Piping **NPS 6 (DN 150)** and Larger: **Galvanized-steel-sheet sleeves.**

END OF SECTION 230517

## SECTION 230593

### TESTING, ADJUSTING, AND BALANCING FOR HVAC

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- A. Section Includes:
  - 1. Balancing Air Systems:
    - a. Constant-volume air systems

##### 1.3 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.

##### 1.4 ACTION SUBMITTALS

- A. LEED Submittals:
  - 1. Air-Balance Report for Prerequisite IEQ 1: Documentation of work performed for ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
  - 2. TAB Report for Prerequisite EA 2: Documentation of work performed for ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

## 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within **30** days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within **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. Certified TAB reports.
- E. Sample report forms.
- F. Instrument calibration reports, to include the following:
  - 1. Instrument type and make.
  - 2. Serial number.
  - 3. Application.
  - 4. Dates of use.
  - 5. Dates of calibration.

## 1.6 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB entity certified by **AABC, NEBB or TABB**.
  - 1. TAB Field Supervisor: Employee of the TAB contractor and certified by **AABC, NEBB or TABB**.
  - 2. TAB Technician: Employee of the TAB contractor and who is certified by **AABC, NEBB or TABB** as a TAB technician.
- B. TAB Conference: Meet with **Construction Manager and Commissioning Agent** on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide **seven** days' advance notice of scheduled meeting time and location.
  - 1. Agenda Items:
    - a. The Contract Documents examination report.
    - b. The TAB plan.
    - c. Coordination and cooperation of trades and subcontractors.
    - d. Coordination of documentation and communication flow.
- C. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
  2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- D. TAB Report Forms: Use standard TAB contractor's forms approved by **Commissioning Authority**.
- E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."
- F. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- G. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

## 1.7 PROJECT CONDITIONS

- A. Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

## 1.8 COORDINATION

- A. Notice: Provide **seven** days' advance notice for each test. Include scheduled test dates and times.
- B. Perform TAB after leakage and pressure tests on **air and water** distribution systems have been satisfactorily completed.

## PART 2 - PRODUCTS (Not Applicable)

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.

- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine ceiling plenums and used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Division 23 Section "**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 heat-transfer coils for correct piping connections and for clean and straight fins.
- L. Examine operating safety interlocks and controls on HVAC 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 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. Automatic temperature-control systems are operational.
3. Equipment and duct access doors are securely closed.
4. Balance, smoke, and fire dampers are open.
5. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
6. Windows and doors can be closed so indicated conditions for system operations can be met.

### 3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in **AABC's "National Standards for Total System Balance"** or **ASHRAE 111**, or **NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems"**, or **SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing"** and in this Section.
  1. Comply with requirements in ASHRAE 62.1, 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. After testing and balancing, install test ports and duct access doors that comply with requirements in Division 23 Section "Air Duct Accessories."
  3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in **inch-pound (IP)** units.

### 3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. 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 Division 23 Section "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 **Commissioning Agent** for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
  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 VARIABLE-AIR-VOLUME SYSTEMS

- A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
- B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
  2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
  3. Measure total system airflow. Adjust to within indicated airflow.
  4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
  5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
    - a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
  6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
    - a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.
  7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
  8. Record final fan-performance data.
- C. Pressure-Dependent, Variable-Air-Volume Systems without Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
1. Balance variable-air-volume systems the same as described for constant-volume air systems.
  2. Set terminal units and supply fan at full-airflow condition.

3. Adjust inlet dampers of each terminal unit to indicated airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
  4. Readjust fan airflow for final maximum readings.
  5. Measure operating static pressure at the sensor that controls the supply fan if one is installed, and verify operation of the static-pressure controller.
  6. Set supply fan at minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.
  7. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
    - a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.
  8. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
    - a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.
- D. Pressure-Dependent, Variable-Air-Volume Systems with Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
1. Set system at maximum indicated airflow by setting the required number of terminal units at minimum airflow. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
  2. Adjust supply fan to maximum indicated airflow with the variable-airflow controller set at maximum airflow.
  3. Set terminal units at full-airflow condition.
  4. Adjust terminal units starting at the supply-fan end of the system and continuing progressively to the end of the system. Adjust inlet dampers of each terminal unit to indicated airflow. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
  5. Adjust terminal units for minimum airflow.
  6. Measure static pressure at the sensor.
  7. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

### 3.7 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.

### 3.8 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

### 3.9 TOLERANCES

- A. Set HVAC system's air flow rates 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.**

### 3.10 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 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.

### 3.11 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. Fan 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 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 and hydronic distribution systems. Present each system with single-line diagram and include the following:
- 1. Quantities of outdoor, supply, return, and exhaust airflows.
  - 2. Water and steam flow rates.
  - 3. Duct, outlet, and inlet sizes.
  - 4. Pipe and valve sizes and locations.
  - 5. Terminal units.
  - 6. Balancing stations.
  - 7. Position of balancing devices.
- E. Gas- and Oil-Fired Heat Apparatus 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 (kW)**.
    - h. Ignition type.
    - i. Burner-control types.
    - j. Motor horsepower and rpm.
    - k. Motor volts, phase, and hertz.
    - l. Motor full-load amperage and service factor.
    - m. Sheave make, size in **inches (mm)**, and bore.
    - n. Center-to-center dimensions of sheave, and amount of adjustments in **inches (mm)**.
  - 2. Test Data (Indicated and Actual Values):
    - a. Total air flow rate in **cfm (L/s)**.
    - b. Entering-air temperature in **deg F (deg C)**.
    - c. Leaving-air temperature in **deg F (deg C)**.
    - d. Air temperature differential in **deg F (deg C)**.
    - e. Entering-air static pressure in **inches wg (Pa)**.
    - f. Leaving-air static pressure in **inches wg (Pa)**.
    - g. Air static-pressure differential in **inches wg (Pa)**.
    - h. Low-fire fuel input in **Btu/h (kW)**.
    - i. High-fire fuel input in **Btu/h (kW)**.
    - j. Manifold pressure in **psig (kPa)**.
    - k. High-temperature-limit setting in **deg F (deg C)**.
    - l. Operating set point in **Btu/h (kW)**.



- m. Motor voltage at each connection.
- n. Motor amperage for each phase.
- o. Heating value of fuel in **Btu/h (kW)**.

F. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

- a. System identification.
- b. Location.
- c. Make and type.
- d. Model number and size.
- e. Manufacturer's serial number.
- f. Arrangement and class.
- g. Sheave make, size in **inches (mm)**, and bore.
- h. Center-to-center dimensions of sheave, and amount of adjustments in **inches (mm)**.

2. Motor Data:

- a. Motor make, and frame type and size.
- b. Horsepower and rpm.
- c. Volts, phase, and hertz.
- d. Full-load amperage and service factor.
- e. Sheave make, size in **inches (mm)**, and bore.
- f. Center-to-center dimensions of sheave, and amount of adjustments in **inches (mm)**.
- g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

- a. Total airflow rate in **cfm (L/s)**.
- b. Total system static pressure in **inches wg (Pa)**.
- c. Fan rpm.
- d. Discharge static pressure in **inches wg (Pa)**.
- e. Suction static pressure in **inches wg (Pa)**.

G. Air-Terminal-Device Reports:

1. Unit Data:

- a. System and air-handling unit identification.
- b. Location and zone.
- c. Apparatus used for test.
- d. Area served.
- e. Make.
- f. Number from system diagram.
- g. Type and model number.
- h. Size.

- i. Effective area in **sq. ft. (sq. m)**.
2. Test Data (Indicated and Actual Values):
  - a. Air flow rate in **cfm (L/s)**.
  - b. Air velocity in **fpm (m/s)**.
  - c. Preliminary air flow rate as needed in **cfm (L/s)**.
  - d. Preliminary velocity as needed in **fpm (m/s)**.
  - e. Final air flow rate in **cfm (L/s)**.
  - f. Final velocity in **fpm (m/s)**.
  - g. Space temperature in **deg F (deg C)**.

### 3.12 INSPECTIONS

#### A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:
  - a. Measure airflow of at least **10** percent of air outlets.
  - b. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
  - c. Verify that balancing devices are marked with final balance position.
  - d. Note deviations from the Contract Documents in the final report.

#### B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by **Commissioning Authority**.
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of **Commissioning Authority**.
3. **Commissioning Authority** shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

- C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

### 3.13 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 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 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.
- B. Related Sections:
  - 1. Division 23 Section "HVAC Equipment Insulation."
  - 2. Division 23 Section "HVAC Piping Insulation."
  - 3. Division 23 Section "Metal Ducts" for duct liners.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).
- B. LEED Submittals:
  - 1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
  - 2. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that products 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. 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.
- D. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:
1. Sheet Form Insulation Materials: 12 inches (300 mm) square.
  2. Sheet Jacket Materials: 12 inches (300 mm) square.
  3. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Qualified Installer with minimum 10 years experience
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. 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.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

## 1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

## 1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

## PART 2 - PRODUCTS

### 2.1 INSULATION MATERIALS

- A. Comply with requirements in "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 .
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. CertainTeed Corp.; SoftTouch Duct Wrap.
    - b. Johns Manville; Microlite.
    - c. Knauf Insulation; Friendly Feel Duct Wrap.
    - d. Manson Insulation Inc.; Alley Wrap.
    - e. Owens Corning; SOFTR All-Service Duct Wrap..
- 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 without factory-applied jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. CertainTeed Corp.; Commercial Board.
    - b. Fibrex Insulations Inc.; FBX.
    - c. Johns Manville; 800 Series Spin-Glas.
    - d. Knauf Insulation; Insulation Board.
    - e. Manson Insulation Inc.; AK Board.

## 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. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Aeroflex USA, Inc.; Aero seal.
    - b. Armacell LLC; Armaflex 520 Adhesive.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
  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).
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
    - b. Eagle Bridges - Marathon Industries; 225.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
  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).
- D. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
    - b. Eagle Bridges - Marathon Industries; 225.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
  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).
- E. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Dow Corning Corporation; 739, Dow Silicone.
    - b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
    - c. P.I.C. Plastics, Inc.; Welding Adhesive.
  2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## 2.3 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. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
    - b. Vimasco Corporation; 749.
  2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
  3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
  4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
  5. Color: White.
- C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-30.
    - b. Eagle Bridges - Marathon Industries; 501.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-35.
    - d. Mon-Eco Industries, Inc.; 55-10.
  2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.03 metric perm) at 35-mil (0.9-mm) dry film thickness.
  3. Service Temperature Range: 0 to 180 deg F (Minus 18 to plus 82 deg C).
  4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
  5. Color: White.
- D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Encacel.
    - b. Eagle Bridges - Marathon Industries; 570.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 60-95/60-96.
  2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.033 metric perm) at 30-mil (0.8-mm) dry film thickness.

3. Service Temperature Range: **Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C)**.
  4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
  5. Color: White.
- E. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
    - b. Eagle Bridges - Marathon Industries; 550.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
    - d. Mon-Eco Industries, Inc.; 55-50.
    - e. Vimasco Corporation; WC-1/WC-5.
  2. Water-Vapor Permeance: ASTM F 1249, **1.8 perms (1.2 metric perms)** at **0.0625-inch (1.6-mm)** dry film thickness.
  3. Service Temperature Range: **Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C)**.
  4. Solids Content: 60 percent by volume and 66 percent by weight.
  5. Color: White.

## 2.4 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
    - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
    - c. Vimasco Corporation; 713 and 714.
  3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
  4. Service Temperature Range: **0 to plus 180 deg F (Minus 18 to plus 82 deg C)**.
  5. Color: White.

## 2.5 SEALANTS

### A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
  - b. Eagle Bridges - Marathon Industries; 405.
  - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
  - d. Mon-Eco Industries, Inc.; 44-05.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: **Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C)**.
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).

### B. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: **Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C)**.
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).

## 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 (0.86 metric perm) 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 Glass-Fiber Fabric: Approximately 6 oz./sq. yd. (203 g/sq. m) with a thread count of 5 strands by 5 strands/sq. in. (2 strands by 2 strands/sq. mm) for covering ducts.
  1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Chil-Glas No. 5.
- B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm), in a Leno weave, for ducts.
  1. Products: Subject to compliance with requirements, **available products that may be incorporated into the Work include, but are not limited to, the following]**:
    - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Mast-A-Fab.
    - b. Vimasco Corporation; Elastafab 894.

## 2.8 FIELD-APPLIED CLOTHS

- A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd. (271 g/sq. m).
  1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

## 2.9 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. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Johns Manville; Zeston.
    - b. P.I.C. Plastics, Inc.; FG Series.
    - c. Proto Corporation; LoSmoke.
    - d. Speedline Corporation; SmokeSafe..
  2. Adhesive: As recommended by jacket material manufacturer.
  3. Color: White.
- D. Metal Jacket:
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
    - b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
    - c. RPR Products, Inc.; Insul-Mate.
  2. Aluminum Jacket: Comply with **ASTM B 209 (ASTM B 209M)**, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
    - a. Sheet and roll stock ready for shop or field sizing.
    - b. Finish and thickness are indicated in field-applied jacket schedules.
    - c. Moisture Barrier for Indoor Applications: **1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper.**
    - d. Moisture Barrier for Outdoor Applications: **3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.**
  3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
    - a. **Sheet and roll stock ready for shop or field sizing.**
    - b. Material, finish, and thickness are indicated in field-applied jacket schedules.
    - c. Moisture Barrier for Indoor Applications: **1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper.**
    - d. Moisture Barrier for Outdoor Applications: **3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.**
- E. Self-Adhesive Outdoor Jacket: **60-mil- (1.5-mm-) 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. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Polyguard Products, Inc.; Alumaguard 60.

## 2.10 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
  - a. ABI, Ideal Tape Division; 428 AWF ASJ.
  - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
  - c. Compac Corporation; 104 and 105.
  - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
2. Width: 3 inches (75 mm).
3. Thickness: 11.5 mils (0.29 mm).
4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
  - a. ABI, Ideal Tape Division; 491 AWF FSK.
  - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
  - c. Compac Corporation; 110 and 111.
  - d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ..
2. Width: 3 inches (75 mm).
3. Thickness: 6.5 mils (0.16 mm).
4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

- a. ABI, Ideal Tape Division; 370 White PVC tape.
  - b. Compac Corporation; 130.
  - c. Venture Tape; 1506 CW NS.
2. Width: **2 inches (50 mm)**.
  3. Thickness: **6 mils (0.15 mm)**.
  4. Adhesion: **64 ounces force/inch (0.7 N/mm)** in width.
  5. Elongation: 500 percent.
  6. Tensile Strength: **18 lbf/inch (3.3 N/mm)** in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. ABI, Ideal Tape Division; 488 AWF.
    - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
    - c. Compac Corporation; 120.
    - d. Venture Tape; 3520 CW.
  2. Width: **2 inches (50 mm)**.
  3. Thickness: **3.7 mils (0.093 mm)**.
  4. Adhesion: **100 ounces force/inch (1.1 N/mm)** in width.
  5. Elongation: 5 percent.
  6. Tensile Strength: **34 lbf/inch (6.2 N/mm)** in width.

## 2.11 SECUREMENTS

### A. Bands:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
  - a. ITW Insulation Systems; Gerrard Strapping and Seals.
2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; **0.015 inch (0.38 mm)** thick, **1/2 inch (13 mm)** wide with wing seal.
3. Aluminum: **ASTM B 209 (ASTM B 209M)**, Alloy 3003, 3005, 3105, or 5005; Temper H-14, **0.020 inch (0.51 mm)** thick, [**1/2 inch (13 mm)**] wide with wing seal.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

### B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, **0.106-inch- (2.6-mm-)** diameter shank, length to suit depth of insulation indicated.

- a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
  - 1) AGM Industries, Inc.; CWP-1.
  - 2) GEMCO; CD.
  - 3) Midwest Fasteners, Inc.; CD.
  - 4) Nelson Stud Welding; TPA, TPC, and TPS. >.
  
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, **0.106-inch- (2.6-mm-)** diameter shank, length to suit depth of insulation indicated with integral **1-1/2-inch (38-mm)** galvanized carbon-steel washer.
  - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - 1) AGM Industries, Inc.; CHP-1.
    - 2) GEMCO; Cupped Head Weld Pin.
    - 3) Midwest Fasteners, Inc.; Cupped Head.
    - 4) Nelson Stud Welding; CHP.
  
3. 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. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - 1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
    - 2) GEMCO; Perforated Base.
    - 3) Midwest Fasteners, Inc.; Spindle.
  - b. Baseplate: Perforated, galvanized carbon-steel sheet, **0.030 inch (0.76 mm)** thick by **2 inches (50 mm)** square.
  - c. Spindle: **Copper- or zinc-coated, low-carbon steel, Aluminum, or Stainless steel**, fully annealed, **0.106-inch- (2.6-mm-)** diameter shank, length to suit depth of insulation indicated.
  - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
  
4. 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. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - 1) GEMCO; Nylon Hangers.
    - 2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
  - b. Baseplate: Perforated, nylon sheet, 0.030 inch (0.76 mm) thick by 1-1/2 inches (38 mm) in diameter.
  - c. Spindle: Nylon, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches (63 mm).
  - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
- a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - 1) AGM Industries, Inc.; Tactoo Self-Adhering Insul-Hangers.
    - 2) GEMCO; Peel & Press.
    - 3) Midwest Fasteners, Inc.; Self Stick.
  - b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
  - c. Spindle: Copper- or zinc-coated, low-carbon steel or Aluminum, or Stainless steel, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
  - d. Adhesive-backed base with a peel-off protective cover.
6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick, galvanized-steel, or aluminum, or stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
- a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - 1) AGM Industries, Inc.; RC-150.
    - 2) GEMCO; R-150.
    - 3) Midwest Fasteners, Inc.; WA-150.
    - 4) Nelson Stud Welding; Speed Clips.

- b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from **0.016-inch- (0.41-mm-)** thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than **1-1/2 inches (38 mm)** in diameter.
- 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) GEMCO.
    - 2) Midwest Fasteners, Inc.
    - 3) **<Insert manufacturer's name>**.
- C. Staples: Outward-clinching insulation staples, nominal **3/4-inch- (19-mm-)** wide, stainless steel or Monel.
- D. Wire: **0.080-inch (2.0-mm) nickel-copper alloy**, or **0.062-inch (1.6-mm) soft-annealed, stainless steel**, or **0.062-inch (1.6-mm) soft-annealed, galvanized steel**.
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. C & F Wire.

## 2.12 CORNER ANGLES

- A. PVC Corner Angles: **30 mils (0.8 mm)** thick, minimum **1 by 1 inch (25 by 25 mm)**, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: **0.040 inch (1.0 mm)** thick, minimum **1 by 1 inch (25 by 25 mm)**, aluminum according to **ASTM B 209 (ASTM B 209M)**, Alloy 3003, 3005, 3105, or 5005; Temper H-14.
- C. Stainless-Steel Corner Angles: **0.024 inch (0.61 mm)** thick, minimum **1 by 1 inch (25 by 25 mm)**, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, **Type 304 or [Type 316]**.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
  - 1. Verify that systems to be insulated have been tested and are free of defects.
  - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

### 3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of 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- (75-mm-)** wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced **4 inches (100 mm)** o.c.
  3. Overlap jacket longitudinal seams at least **1-1/2 inches (38 mm)**. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at **2 inches (50 mm)** 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 (100 mm)** beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

### 3.4 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 (50 mm)** 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 (50 mm)**.
  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 (50 mm)**.
1. Comply with requirements in Division 07 Section "Penetration Firestopping" firestopping and fire-resistive joint sealers.
- 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 (50 mm)**.
  2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

### 3.5 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 (450 mm)** and smaller, place pins along longitudinal centerline of duct. Space **3 inches (75 mm)** maximum from insulation end joints, and **16 inches (400 mm)** o.c.
  - b. On duct sides with dimensions larger than **18 inches (450 mm)**, place pins **16 inches (400 mm)** o.c. each way, and **3 inches (75 mm)** 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 (50 mm)** from one edge and one end of insulation segment. Secure laps to adjacent insulation section with **1/2-inch (13-mm)** outward-clinching staples, **1 inch (25 mm)** 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 (10 deg C)** at **18-foot (5.5-m)** 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 (75 mm)**.
  5. Overlap unfaced blankets a minimum of **2 inches (50 mm)** on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of **18 inches (450 mm)** 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- (150-mm-)** wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced **6 inches (150 mm)** 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] [50] <Insert number>** 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 (450 mm)** and smaller, place pins along longitudinal centerline of duct. Space **3 inches (75 mm)** maximum from insulation end joints, and **16 inches (400 mm)** o.c.
  - b. On duct sides with dimensions larger than **18 inches (450 mm)**, space pins **16 inches (400 mm)** o.c. each way, and **3 inches (75 mm)** 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 (50 mm)** from one edge and one end of insulation segment. Secure laps to adjacent insulation section with **1/2-inch (13-mm)** outward-clinching staples, **1 inch (25 mm)** 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 (10 deg C)** at **18-foot (5.5-m)** 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 (75 mm)**.
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- (150-mm-)** wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced **6 inches (150 mm)** o.c.

### 3.6 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
1. Draw jacket smooth and tight to surface with **2-inch (50-mm)** overlap at seams and joints.
  2. Embed glass cloth between two **0.062-inch- (1.6-mm-)** thick coats of lagging adhesive.
  3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. 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 (38-mm)** laps at longitudinal seams and **3-inch- (75-mm-)** wide joint strips at end joints.
  5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where PVC jackets are indicated, install with **1-inch (25-mm)** 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.
- D. Where metal jackets are indicated, install with **2-inch (50-mm)** 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 (300 mm)** o.c. and at end joints.

### 3.7 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.
- B. Insulate duct access panels and doors to achieve same fire rating as duct.
- C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 07 Section "Penetration Firestopping."



### 3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing commissioning agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. 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 not less than two locations for each duct system defined in the "Duct Insulation Schedule, General" Article.
- D. 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. Outdoor, concealed supply and return.
  - 6. 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, round and flat-oval, supply-air duct insulation shall be one of the following:
  - 1. Flexible Elastomeric: **1 inch (25 mm)** thick.
  - 2. Mineral-Fiber Board: **1-1/2 inches (38 mm)** thick and **2-lb/cu. ft. (32-kg/cu. M)** nominal density.

- B. Concealed, round and flat-oval, return-air duct insulation shall be **one of** the following:
1. Flexible Elastomeric: **1 inch (25 mm)** thick.
  2. Mineral-Fiber Board: **1-1/2 inches (38 mm)** thick and **2-lb/cu. ft. (32-kg/cu. M)** nominal density.
- C. Concealed, round and flat-oval, outdoor-air duct insulation shall be **one of** the following:
1. Flexible Elastomeric: **1 inch (25 mm)** thick.
  2. Mineral-Fiber Board: **1-1/2 inches (38 mm)** thick and **2-lb/cu. ft. (32-kg/cu. M)** nominal density.
- D. Concealed, rectangular, supply-air duct insulation shall be **one of** the following:
1. Flexible Elastomeric: **2 inch** thick.
  2. Mineral-Fiber Board: **2 inches (50 mm)** thick and **2-lb/cu. ft. (32-kg/cu. M)** nominal density.
- E. Concealed, return-air plenum insulation shall be[ **one of**] the following:
1. Flexible Elastomeric: **2 inch** thick.
  2. Mineral-Fiber Board: **2 inches (50 mm)** thick and **2-lb/cu. ft. (32-kg/cu. m)** nominal density.
- F. Concealed, outdoor-air plenum insulation shall be **one of** the following:
1. Mineral-Fiber Board: **2 inches (50 mm)** thick and **2-lb/cu. ft. (32-kg/cu. m)** nominal density.
- G. Concealed, exhaust-air plenum insulation shall be **one of** the following:
1. Mineral-Fiber Board: **1-1/2 inches (38 mm)** thick and **2-lb/cu. ft. (32-kg/cu. m)** nominal density.
- H. Exposed, rectangular, supply-air duct insulation shall be **one of** the following:
1. Flexible Elastomeric: **2 inch** thick.
  2. Mineral-Fiber Board: **2 inches (50 mm)** thick and **2-lb/cu. ft. (32-kg/cu. m)** nominal density.
- I. Exposed, supply-air plenum insulation shall be[ **one of**] the following:
1. Flexible Elastomeric: **2 inch (25 mm)** thick.
  2. Mineral-Fiber Board: **2 inches (50 mm)** thick and **2-lb/cu. ft. (32-kg/cu. m)** nominal density.
- J. Exposed, return-air plenum insulation shall be **one of** the following:
1. Flexible Elastomeric: **2 inch** thick.

2. Mineral-Fiber Board: **2 inches (50 mm)** thick and **2-lb/cu. ft. (32-kg/cu. M)** nominal density.

### 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, Exposed:
  1. None.
  2. **PVC: 20 mils (0.5 mm)** thick.

### 3.12 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Ducts and Plenums, Concealed:
  1. **PVC: [20 mils (0.5 mm)] [30 mils (0.8 mm)]** thick.
- D. Ducts and Plenums, Exposed, up to **48 Inches (1200 mm)** in Diameter or with Flat Surfaces up to **72 Inches (1800 mm)**:
  1. Painted Aluminum, **Smooth: 0.016 inch (0.41 mm)** thick.

END OF SECTION 230713

## SECTION 231123

### FACILITY NATURAL-GAS PIPING

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- A. Section Includes:
  - 1. Pipes, tubes, and fittings.
  - 2. Piping specialties.
  - 3. Piping and tubing joining materials.
  - 4. Valves.
  - 5. Pressure regulators.
  - 6. Service meters.
  - 7. Concrete bases.

##### 1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

##### 1.4 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
  - 1. Piping and Valves: **100 psig (690 kPa)** minimum unless otherwise indicated.
  - 2. Service Regulators: **65 psig (450 kPa)** minimum unless otherwise indicated.
  - 3. Minimum Operating Pressure of Service Meter: **5 psig (34.5 kPa)**.

- B. Natural-Gas System Pressure within Buildings: **More than 0.5 psig (3.45 kPa) but not more than 2 psig (13.8 kPa) >**.
- C. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than **0.5 psig (3.45 kPa)** but not more than **2 psig (13.8 kPa)**, and is reduced to secondary pressure of **0.5 psig (3.45 kPa)** or less.
- D. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

## 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
  - 1. Piping specialties.
  - 2. Corrugated, stainless-steel tubing with associated components.
  - 3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
  - 4. Pressure regulators. Indicate pressure ratings and capacities.
  - 5. Service meters. Indicate **pressure ratings and capacities**. Include **bypass fittings and meter bars**.
  - 6. Dielectric fittings.
- B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
  - 1. Shop Drawing Scale: **1/4 inch per foot (1:50)**.
  - 2. Detail mounting, supports, and valve arrangements for **service meter assembly and pressure regulator assembly**.

## 1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.
- B. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.
- C. Welding certificates.
- D. Field quality-control reports.

## 1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For **pressure regulators and service meters** to include in emergency, operation, and maintenance manuals.

## 1.8 QUALITY ASSURANCE

- A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.
- B. 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.
- C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.
- D. Protect stored PE pipes and valves from direct sunlight.

## 1.10 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.
- B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:
  - 1. Notify **Construction Manager** no fewer than **two** days in advance of proposed interruption of natural-gas service.
  - 2. Do not proceed with interruption of natural-gas service without **Construction Manager's** written permission.

## 1.11 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Division 08 Section "Access Doors and Frames."

## PART 2 - PRODUCTS

### 2.1 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, 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. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
    - a. Material Group: 1.1.
    - b. End Connections: Threaded or butt welding to match pipe.
    - c. Lapped Face: Not permitted underground.
    - d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
    - e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
  - 5. 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.
  - 6. Mechanical Couplings:
    - a. Manufacturers: Subject to compliance with requirements, **manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:**
      - 1) Dresser Piping Specialties; Division of Dresser, Inc.
      - 2) Smith-Blair, Inc.
    - b. **Steel** flanges and tube with epoxy finish.
    - c. Buna-nitrile seals.

- d. **Steel** bolts, washers, and nuts.
- e. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
- f. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.

B. 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 or flanged or 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 or flanged or 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.
5. Plastic Mechanical Couplings, **NPS 1-1/2 (DN 40)** and Smaller: Capable of joining PE pipe to PE pipe.
  - 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) Lyall, R. W. & Company, Inc.
    - 2) Mueller Co.; Gas Products Div.
    - 3) Perfection Corporation; a subsidiary of American Meter Company.



- b. PE body with molded-in, stainless-steel support ring.
  - c. Buna-nitrile seals.
  - d. Acetal collets.
  - e. Electro-zinc-plated steel stiffener.
6. Plastic Mechanical Couplings, **NPS 2 (DN 50)** and Larger: Capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
- 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) Lyall, R. W. & Company, Inc.
    - 2) Mueller Co.; Gas Products Div.
    - 3) Perfection Corporation; a subsidiary of American Meter Company.
  - b. Fiber-reinforced plastic body.
  - c. PE body tube.
  - d. Buna-nitrile seals.
  - e. Acetal collets.
  - f. Stainless-steel bolts, nuts, and washers.
7. Steel Mechanical Couplings: Capable of joining plain-end PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
- 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) Dresser Piping Specialties; Division of Dresser, Inc.
    - 2) Smith-Blair, Inc.
  - b. **Steel** flanges and tube with epoxy finish.
  - c. Buna-nitrile seals.
  - d. **Steel** bolts, washers, and nuts.
  - e. Factory-installed anode for steel-body couplings installed underground.

## 2.2 PIPING SPECIALTIES

### A. Appliance Flexible Connectors:

- 1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
- 2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
- 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 (3.45 kPa)**.

6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: **72 inches (1830 mm)**.

B. 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.

C. 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: **40**-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: **125 psig (862 kPa)**.

D. Basket Strainers:

1. Body: ASTM A 126, Class B, high-tensile 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: **40**-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: **125 psig (862 kPa)**.

E. T-Pattern Strainers:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.
3. Strainer Screen: **[40] [60]**-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
4. CWP Rating: **750 psig (5170 kPa)**.

F. 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 natural gas.

- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F (540 deg C) complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

## 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. General Requirements for Metallic Valves, NPS 2 (DN 50) and Smaller: Comply with ASME B16.33.
  - 1. CWP Rating: 125 psig (862 kPa).
  - 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 (25 mm) and smaller.
  - 6. Service Mark: Valves 1-1/4 inches (32 mm) to NPS 2 (DN 50) shall have initials "WOG" permanently marked on valve body.
- C. General Requirements for Metallic Valves, NPS 2-1/2 (DN 65) and Larger: Comply with ASME B16.38.
  - 1. CWP Rating: 125 psig (862 kPa)
  - 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
  - 3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  - 4. Service Mark: Initials "WOG" shall be 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 (4140 kPa).
9. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas 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 (4140 kPa).
9. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas 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 (4140 kPa).
9. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas 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, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig (862 kPa).
7. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

H. Cast-Iron, Nonlubricated 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. McDonald, A. Y. Mfg. Co.
  - b. Mueller Co.; Gas Products Div.
  - c. Xomox Corporation; a Crane company.
2. Body: Cast iron, complying with ASTM A 126, Class B.
3. Plug: Bronze or nickel-plated cast iron.
4. Seat: Coated with thermoplastic.
5. Stem Seal: Compatible with natural gas.

6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
7. Operator: Square head or lug type with tamperproof feature where indicated.
8. Pressure Class: 125 psig (862 kPa).
9. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

I. Cast-Iron, Lubricated 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. Flowserve.
  - b. Homestead Valve; a division of Olson Technologies, Inc.
  - c. McDonald, A. Y. Mfg. Co.
  - d. Milliken Valve Company.
  - e. Mueller Co.; Gas Products Div.
  - f. R&M Energy Systems, A Unit of Robbins & Myers, Inc.
2. Body: Cast iron, complying with ASTM A 126, Class B.
3. Plug: Bronze or nickel-plated cast iron.
4. Seat: Coated with thermoplastic.
5. Stem Seal: Compatible with natural gas.
6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
7. Operator: Square head or lug type with tamperproof feature where indicated.
8. Pressure Class: 125 psig (862 kPa).
9. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

J. 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 (125 mm) 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 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators **NPS 2 (DN 50)** and smaller; flanged for regulators **NPS 2-1/2 (DN 65)** and larger.

B. Service 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:**
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: **100 psig (690 kPa)**.

C. 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:**
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.

11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: **2 psig (13.8 kPa)**.

D. 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:**
  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 (6.9 kPa)**.

2.6 SERVICE METERS (by Local Gas Utility Company per same standards)

2.7 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. Capitol Manufacturing Company.
  - b. Central Plastics Company.
  - c. Hart Industries International, Inc.
  - d. Jomar International Ltd.
  - e. Matco-Norca, Inc.
  - f. McDonald, A. Y. Mfg. Co.
  - g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - h. Wilkins; a Zurn company.
2. Description:
  - a. Standard: ASSE 1079.



- b. Pressure Rating: **125 psig (860 kPa) minimum at 180 deg F (82 deg C)**.
- c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

- 1. Manufacturers: Subject to compliance with requirements, **available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:**
  - a. Capitol Manufacturing Company.
  - b. Central Plastics Company.
  - c. Matco-Norca, Inc.
  - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - e. Wilkins; a Zurn company.
- 2. Description:
  - a. Standard: ASSE 1079.
  - b. Factory-fabricated, bolted, companion-flange assembly.
  - c. Pressure Rating: **125 psig (860 kPa) minimum at 180 deg F (82 deg C)**.
  - d. 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, **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. Central Plastics Company.
  - d. Pipeline Seal and Insulator, Inc.
- 2. Description:
  - a. Nonconducting materials for field assembly of companion flanges.
  - b. Pressure Rating: **150 psig (1035 kPa)**.
  - c. Gasket: Neoprene or phenolic.
  - d. Bolt Sleeves: Phenolic or polyethylene.
  - e. Washers: Phenolic with steel backing washers.

## 2.8 LABELING AND IDENTIFYING

- A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of **6 inches (150 mm)** wide and **4 mils (0.1 mm)** 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 (750 mm)** deep; colored yellow.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural-gas piping according to **NFPA 54 and the International Fuel Gas Code** to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with **NFPA 54 and the International Fuel Gas Code** requirements for prevention of accidental ignition.

### 3.3 OUTDOOR PIPING INSTALLATION

- A. Comply with **NFPA 54 and the International Fuel Gas Code** for installation and purging of natural-gas piping.
- B. Install underground, natural-gas piping buried at least **36 inches (900 mm)** below finished grade. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.
  - 1. If natural-gas piping is installed less than **36 inches (900 mm)** below finished grade, install it in containment conduit.
- C. Install underground, PE, natural-gas piping according to ASTM D 2774.
- D. Steel Piping with Protective Coating:
  - 1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
  - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
  - 3. Replace pipe having damaged PE coating with new pipe.
- E. 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. Install pressure gage [**downstream**] [**upstream and downstream**] from each service regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

### 3.4 INDOOR PIPING INSTALLATION

A. Comply with **NFPA 54 and the International Fuel Gas Code** for installation and purging of natural-gas piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Verify final equipment locations for roughing-in.

L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

- M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than **3 inches (75 mm)** long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- O. 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.
- P. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.
1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
  2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of **1-1/2 inches (38 mm)** of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
  3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
  4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
    - a. Exception: Tubing passing through partitions or walls does not require striker barriers.
  5. Prohibited Locations:
    - a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
    - b. Do not install natural-gas piping in solid walls or partitions.
- 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 (DN 50)** and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- T. Do not use natural-gas piping as grounding electrode.
- U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- V. Install pressure gage[**downstream** from each line regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."
- W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."
- X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."
- Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 Section "Escutcheons for HVAC Piping."
- Z. SERVICE-METER ASSEMBLY INSTALLATION (per Local Utility Standard).

### 3.5 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
- B. Install underground valves with valve boxes.
- C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
- D. Install anode for metallic valves in underground PE piping.

### 3.6 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
  1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.

2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

G. 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.

H. 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.

### 3.7 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hangers and supports specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. **NPS 1 (DN 25) and Smaller:** Maximum span, **96 inches (2438 mm)**; minimum rod size, **3/8 inch (10 mm)**.
2. **NPS 1-1/4 (DN 32):** Maximum span, **108 inches (2743 mm)**; minimum rod size, **3/8 inch (10 mm)**.
3. **NPS 1-1/2 and NPS 2 (DN 40 and DN 50):** Maximum span, **108 inches (2743 mm)**; minimum rod size, **3/8 inch (10 mm)**.

4. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): Maximum span, 10 feet (3 m); minimum rod size, 1/2 inch (13 mm).
  5. NPS 4 (DN 100) and Larger: Maximum span, 10 feet (3 m); minimum rod size, 5/8 inch (15.8 mm).
- C. Install hangers for horizontal drawn-temper copper tubing with the following maximum spacing and minimum rod sizes:
1. NPS 3/8 (DN 10): Maximum span, 48 inches (1220 mm); minimum rod size, 3/8 inch (10 mm).
  2. NPS 1/2 and NPS 5/8 (DN 15 and DN 18): Maximum span, 72 inches (1830 mm); minimum rod size, 3/8 inch (10 mm).
  3. NPS 3/4 and NPS 7/8 (DN 20 and DN 22): Maximum span, 84 inches (2134 mm); minimum rod size, 3/8 inch (10 mm).
  4. NPS 1 (DN 25): Maximum span, 96 inches (2440 mm); minimum rod size, 3/8 inch (10 mm).
- D. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:
1. NPS 3/8 (DN 10): Maximum span, 48 inches (1220 mm); minimum rod size, 3/8 inch (10 mm).
  2. NPS 1/2 (DN 15): Maximum span, 72 inches (1830 mm); minimum rod size, 3/8 inch (10 mm).
  3. NPS 3/4 (DN 20) and Larger: Maximum span, 96 inches (2440 mm); minimum rod size, 3/8 inch (10 mm).

### 3.8 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches (1800 mm) of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

### 3.9 LABELING AND IDENTIFYING

- A. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for piping and valve identification.
- B. Install detectable warning tape directly above gas piping, **12 inches (300 mm)** below finished grade, except **6 inches (150 mm)** below subgrade under pavements and slabs.

### 3.10 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
  - 1. Test, inspect, and purge natural gas according to **NFPA 54** and **the International Fuel Gas Code** and authorities having jurisdiction.
- C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

### 3.11 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain earthquake valves.

### 3.12 OUTDOOR PIPING SCHEDULE

- A. Underground natural-gas pipingshall be **one of** the following:
  - 1. PE pipe and fittings joined by heat fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.
  - 2. Steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.
  - 3. **Drawn**-temper copper tube with wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.
- B. Aboveground natural-gas pipingshall be **one of** the following:
  - 1. Steel pipe with malleable-iron fittings and threaded joints.
  - 2. Steel pipe with wrought-steel fittings and welded joints.
- C. Branch Piping in Cast-in-Place Concrete to Single Appliance: Annealed-temper copper tube with wrought-copper fittings and **brazed** joints. Install piping embedded in concrete with no joints in concrete.



- D. Containment Conduit: 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 (3.45 kPa)

- A. Aboveground, branch piping NPS 1 (DN 25) and smaller shall be **one of** the following:
  - 1. Steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground, distribution piping shall be **one of** the following:
  - 1. Steel pipe with malleable-iron fittings and threaded joints.
  - 2. Steel pipe with wrought-steel fittings and welded joints.
- C. Underground, below building, piping shall be **one of** the following:
  - 1. Steel pipe with malleable-iron fittings and threaded joints.
  - 2. Steel pipe with wrought-steel fittings and welded joints.
- D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
- E. Containment Conduit Vent Piping: 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 (3.45 kPa) AND LESS THAN 5 PSIG (34.5 kPa)

- A. Aboveground, branch piping NPS 1 (DN 25) and smaller shall be **one of** the following:
  - 1. Steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground, distribution piping shall be **one of** the following:
  - 1. Steel pipe with malleable-iron fittings and threaded joints.
  - 2. Steel pipe with steel welding fittings and welded joints.
- C. Underground, below building, piping shall be **one of** the following:
  - 1. Steel pipe with malleable-iron fittings and threaded joints.
  - 2. Steel pipe with wrought-steel fittings and welded joints.
- D. Containment Conduit: 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: 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. Valves for pipe sizes **NPS 2 (DN 50)** and smaller at service meter shall be **one of** the following:
  - 1. One-piece, bronze ball valve with bronze trim.
  - 2. Bronze plug valve.
- B. Valves for pipe sizes **NPS 2-1/2 (DN 65)** and larger at service meter shall be **one of** the following:
  - 1. Two-piece, **full**-port, bronze ball valves with bronze trim.
  - 2. Bronze plug valve.
  - 3. Cast-iron, nonlubricated plug valve.
- C. Distribution piping valves for pipe sizes **NPS 2 (DN 50)** 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. Distribution piping valves for pipe sizes **NPS 2-1/2 (DN 65)** and larger shall be **one of** the following:
  - 1. Two-piece, **full**-port, bronze ball valves with bronze trim.
  - 2. Bronze plug valve.
- E. 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 231123

## SECTION 233113

### METAL DUCTS

#### 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. Single-wall rectangular ducts and fittings.
- 2. Single-wall round ducts and fittings.
- 3. Sheet metal materials.
- 4. Duct liner.
- 5. Sealants and gaskets.
- 6. Hangers and supports.

- B. Related Sections:

- 1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
- 2. Division 23 Section "Nonmetal Ducts" for fibrous-glass ducts, thermoset fiber-reinforced plastic ducts, thermoplastic ducts, PVC ducts, and concrete ducts.
- 3. Division 23 Section "HVAC Casings" for factory- and field-fabricated casings for mechanical equipment.
- 4. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

##### 1.3 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.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of the following products:

- 1. Liners and adhesives.
- 2. Sealants and gaskets.

- B. LEED Submittals:

- 1. Product Data for Prerequisite IEQ 1: Documentation indicating that duct systems comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
- 2. Product Data for Prerequisite EA 2: Documentation indicating that duct systems comply with ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
- 3. Leakage Test Report for Prerequisite EA 2: Documentation of work performed for compliance with ASHRAE/IESNA 90.1, Section 6.4.4.2.2 - "Duct Leakage Tests."
- 4. Duct-Cleaning Test Report for Prerequisite IEQ 1: Documentation of work performed for compliance with ASHRAE 62.1, Section 7.2.4 - "Ventilation System Start-up."
- 5. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.

- C. Shop Drawings:

- 1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
- 2. Factory- and shop-fabricated ducts and fittings.
- 3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
- 4. Elevation of top of ducts.
- 5. Dimensions of main duct runs from building grid lines.
- 6. Fittings.
- 7. Reinforcement and spacing.
- 8. Seam and joint construction.
- 9. Penetrations through fire-rated and other partitions.
- 10. Equipment installation based on equipment being used on Project.
- 11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
- 12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

- D. 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.

## 1.5 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.
- C. Field quality-control reports.

## 1.6 QUALITY ASSURANCE

- A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."
- B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

## PART 2 - PRODUCTS

### 2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 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 SINGLE-WALL ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
  - 1. Manufacturers: Subject to compliance with requirements, **available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:**
    - a. Lindab Inc.
    - b. McGill AirFlow LLC.
    - c. SEMCO Incorporated.
    - d. Sheet Metal Connectors, Inc.
    - e. Spiral Manufacturing Co., Inc.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "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 (1524 mm)** 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 (2286 mm)** in diameter with butt-welded longitudinal seams.
  2. Fabricate flat-oval ducts larger than **72 inches (1830 mm)** in width (major dimension) with butt-welded longitudinal seams.
- D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "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: [**G60 (Z180)**] [**G90 (Z275)**].
  2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. PVC-Coated, Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
1. Galvanized Coating Designation: [**G60 (Z180)**] [**G90 (Z275)**].
  2. Minimum Thickness for Factory-Applied PVC Coating: **4 mils (0.10 mm)** thick on sheet metal surface of ducts and fittings exposed to corrosive conditions, and minimum **1 mil (0.025 mm)** thick on opposite surface.
  3. Coating Materials: Acceptable to authorities having jurisdiction for use on ducts listed and labeled by an NRTL for compliance with UL 181, Class 1.
- D. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.
- E. 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.
- F. Aluminum Sheets: Comply with **ASTM B 209 (ASTM B 209M)** Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

G. Factory- or Shop-Applied Antimicrobial Coating:

1. Apply to the surface of sheet metal that will form the interior surface of the duct. An untreated clear coating shall be applied to the exterior surface.
2. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
3. Coating containing the antimicrobial compound shall have a hardness of 2H, minimum, when tested according to ASTM D 3363.
4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
5. Antimicrobial coating on sheet metal is not required for duct containing liner treated with antimicrobial coating.

H. 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.

I. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.4 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
  - a. CertainTeed Corporation; Insulation Group.
  - b. Johns Manville.
  - c. Knauf Insulation.
  - d. Owens Corning.
  - e. Maximum Thermal Conductivity:
    - 1) Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K) at 75 deg F (24 deg C) mean temperature.
    - 2) Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F (0.033 W/m x K) at 75 deg F (24 deg C) mean temperature.



3. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
  4. Solvent or Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
    - a. 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).
- B. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.
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. Aeroflex USA Inc.
    - b. Armacell LLC.
    - c. Rubatex International, LLC
    - d. **<Insert manufacturer's name>**.
  2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
  3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
    - a. 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).
- C. Insulation Pins and Washers:
1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, **0.106-inch- (2.6-mm-)** diameter shank, length to suit depth of insulation indicated with integral **1-1/2-inch (38-mm)** galvanized carbon-steel washer.
  2. Insulation-Retaining Washers: Self-locking washers formed from **0.016-inch- (0.41-mm-)** thick **galvanized steel**, or **aluminum**, or **stainless steel**; with beveled edge sized as required to hold insulation securely in place but not less than **1-1/2 inches (38 mm)** in diameter.
- D. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."
1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.

2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of **2500 fpm (12.7 m/s)**.
7. Secure liner with mechanical fasteners **4 inches (100 mm)** from corners and at intervals not exceeding **12 inches (300 mm)** transversely; at **3 inches (75 mm)** from transverse joints and at intervals not exceeding **18 inches (450 mm)** longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
  - a. Fan discharges.
  - b. Intervals of lined duct preceding unlined duct.
  - c. Upstream edges of transverse joints in ducts where air velocities are higher than **2500 fpm (12.7 m/s)** or where indicated.
9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
  - a. Sheet Metal Inner Duct Perforations: **3/32-inch (2.4-mm)** diameter, with an overall open area of 23 percent.
10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

## 2.5 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:
  1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
  2. Tape Width: **3 inches (76 mm)**.
  3. Sealant: Modified styrene acrylic.

4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).
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 (2500 Pa), 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. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. 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).
9. VOC: Maximum 395 g/L.
10. 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."
11. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive or negative.
12. Service: Indoor or outdoor.
13. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. 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."
- F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- G. Round Duct Joint O-Ring Seals:
1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg (0.14 L/s per sq. m at 250 Pa) and shall be rated for 10-inch wg (2500-Pa) 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.

## 2.6 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 (Table 5-1M), "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 (25 mm)**, 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 (38 mm)**.
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.

- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

### 3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

### 3.3 ADDITIONAL INSTALLATION REQUIREMENTS FOR COMMERCIAL KITCHEN HOOD EXHAUST DUCT

- A. Install commercial kitchen hood exhaust ducts without dips and traps that may hold grease, and sloped a minimum of 2 percent to drain grease back to the hood.
- B. Install fire-rated access panel assemblies at each change in direction and at maximum intervals of **12 feet (3.7 m)** in horizontal ducts, and at every floor for vertical ducts, or as indicated on Drawings. Locate access panel on top or sides of duct a minimum of **1-1/2 inches (38 mm)** from bottom of duct.
- C. Do not penetrate fire-rated assemblies except as allowed by applicable building codes and authorities having jurisdiction.

### 3.4 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 (500 Pa) and Lower: Seal Class B.
6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg (500 Pa): 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 (500 Pa) and Lower: Seal Class C.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg (500 Pa): Seal Class B.
11. Conditioned Space, Exhaust Ducts: Seal Class B.
12. Conditioned Space, Return-Air Ducts: Seal Class C.

### 3.5 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 (100 mm) thick.
  4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) 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 (Table 5-1M), "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 (610 mm) of each elbow and within 48 inches (1200 mm) 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 (5 m).
- 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.

### 3.6 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

### 3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
  - 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
  - 2. Test the following systems:
    - a. Ducts with a Pressure Class Higher Than **2-Inch wg (500 Pa)**: Test representative duct sections, totaling no less than 50 percent of total installed duct area for each designated pressure class.
    - b. Supply Ducts with a Pressure Class of **4-Inch wg (1000 Pa)** or Higher: Test representative duct sections **50** percent of total installed duct area for each designated pressure class.
    - c. Return Ducts with a Pressure Class of **2-Inch wg (500 Pa)** or Higher: Test representative duct sections totaling no less than **50** percent of total installed duct area for each designated pressure class.
    - d. Exhaust Ducts with a Pressure Class of **2-Inch wg (500 Pa)** or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
    - e. Outdoor Air Ducts with a Pressure Class of **2-Inch wg (500 Pa)** or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
  - 3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
  - 4. Test for leaks before applying external insulation.
  - 5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
  - 6. Give 7 days' advance notice for testing.
- C. Duct System Cleanliness Tests:
  - 1. Visually inspect duct system to ensure that no visible contaminants are present.



2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

- a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

### 3.8 DUCT CLEANING

A. Clean duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 23 Section "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.9 START UP

- A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

3.10 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

B. Supply Ducts:

1. Ducts Connected to Rooftop Units:
  - a. Pressure Class: Positive **4-inch wg (1000 Pa)**.
  - b. Minimum SMACNA Seal Class: **A**.
  - c. SMACNA Leakage Class for Rectangular: **3**
  - d. SMACNA Leakage Class for Round and Flat Oval: **3**
2. Ducts Connected to Equipment Not Listed Above:
  - a. Pressure Class: Positive [**2-inch wg (500 Pa)**].
  - 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: Same As Supply above

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
  - a. Pressure Class: Negative **2-inch wg (500 Pa)**.
  - 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: **12**.
2. Ducts Connected to Air-Handling Units and Retail Fan Coils:
  - a. Pressure Class: Positive or negative **2-inch wg (500 Pa)**.
  - b. Minimum SMACNA Seal Class: **B** if negative pressure, and A if positive pressure.
  - c. SMACNA Leakage Class for Rectangular: **12**.
  - d. SMACNA Leakage Class for Round and Flat Oval: **12**.
3. Ducts Connected to Commercial Kitchen Hoods: Comply with NFPA 96.
  - a. Exposed to View: Type 304, stainless-steel sheet, **No. 4** finish.
  - b. Concealed: **Type 304, stainless-steel sheet, No. 2D finish**.
  - c. Welded seams and joints.
  - d. Pressure Class: Positive or negative **3-inch wg (750 Pa)**.
  - e. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
  - f. SMACNA Leakage Class: **3**.
4. Ducts Connected to Equipment Not Listed Above:
  - a. Pressure Class: Positive or negative **2-inch wg (500 Pa)**.
  - b. Minimum SMACNA Seal Class: **B** if negative pressure, and A if positive pressure.
  - c. SMACNA Leakage Class for Rectangular: **12**.
  - d. SMACNA Leakage Class for Round and Flat Oval: **12**.

E. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.
2. PVC-Coated Ducts:
  - a. Exposed to Airstream: Match duct material.
  - b. Not Exposed to Airstream: **Match duct material**.
3. Stainless-Steel Ducts:
  - a. Exposed to Airstream: Match duct material.
  - b. Not Exposed to Airstream: **Match duct material**.

4. Aluminum Ducts: **Aluminum**
- F. Liner (where indicated on plans):
1. Supply Air Ducts: **Fibrous glass, Type I or Flexible elastomeric or Natural fiber, 1 inch (25 mm)** thick unless noted otherwise on plans.
- G. Double-Wall Duct Interstitial Insulation (where indicated on plans):
1. **2 inches (51 mm)** thick.
- H. 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 (5 m/s)** 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 (5 to 7.6 m/s)**:
      - 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 (7.6 m/s)** 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 (5 m/s)** or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
    - 2) Velocity **1000 to 1500 fpm (5 to 7.6 m/s)**: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
    - 3) Velocity **1500 fpm (7.6 m/s)** 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 (305 mm)**] <Insert dimension> and Smaller in Diameter: Stamped or pleated.
  - c. Round Elbows, [**14 Inches (356 mm)**] <Insert dimension> and Larger in Diameter: [**Standing seam**] [**Welded**].
- I. 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 and Flat Oval: 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 (5 m/s)** or Lower: 90-degree tap.
    - b. Velocity **1000 to 1500 fpm (5 to 7.6 m/s)**: Conical tap.
    - c. Velocity **1500 fpm (7.6 m/s)** or Higher: 45-degree lateral.

END OF SECTION 233113

**SECTION 233300**  
**AIR DUCT ACCESSORIES**

**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. Backdraft and pressure relief dampers.
2. Barometric relief dampers.
3. Manual volume dampers.
4. Control dampers.
5. Fire dampers.
6. Ceiling dampers.
7. Flange connectors.
8. Duct silencers.
9. Turning vanes.
10. Duct-mounted access doors.
11. Flexible connectors.
12. Flexible ducts.
13. Duct accessory hardware.

B. Related Sections:

1. Division 23 Section "HVAC Gravity Ventilators" for roof-mounted ventilator caps.
2. Division 28 Section "Fire Detection and Alarm" for duct-mounted fire and smoke detectors.

**1.3 ACTION SUBMITTALS**

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

1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

B. LEED Submittals:

1. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
  2. Product Data for Prerequisite EA 2: Documentation indicating that duct insulation R-values comply with tables in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air Conditioning."
- C. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
    - a. Special fittings.
    - b. Manual volume damper installations.
    - c. Control damper installations.
    - d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
    - e. Duct security bars.
    - f. Wiring Diagrams: For power, signal, and control wiring.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.
- B. Source quality-control reports.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

#### 1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Fusible Links: Furnish quantity equal to **10** percent of amount installed.

## 1.7 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with AMCA 500-D testing for damper rating.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
  - 1. Galvanized Coating Designation: [G60 (Z180)] [G90 (Z275)].
  - 2. Exposed-Surface Finish: Mill phosphatized.
- C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a **No. 2** finish for concealed ducts.
- D. Aluminum Sheets: Comply with **ASTM B 209 (ASTM B 209M)**, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- E. Extruded Aluminum: Comply with **ASTM B 221 (ASTM B 221M)**, Alloy 6063, Temper T6.
- F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- G. Tie Rods: Galvanized steel, **1/4-inch (6-mm)** minimum diameter for lengths **36 inches (900 mm)** or less; **3/8-inch (10-mm)** minimum diameter for lengths longer than **36 inches (900 mm)**.

### 2.2 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- 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. Air Balance Inc.; a division of Mestek, Inc.



2. American Warming and Ventilating; a division of Mestek, Inc.
  3. Cesco Products; a division of Mestek, Inc.
  4. Duro Dyne Inc.
  5. Greenheck Fan Corporation.
  6. Lloyd Industries, Inc.
  7. Nailor Industries Inc.
  8. NCA Manufacturing, Inc.
  9. Pottorff; a division of PCI Industries, Inc.
  10. Ruskin Company.
  11. SEMCO Incorporated.
  12. Vent Products Company, Inc.
- B. Description: Gravity balanced.
- C. Maximum Air Velocity: **2000 fpm (10 m/s)**.
- D. Maximum System Pressure: **1-inch wg (0.25 kPa)**.
- E. Frame: **0.052-inch- (1.3-mm-) thick, galvanized sheet steel**, with welded corners **and mounting flange**.
- F. Blades: Multiple single-piece blades, maximum **6-inch (150-mm) width, 0.025-inch- 0.6-mm-) thick, roll-formed aluminum** or **0.050-inch- (1.2-mm-) thick aluminum sheet** with sealed edges.
- G. Blade Action: Parallel.
- H. Blade Seals: **Neoprene, mechanically locked**.
- I. Blade Axles:
1. Material: **Galvanized steel**
  2. Diameter: **0.20 inch (5 mm)**
- J. Tie Bars and Brackets: **Galvanized steel**
- K. Return Spring: Adjustable tension.
- L. Bearings: **Steel ball or synthetic pivot bushings**
- 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 (1.0-mm) minimum**.

- b. Sleeve Length: **6 inches (152 mm)** minimum.
- 6. Screen Mounting: Rear mounted.
- 7. Screen Material: **Galvanized steel or Aluminum**
- 8. Screen Type: **Bird**
- 9. 90-degree stops.

## 2.3 BAROMETRIC RELIEF DAMPERS

- 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. Air Balance Inc.; a division of Mestek, Inc.
  - 2. American Warming and Ventilating; a division of Mestek, Inc.
  - 3. Cesco Products; a division of Mestek, Inc.
  - 4. Duro Dyne Inc.
  - 5. Greenheck Fan Corporation.
  - 6. Lloyd Industries, Inc.
  - 7. Nailor Industries Inc.
  - 8. NCA Manufacturing, Inc.
  - 9. Pottorff; a division of PCI Industries, Inc.
  - 10. Ruskin Company.
  - 11. SEMCO Incorporated.
  - 12. Vent Products Company, Inc.
- B. Suitable for horizontal or vertical mounting.
- C. Maximum Air Velocity: **2000 fpm (10 m/s)**.
- D. Maximum System Pressure: **2-inch wg (0.5 kPa)**.
- E. Frame: **0.064-inch- (1.6-mm-) thick, galvanized sheet steel**, with welded corners **and mounting flange**].
- F. Blades:
  - 1. Multiple, [**0.025-inch- (0.6-mm-) thick, roll-formed aluminum**] [**0.050-inch- (1.2-mm-) thick aluminum sheet**].
  - 2. Maximum Width: **6 inches (150 mm)**.
  - 3. Action: Parallel.
  - 4. Balance: Gravity.
  - 5. Eccentrically pivoted.
- G. Blade Seals: **Vinyl or Neoprene**.
- H. Blade Axles: **Galvanized steel or Nonferrous metal**

- I. Tie Bars and Brackets:
  - 1. Material: **Aluminum** or **Galvanized steel** (match same)
  - 2. Rattle free with 90-degree stop.
- J. Return Spring: Adjustable tension.
- K. Bearings: **Synthetic, Stainless steel or Bronze** (as compatible)
- L. Accessories:
  - 1. Flange on intake.
  - 2. Adjustment device to permit setting for varying differential static pressures.

## 2.4 MANUAL VOLUME DAMPERS

- A. Standard, Steel, Manual Volume Dampers:
  - 1. 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]:**
    - a. Air Balance Inc.; a division of Mestek, Inc.
    - b. American Warming and Ventilating; a division of Mestek, Inc.
    - c. Flexmaster U.S.A., Inc.
    - d. McGill AirFlow LLC.
    - e. METALAIRE, Inc.
    - f. Nailor Industries Inc.
    - g. Pottorff; a division of PCI Industries, Inc.
    - h. Ruskin Company.
    - i. Trox USA Inc.
    - j. Vent Products Company, Inc.
  - 2. Standard leakage rating, with linkage outside airstream.
  - 3. Suitable for horizontal or vertical applications.
  - 4. Frames:
    - a. Hat-shaped, **galvanized** or **stainless**-steel channels, **0.064-inch (1.62-mm)** minimum thickness.
    - b. Mitered and welded corners.
    - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
  - 5. Blades:
    - a. Multiple or single blade.
    - b. Parallel- or opposed-blade design.
    - c. Stiffen damper blades for stability.
    - d. **Galvanized** or **Stainless**-steel, **0.064 inch (1.62 mm)** thick.

6. Blade Axles: **Galvanized steel** or **Stainless steel** or **Nonferrous metal**.
  7. Bearings:
    - a. **Stainless-steel sleeve**
    - b. Dampers in ducts with pressure classes of **3-inch wg (750 Pa)** 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. Low-Leakage, Steel, Manual Volume Dampers:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Air Balance Inc.; a division of Mestek, Inc.
    - b. American Warming and Ventilating; a division of Mestek, Inc.
    - c. Flexmaster U.S.A., Inc.
    - d. McGill AirFlow LLC.
    - e. METALAIRE, Inc.
    - f. Nailor Industries Inc.
    - g. Pottorff; a division of PCI Industries, Inc.
    - h. Ruskin Company.
    - i. Trox USA Inc.
  2. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
  3. Suitable for horizontal or vertical applications.
  4. Frames:
    - a. **Hat** shaped.
    - b. **Galvanized**-steel channels, **0.064 inch (1.62 mm)** thick.
    - c. Mitered and welded corners.
    - d. Flanges for attaching to walls and flangeless frames for installing in ducts.
  5. Blades:
    - a. Multiple or single blade.
    - b. Parallel- or opposed-blade design.
    - c. Stiffen damper blades for stability.
    - d. **Galvanized**, roll-formed steel, **0.064 inch (1.62 mm)** thick.
  6. Blade Axles: **Galvanized steel**.
  7. Bearings:
    - a. **Stainless-steel sleeve**.

- b. Dampers in ducts with pressure classes of **3-inch wg (750 Pa)** or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
  - 8. Blade Seals: **Neoprene**.
  - 9. Jamb Seals: Cambered **stainless steel**
  - 10. Tie Bars and Brackets: **Galvanized steel** .
  - 11. Accessories:
    - a. Include locking device to hold single-blade dampers in a fixed position without vibration.
- C. Damper Hardware:
  - 1. Zinc-plated, die-cast core with dial and handle made of **3/32-inch- (2.4-mm-)** thick zinc-plated steel, and a **3/4-inch (19-mm)** hexagon locking nut.
  - 2. Include center hole to suit damper operating-rod size.
  - 3. Include elevated platform for insulated duct mounting.

## 2.5 CONTROL DAMPERS

- 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. American Warming and Ventilating; a division of Mestek, Inc.
  - 2. Arrow United Industries; a division of Mestek, Inc.
  - 3. Cesco Products; a division of Mestek, Inc.
  - 4. Duro Dyne Inc.
  - 5. Flexmaster U.S.A., Inc.
  - 6. Greenheck Fan Corporation.
  - 7. Lloyd Industries, Inc.
  - 8. M&I Air Systems Engineering; Division of M&I Heat Transfer Products Ltd.
  - 9. McGill AirFlow LLC.
  - 10. METALAIRE, Inc.
  - 11. Metal Form Manufacturing, Inc.
  - 12. Nailor Industries Inc.
  - 13. NCA Manufacturing, Inc.
  - 14. Ruskin Company.
  - 15. Vent Products Company, Inc.
- B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
- C. Frames:
  - 1. **Hat** shaped.
  - 2. **Galvanized**-steel channels, **0.064 inch (1.62 mm)** thick.

3. Mitered and welded corners.

D. Blades:

1. Multiple blade with maximum blade width of **8 inches (200 mm)**.
2. **Parallel- and opposed-**blade design.
3. **Galvanized** steel.
4. **0.064 inch (1.62 mm)** thick.
5. Blade Edging: Closed-cell neoprene edging.
6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.

E. Blade Axles: **1/2-inch- (13-mm-)** 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 (minus 40 to plus 93 deg C)**.

F. Bearings:

1. **Stainless-steel sleeve.**
2. Dampers in ducts with pressure classes of **3-inch wg (750 Pa)** 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.

## 2.6 FIRE DAMPERS

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. Air Balance Inc.; a division of Mestek, Inc.
2. Arrow United Industries; a division of Mestek, Inc.
3. Cesco Products; a division of Mestek, Inc.
4. Greenheck Fan Corporation.
5. McGill AirFlow LLC.
6. METALAIRE, Inc.
7. Nailor Industries Inc.
8. NCA Manufacturing, Inc.
9. PHL, Inc.
10. Pottorff; a division of PCI Industries, Inc.
11. Prefco; Perfect Air Control, Inc.
12. Ruskin Company.
13. Vent Products Company, Inc.

B. Type: **Static and dynamic**; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to **4-inch wg (1-kPa)** static pressure class and minimum **4000-fpm (20-m/s)** velocity.

- D. Fire Rating: **1-1/2 to 3** hours (as required).
- E. Frame: **Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream**; fabricated with roll-formed, **0.034-inch- (0.85-mm-)** thick galvanized steel; with mitered and interlocking corners.
- F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
  - 1. Minimum Thickness: **0.052 or 0.138 inch (1.3 or 3.5 mm)** 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- (0.85-mm-)** thick, galvanized sheet steel. In place of interlocking blades, use full-length, **0.034-inch- (0.85-mm-)** thick, galvanized-steel blade connectors.
- I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- J. Heat-Responsive Device: Replaceable, **165 deg F (74 deg C)** rated, fusible links.

## 2.7 FLANGE CONNECTORS

- 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. Ductmate Industries, Inc.
  - 2. Nexus PDQ; Division of Shilco Holdings Inc.
  - 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Description: **Add-on or roll-formed**, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gage and Shape: Match connecting ductwork.

## 2.8 DUCT SILENCERS

- 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. Industrial Noise Control, Inc.
  2. McGill AirFlow LLC.
  3. Ruskin Company.
  4. Vibro-Acoustics.
- B. General Requirements:
1. Factory fabricated.
  2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84.
  3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- C. Shape:
1. Rectangular straight with splitters or baffles.
- D. Rectangular Silencer Outer Casing: ASTM A 653/A 653M, **G90 (Z275)**, galvanized sheet steel, **0.034 inch (0.85 mm)** thick.
- E. Inner Casing and Baffles: ASTM A 653/A 653M, [**G90 (Z275)**] [**G60 (Z180)**] galvanized sheet metal, **0.034 inch (0.85 mm)** thick, and with **1/8-inch- (3-mm-)** diameter perforations.
- F. Special Construction:
1. Suitable for outdoor use.
  2. High transmission loss **to achieve STC 45**.
- G. Connection Sizes: Match connecting ductwork unless otherwise indicated.
- H. Principal Sound-Absorbing Mechanism:
1. Controlled impedance membranes and broadly tuned resonators without absorptive media.
- I. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.
1. **Lock form and seal or continuously weld joints.**
  2. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
  3. Reinforcement: Cross or trapeze angles for rigid suspension.
- J. Source Quality Control: Test according to ASTM E 477.
1. Testing to be witnessed by Architect's Sound Consultant



2. Record acoustic ratings, including dynamic insertion loss and generated-noise power levels with an airflow of at least **2000-fpm (10-m/s)** face velocity.
3. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or **6-inch wg (1500-Pa)** static pressure, whichever is greater.

## 2.9 TURNING VANES

- 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. Ductmate Industries, Inc.
  2. Duro Dyne Inc.
  3. METALAIRE, Inc.
  4. SEMCO Incorporated.
- B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
  1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- C. 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.
- D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vaness and Vane Runners," and 4-4, "Vane Support in Elbows."
- E. Vane Construction: **Single** wall.
- F. Vane Construction: Single wall for ducts up to **48 inches (1200 mm)** wide and double wall for larger dimensions.

## 2.10 DUCT-MOUNTED ACCESS DOORS

- 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. American Warming and Ventilating; a division of Mestek, Inc.
  2. Cesco Products; a division of Mestek, Inc.
  3. Ductmate Industries, Inc.
  4. Flexmaster U.S.A., Inc.
  5. Greenheck Fan Corporation.

6. McGill AirFlow LLC.
  7. Nailor Industries Inc.
  8. Pottorff; a division of PCI Industries, Inc.
  9. Ventfabrics, Inc.
  10. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2 (7-2M), "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-inch (25-by-25-mm) butt 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 (300 mm) Square: No hinges and two sash locks.
    - b. Access Doors up to 18 Inches (460 mm) Square: Two hinges and two sash locks.
    - c. Access Doors up to 24 by 48 Inches (600 by 1200 mm): Three hinges and two compression latches **with outside and inside handles**.
    - d. Access Doors Larger Than 24 by 48 Inches (600 by 1200 mm): Four hinges and two compression latches with outside and inside handles.
- C. Pressure Relief Access Door:
1. Door and Frame Material: Galvanized sheet steel.
  2. Door: **Single wall** or **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 **10-inch wg (2500 Pa)**.
  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- (25-mm-) thick, fibrous-glass or polystyrene-foam board.

## 2.11 DUCT ACCESS PANEL ASSEMBLIES

- 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. Ductmate Industries, Inc.
  2. Flame Gard, Inc.
  3. 3M.
- B. Labeled according to UL 1978 by an NRTL.
- C. Panel and Frame: Minimum thickness **0.0528-inch (1.3-mm) carbon or 0.0428-inch (1.1-mm) stainless steel**.
- D. Fasteners: **Carbon** or **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 (1093 deg C)**.
- F. Minimum Pressure Rating: **10-inch wg (2500 Pa)**, positive or negative.

## 2.12 FLEXIBLE CONNECTORS

- 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. Ductmate Industries, Inc.
  2. Duro Dyne Inc.
  3. Ventfabrics, Inc.
  4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip [**3-1/2 inches (89 mm)**] wide attached to 2 strips of **2-3/4-inch- (70-mm-)** wide, **0.028-inch- (0.7-mm-)** thick, galvanized sheet steel or **0.032-inch- (0.8-mm-)** 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. (880 g/sq. m)**.
  2. Tensile Strength: **480 lbf/inch (84 N/mm)** in the warp and **360 lbf/inch (63 N/mm)** in the filling.
  3. Service Temperature: **Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C)**.

- 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. (810 g/sq. m).
  2. Tensile Strength: 530 lbf/inch (93 N/mm) in the warp and 440 lbf/inch (77 N/mm) in the filling.
  3. Service Temperature: Minus 50 to plus 250 deg F (Minus 45 to plus 121 deg C).
- G. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.
1. Minimum Weight: 16 oz./sq. yd. (542 g/sq. m).
  2. Tensile Strength: 285 lbf/inch (50 N/mm) in the warp and 185 lbf/inch (32 N/mm) in the filling.
  3. Service Temperature: Minus 67 to plus 500 deg F (Minus 55 to plus 260 deg C).
- H. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.
1. Minimum Weight: 14 oz./sq. yd. (474 g/sq. m).
  2. Tensile Strength: 450 lbf/inch (79 N/mm) in the warp and 340 lbf/inch (60 N/mm) in the filling.
  3. Service Temperature: Minus 67 to plus 500 deg F (Minus 55 to plus 260 deg C).
- I. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
  2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
  7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch (6-mm) movement at start and stop.

## 2.13 FLEXIBLE DUCTS

- 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. Flexmaster U.S.A., Inc.

2. McGill AirFlow LLC.
- B. Noninsulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire.
1. Pressure Rating: 10-inch wg (2500 Pa) positive and 1.0-inch wg (250 Pa) negative.
  2. Maximum Air Velocity: 4000 fpm (20 m/s).
  3. Temperature Range: Minus 10 to plus 160 deg F (Minus 23 to plus 71 deg C).
- C. Noninsulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire.
1. Pressure Rating: 4-inch wg (1000 Pa) positive and 0.5-inch wg (125 Pa) negative.
  2. Maximum Air Velocity: 4000 fpm (20 m/s).
  3. Temperature Range: Minus 20 to plus 175 deg F (Minus 29 to plus 79 deg C).
- D. Noninsulated, Flexible Duct: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire.
1. Pressure Rating: 10-inch wg (2500 Pa) positive and 1.0-inch wg (250 Pa) negative.
  2. Maximum Air Velocity: 4000 fpm (20 m/s).
  3. Temperature Range: Minus 20 to plus 210 deg F (Minus 29 to plus 99 deg C).
- E. Noninsulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire.
1. Pressure Rating: 10-inch wg (2500 Pa) positive and 1.0-inch wg (250 Pa) negative.
  2. Maximum Air Velocity: 4000 fpm (20 m/s).
  3. Temperature Range: Minus 20 to plus 210 deg F (Minus 29 to plus 99 deg C).
- F. Noninsulated, Flexible Duct: UL 181, Class 0, interlocking spiral of aluminum foil.
1. Pressure Rating: 8-inch wg (2280 Pa) positive or negative.
  2. Maximum Air Velocity: 5000 fpm (25 m/s).
  3. Temperature Range: Minus 100 to plus 435 deg F (Minus 73 to plus 224 deg C).
- G. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; **polyethylene** vapor-barrier film.
1. Pressure Rating: 10-inch wg (2500 Pa) positive and 1.0-inch wg (250 Pa) negative.
  2. Maximum Air Velocity: 4000 fpm (20 m/s).
  3. Temperature Range: Minus 10 to plus 160 deg F (Minus 23 to plus 71 deg C).
  4. Insulation R-value: **Comply with ASHRAE/IESNA 90.1**

- H. Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; **polyethylene** vapor-barrier film.
  - 1. Pressure Rating: **4-inch wg (1000 Pa)** positive and **0.5-inch wg (125 Pa)** negative.
  - 2. Maximum Air Velocity: **4000 fpm (20 m/s)**.
  - 3. Temperature Range: **Minus 20 to plus 175 deg F (Minus 29 to plus 79 deg C)**.
  - 4. Insulation R-Value: **Comply with ASHRAE/IESNA 90.1..**
- I. Flexible Duct Connectors:
  - 1. Clamps: [**Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action**] [**Nylon strap**] in sizes **3 through 18 inches (75 through 460 mm)**, to suit duct size.
  - 2. Non-Clamp Connectors: [**Adhesive**] [**Liquid adhesive plus tape**] [**Adhesive plus sheet metal screws**].

## 2.14 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install **backdraft** and/or **control** dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.
  2. Install aluminum volume dampers in aluminum ducts.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install fire **and smoke** dampers according to UL listing.
- H. Connect ducts to duct silencers **with flexible duct connectors or rigidly** as required (where indicated on drawings).
- I. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
1. On both sides of duct coils.
  2. Upstream from duct filters.
  3. At outdoor-air intakes and mixed-air plenums.
  4. At drain pans and seals.
  5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
  6. 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. Control devices requiring inspection.
  8. Elsewhere as indicated.
- J. Install access doors with swing against duct static pressure.
- K. Access Door Sizes:
1. One-Hand or Inspection Access: **8 by 5 inches** (200 by 125 mm).
  2. Two-Hand Access: **12 by 6 inches** (300 by 150 mm).
  3. Head and Hand Access: **18 by 10 inches** (460 by 250 mm).
  4. Head and Shoulders Access: **21 by 14 inches** (530 by 355 mm).
  5. Body Access: **25 by 14 inches** (635 by 355 mm).
  6. Body plus Ladder Access: **25 by 17 inches** (635 by 430 mm).
- L. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- M. Install flexible connectors to connect ducts to equipment.
- N. For fans developing static pressures of **5-inch wg** (1250 Pa) and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

- O. Connect terminal units to supply ducts **directly or** with maximum **12-inch (300-mm)** lengths of flexible duct. Do not use flexible ducts to change directions.
- P. Connect diffusers or light troffer boots to ducts **directly or** with maximum **60-inch (1500-mm)** lengths of flexible duct clamped or strapped in place.
- Q. Connect flexible ducts to metal ducts with **adhesive plus sheet metal screws**.
- R. Install duct test holes where required for testing and balancing purposes.
- S. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of **1/4-inch (6-mm)** movement during start and stop of fans.

### 3.2 FIELD QUALITY CONTROL

#### A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination 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.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233300



## SECTION 235400 - FURNACES

### 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. **Gas-fired, condensing** furnaces and accessories complete with controls.
  - 2. Air filters.
  - 3. Refrigeration components.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each of the following:
  - 1. Furnace.
  - 2. Thermostat.
  - 3. Air filter.
  - 4. Refrigeration components.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 1. Wiring Diagrams: Power, signal, and control wiring.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Warranty: Special warranty specified in this Section.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each furnace to include in emergency, operation, and maintenance manuals for each of the following:
  - 1. Furnace and accessories complete with controls.

2. Air filter.
3. Refrigeration components.

## 1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Disposable Air Filters: Furnish 2 complete sets.

## 1.7 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. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- D. Comply with NFPA 70.

## 1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace the following components of furnaces that fail in materials or workmanship within specified warranty period:
  1. Warranty Period, Commencing on Date of Substantial Completion:
    - a. Furnace Heat Exchanger: **20 years.**
    - b. Integrated Ignition and Blower Control Circuit Board: **Five years.**
    - c. Draft-Inducer Motor: **Five years.**
    - d. Refrigeration Compressors: **10 years.**
    - e. Evaporator and Condenser Coils: **Ten years**
    - f. .

## PART 2 - PRODUCTS

### 2.1 GAS-FIRED FURNACES, CONDENSING

- A. Basis-of-Design Product: Subject to compliance with requirements, provide **the product indicated on Drawings** or a comparable product by one of the following:

1. Adams Manufacturing Company.
  2. Amana Heating & Air Conditioning; Goodman Manufacturing Company, L.P.
  3. American Standard Companies, Inc.
  4. Arcoaire Air Conditioning & Heating; a division of International Comfort Products, LLC.
  5. Armstrong Air Conditioning Inc.
  6. Bryant Heating & Cooling Systems; Div. of United Technologies Corp.
  7. Carrier Corporation; Div. of United Technologies Corp.
  8. Clare Brothers.
  9. Comfort-Aire; a division of Heat Controller, Inc.
  10. Comfortmaker Air Conditioning & Heating; a division of International Comfort Products, LLC.
  11. Dornback Furnace.
  12. Goodman Manufacturing Company, L.P.
  13. Heil Heating & Cooling Products; a division of International Comfort Products, LLC.
  14. Lennox Industries Inc.
  15. Luxaire Corporation; a division of Unitary Products Group.
  16. Rheem Manufacturing Company; Air Conditioning Division.
  17. Ruud Air Conditioning Division.
  18. Tempstar Heating & Cooling Products; a division of International Comfort Products, LLC.
  19. Thermo Products, Inc.; a division of Burnham Holdings Inc.
  20. Trane.
  21. York International Corp.; a division of Unitary Products Group.
- B. General Requirements for Gas-Fired, Condensing Furnaces: Factory assembled, piped, wired, and tested; complying with ANSI Z21.47/CSA 2.3, "Gas-Fired Central Furnaces," and with NFPA 54.
- C. Cabinet: **Steel**.
1. Cabinet interior around heat exchanger shall be factory-installed insulation.
  2. Lift-out panels shall expose burners and all other items requiring access for maintenance.
  3. Factory paint external cabinets in manufacturer's standard color.
  4. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Fan: Centrifugal, factory balanced, resilient mounted, direct drive.
1. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
  2. Special Motor Features: Single speed, Premium (TM) efficiency, as defined in Division 23 Section "Common Motor Requirements for HVAC Equipment," and with internal thermal protection and permanent lubrication.
  3. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.
  4. Special Motor Features: Electronically controlled motor (ECM) controlled by integrated furnace/blower control.

- E. Type of Gas: **Natural**.
- F. Burner:
1. Gas Valve: 100 percent safety **two-stage** main gas valve, main shutoff valve, pressure regulator, safety pilot with electronic flame sensor, limit control, transformer, and combination ignition/fan timer control board.
  2. Ignition: Electric pilot ignition, with hot-surface igniter or electric spark ignition.
- G. Gas-Burner Safety Controls:
1. Electronic Flame Sensor: Prevents gas valve from opening until pilot flame is proven; stops gas flow on ignition failure.
  2. Flame Rollout Switch: Installed on burner box; prevents burner operation.
  3. Limit Control: Fixed stop at maximum permissible setting; de-energizes burner on excessive bonnet temperature; automatic reset.
- H. Combustion-Air Inducer: Centrifugal fan with thermally protected motor and sleeve bearings prepurges heat exchanger and vents combustion products; pressure switch prevents furnace operation if combustion-air inlet or flue outlet is blocked.
- I. Furnace Controls: Solid-state board integrates ignition, heat, cooling, and fan speeds; adjustable fan-on and fan-off timing; terminals for connection to accessories; **diagnostic light with viewport**.
- J. Accessories:
1. Combination Combustion-Air Intake and Vent: PVC plastic fitting to combine combustion-air inlet and vent through **roof**.
  2. CPVC Plastic Vent Materials.
    - a. CPVC Plastic Pipe: Schedule 40, complying with ASTM F 441/F 441M.
    - b. CPVC Plastic Fittings: Schedule 40, complying with ASTM F 438, socket type.
    - c. CPVC Solvent Cement: 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."
  3. PVC Plastic Vent Materials:
    - a. PVC Plastic Pipe: Schedule 40, complying with ASTM D 1785.

- b. PVC Plastic Fittings: Schedule 40, complying with ASTM D 2466, socket type.
- c. PVC 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) 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."

K. Capacities and Characteristics: See schedules

## 2.2 THERMOSTATS

- A. Controls shall comply with requirements in ASHRAE/IESNA 90.1, "Controls."
- B. Solid-State Thermostat: **Wall-mounting**, programmable, microprocessor-based unit with **manual** switching from heating to cooling, preferential rate control, seven-day programmability with minimum of four temperature presets per day, **vacation mode**, and battery backup protection against power failure for program settings.
- C. Single-Stage, Heating-Cooling Thermostat: Adjustable, heating-cooling, wall-mounting unit with fan on-automatic selector.
- D. Control Wiring: Unshielded twisted-pair cabling.
  - 1. No. 24 AWG, 100 ohm, four pair.
  - 2. Cable Jacket Color: **[Blue] <Insert color>**.

## 2.3 AIR FILTERS

- A. Disposable Filters: **1-inch- (25-mm-)** thick fiberglass media[ **with ASHRAE 52.2 MERV rating of 11 or higher**, in sheet metal frame.

## 2.4 REFRIGERATION COMPONENTS

- A. General Refrigeration Component Requirements:
  - 1. Refrigeration compressor, coils, and specialties shall be designed to operate with CFC-free refrigerants.
  - 2. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IESNA 90.1, "Energy Standard for Buildings except Low-Rise Residential Buildings."

- B. Refrigerant Coil: Copper tubes mechanically expanded into aluminum fins. Comply with ARI 210/240, "Unitary Air-Conditioning and Air-Source Heat Pump Equipment." Match size with furnace. Include condensate drain pan with accessible drain outlet **complying with ASHRAE 62.1.**
1. Refrigerant Coil Enclosure: Steel, matching furnace and evaporator coil, with access panel and flanges for integral mounting at or on furnace cabinet and galvanized sheet metal drain pan coated with black asphaltic base paint.
- C. Refrigerant Line Kits: Annealed-copper suction and liquid lines factory cleaned, dried, pressurized with nitrogen, sealed, and with suction line insulated. Provide in standard lengths for installation without joints, except at equipment connections.
1. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I, **1/2 inch (13 mm)** thick.
- D. Refrigerant Piping: Comply with requirements in Division 23 Section "Refrigerant Piping."
- E. Air-Cooled, Compressor-Condenser Unit:
1. Casing: Steel, finished with baked enamel, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
  2. Compressor: Hermetically sealed **reciprocating or scroll** type.
    - a. Crankcase heater.
    - b. **Vibration** isolation mounts for compressor.
    - c. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
    - d. Two-speed compressor motors shall have manual-reset high-pressure switch and automatic-reset low-pressure switch.
    - e. Refrigerant Charge: **R-410A.**
    - f. Refrigerant: R-410A.
  3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid subcooler.
  4. Fan: Aluminum-propeller type, directly connected to motor.
  5. Motor: Permanently lubricated, with integral thermal-overload protection.
  6. Low Ambient Kit: Permits operation down to **45 deg F (7 deg C).**
  7. Mounting Base: Polyethylene.
- F. Capacities and Characteristics: See plan schedules.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine factory-installed insulation before furnace installation. Reject units that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for **gas and refrigerant** piping systems to verify actual locations of piping connections before equipment installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install gas-fired furnaces and associated fuel and vent features and systems according to NFPA 54.
- B. Suspended Units: Suspend from structure using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.
  - 1. Install seismic restraints to limit movement of furnace by resisting code-required seismic acceleration.
- C. Base-Mounted Units: Secure units to substrate. Provide optional bottom closure base if required by installation conditions.
  - 1. Anchor furnace to substrate to resist code-required seismic acceleration.
- D. Controls: Install thermostats and humidistats at mounting height of **60 inches (1500 mm)** above floor.
- E. Wiring Method: Install control wiring in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal control wiring except in unfinished spaces.
- F. Install roof-mounted, compressor-condenser components on equipment supports specified per Architectural details or raised above roof on treated 4x4 treated wood base secured to roof.

### 3.3 CONNECTIONS

- A. Gas piping installation requirements are specified in Division 23 Section "**Facility Natural-Gas Piping**." Drawings indicate general arrangement of piping, fittings, and specialties. Connect gas piping with union or flange and appliance connector valve.

- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Vent and Outside-Air Connection, Condensing, Gas-Fired Furnaces: Connect plastic piping vent material to furnace connections and extend outdoors. Terminate vent outdoors with a cap and in an arrangement that will protect against entry of birds, insects, and dirt.
  - 1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
  - 2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
  - 3. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
    - a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
    - b. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
    - c. 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.
    - d. Requirements for Low-Emitting Materials:
      - 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) 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).
      - 3) 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).
      - 4) 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."
  - 4. Slope pipe vent back to furnace or to outside terminal.
- D. Connect ducts to furnace with flexible connector. Comply with requirements in Division 23 Section "Air Duct Accessories."
- E. Connect refrigerant tubing kits to refrigerant coil in furnace and to air-cooled, compressor-condenser unit.
  - 1. Flared Joints: Use ASME B16.26 fitting and flared ends, following procedures in CDA's "Copper Tube Handbook."
  - 2. 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.



3. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Comply with requirements in Division 23 Section "Refrigerant Piping" for installation and joint construction of refrigerant piping.

### 3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
1. Perform electrical test and visual and mechanical inspection.
  2. Leak Test: After installation, charge systems with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
  3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation, product capability, and compliance with requirements.
  4. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.
  5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

### 3.5 STARTUP SERVICE

- A. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
1. Inspect for physical damage to unit casings.
  2. Verify that access doors move freely and are weathertight.
  3. Clean units and inspect for construction debris.
  4. Verify that all bolts and screws are tight.
  5. Adjust vibration isolation and flexible connections.
  6. Verify that controls are connected and operational.
- B. Adjust fan belts to proper alignment and tension.
- C. Start unit according to manufacturer's written instructions and complete manufacturer's operational checklist.
- D. Measure and record airflows.
- E. Verify proper operation of capacity control device.
- F. After startup and performance test, lubricate bearings[ **and adjust belt tension**].

### 3.6 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. Set controls, burner, and other adjustments for optimum heating performance and efficiency. Adjust heat-distribution features, including shutters, dampers, and relays, to provide optimum heating performance and system efficiency.

### 3.7 CLEANING

- A. After completing installation, clean furnaces internally according to manufacturer's written instructions.
- B. Install new filters in each furnace within 14 days after Substantial Completion.

### 3.8 DEMONSTRATION

- A. **Engage a factory-authorized service representative to train** Owner's maintenance personnel to adjust, operate, and maintain condensing units. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 235400

## SECTION 237433

### DEDICATED OUTDOOR-AIR UNITS

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- A. Section includes factory-packaged units capable of supplying up to 100 percent outdoor air and providing cooling and heating.

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include rated capacities, operating characteristics, and furnished specialties and accessories.
- B. LEED Submittals:
  - 1. Product Data for Prerequisite EA 2: Documentation indicating that units comply with applicable requirements in ASHRAE/IESNA 90.1.
  - 2. Product Data for Prerequisite EA 3: Documentation indicating that refrigerants comply.
  - 3. Product Data for Credit EA 4: Documentation indicating that equipment and refrigerants comply.
  - 4. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
  - 5. Product Data for Credit IEQ 1: Documentation indicating that units are equipped with a direct outdoor airflow-measuring device capable of measuring the minimum outdoor airflow with accuracy within 15 percent of the design minimum airflow rate, as defined by ASHRAE 62.1.
  - 6. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
  - 7. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products 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."

8. Product Data for Credit IEQ 5: Documentation indicating that units include MERV 13 filters rated according to ASHRAE 52.2.

C. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Prepare the following by or under the supervision of a qualified professional engineer:
  - a. Mounting Details: For securing and flashing roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
  - b. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Roof-curb mounting 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. Size and location of unit-mounted rails and anchor points and methods for anchoring units to roof curb.
  2. Required roof penetrations for ducts, pipes, and electrical raceways, including size and location of each penetration.
- B. Startup service reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Fan Belts: **One** set for each belt-driven fan.
  2. Filters: **One** set for each unit.

## 1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to replace components of units that fail in materials or workmanship within specified warranty period.
1. Warranty Period for Compressors: **5** years from date of Substantial Completion.
  2. Warranty Period for Heat Exchangers: **10** years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide **product indicated on Drawings** or comparable product by one of the following:
1. AAON.
  2. Addison.
  3. Engineered Air.
  4. Modine

### 2.2 PERFORMANCE REQUIREMENTS

- A. General Fabrication Requirements: Comply with requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Start-up."
- B. Cabinet Thermal Performance:
1. Maximum Overall U-Value: Comply with requirements in ASHRAE/IESNA 90.1.
  2. Maximum Overall U-Value: **0.10 Btu/h x sq. ft. x deg F (0.57 W/sq. m x deg K).**
  3. Include effects of metal-to-metal contact and thermal bridges in the calculations.
- C. Cabinet Surface Condensation:
1. Cabinet shall have additional insulation and vapor seals if required to prevent condensation on the interior and exterior of the cabinet.
  2. Portions of cabinet located downstream from the cooling coil shall have a thermal break at each thermal bridge between the exterior and interior casing to prevent condensation from occurring on the interior and exterior surfaces. The thermal break shall not compromise the structural integrity of the cabinet.
- D. Maximum Cabinet Leakage: **0.5** percent of the total supply-air flow at a pressure rating equal to the fan shut-off pressure.

- E. Cabinet Deflection Performance:
  - 1. Walls and roof deflection shall be within **1/200** of the span at the design working pressure equal to the fan shut-off pressure. Deflection limits shall be measured at any point on the surface.
  - 2. Floor deflections shall be within **1/240** of the span considering the worst-case condition caused by the following:
    - a. Service personnel.
    - b. Internal components.
    - c. Design working pressure defined for the walls and roof.
- F. 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.
- G. Capacities and Characteristics: See drawing schedules

## 2.3 CABINET

- A. Construction: **double** wall.
- B. Exterior Casing Material: **Galvanized steel with paint finish.**
- C. Interior Casing Material: **Galvanized or stainless** steel.
- D. Lifting and Handling Provisions: Factory-installed shipping skids and lifting lugs.
- E. Base Rails: **Galvanized**-steel rails for mounting on roof curb or pad as indicated.
- F. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
  - 1. Service Doors: Hinged access doors with gaskets. Material and construction of doors shall match material and construction of cabinet in which doors are installed.
- G. Roof: Standing seam or membrane; sloped to drain water.
- H. Floor: Reinforced, metal surface; reinforced to limit deflection when walked on by service personnel. Insulation shall be below metal walking surface.
- I. Cabinet Insulation:
  - 1. Type: **Fibrous-glass duct lining complying with ASTM C 1071, Type II or flexible elastomeric insulation complying with ASTM C 534, Type II, sheet materials.**

2. Thickness: **2 inches (50 mm)**
3. Insulation Adhesive: Comply with ASTM C 916, Type I.
4. Mechanical Fasteners: Suitable for adhesive, mechanical, or welding attachment to casing without damaging liner and without causing air leakage when applied as recommended by manufacturer.

J. Condensate Drain Pans:

1. Shape: Rectangular, with **2** percent slope in at least two planes to direct water toward drain connection.
2. Size: Large enough to collect condensate from cooling coils including coil piping connections, coil headers, and return bends.
  - a. Length: Extend drain pan downstream from leaving face **to comply with ASHRAE 62.1.**
  - b. Depth: A minimum of **2 inches (50 mm)** deep.
3. Configuration: Single wall or double wall, with space between walls filled with foam insulation and moisture-tight seal.
4. Material: Galvanized-steel sheet with asphaltic waterproofing compound coating on pan top surface.
5. Material: Stainless-steel sheet.
6. Drain Connection:
  - a. Located on either or both ends at lowest point of pan.
  - b. Terminated with threaded nipple.
  - c. Minimum Connection Size: **NPS 1 (DN 25).**
7. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

K. Surfaces in Contact with Airstream: Comply with requirements in ASHRAE 62.1 for resistance to mold and erosion.

L. Roof Curb: Full-perimeter curb of sheet metal, minimum **16 inches (400 mm)** high, with wood nailer, neoprene sealing strip, and welded Z-bar flashing.

1. Comply with requirements in "The NRCA Roofing Manual."

## 2.4 SUPPLY FAN

A. Forward-Curved Fan Type: Centrifugal; statically and dynamically balanced.

1. Fan Wheel Material: **Galvanized Coated** steel, mounted on solid-steel shaft.
2. Bearings: **Self-aligning, permanently lubricated ball bearings.**

- B. Plenum Fan Type: Single width, non-overloading, with backward-inclined or airfoil blades.
  - 1. Fan Wheel Material: Aluminum; attached directly to motor shaft.
  - 2. Fan Wheel Drive and Arrangement: Direct drive, AMCA Arrangement 4.
  - 3. Fan panel and frame Material: Powder-coated steel, stainless steel, or aluminum.
  - 4. Fan Enclosure: Easily removable enclosure around rotating parts.
  - 5. Fan Balance: Precision balance fan below 0.08 inch/s (2.0 mm/s) at design speed with filter in.
- C. Service Factor for Belt Drive Applications: **Multiple** V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly with minimum **2.0** service factor.
- D. Motors:
  - 1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
  - 2. Enclosure: **Open dripproof.**
  - 3. Retain "Enclosure Materials," "Motor Bearings," "Unusual Service Conditions," "Efficiency," "NEMA Design," and "Service Factor" subparagraphs below if options are available from equipment manufacturers and are different from default requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment." Consider each subparagraph and retain only those that vary from default requirements.
  - 4. Efficiency: Premium efficient.
- E. Mounting: Fan wheel, motor, and drives shall be mounted to fan casing with **spring** isolators.

## 2.5 COOLING COILS

- A. Capacity Ratings: Comply with ASHRAE 33 and ARI
- B. Coil Casing Material: **Aluminum**
- C. Tube Material: **Copper.**
- D. Tube Header Material: **Copper.**
- E. Fin Material: **Copper.**
- F. Fin and Tube Joints: Mechanical bond.



- G. Leak Test: Coils shall be leak tested with air underwater.
- H. Refrigerant Coil Suction and Distributor Header Materials: Seamless copper tube with brazed joints.
- I. Coating: Phenolic epoxy corrosion-protection coating after assembly.

## 2.6 REFRIGERATION SYSTEM

- A. Comply with requirements in ASHRAE 15, "Safety Standard for Refrigeration Systems."
- B. Refrigerant Charge: Factory charged with refrigerant and filled with oil.
- C. Compressors: **Reciprocating or scroll** compressors with integral vibration isolators, internal overcurrent and overtemperature protection, internal pressure relief
- D. LEED-NC, LEED-CS, and LEED for Schools Credit EA 4 award a single point if all HVAC&R equipment uses environmentally friendly refrigerants. R-134a, R-407C, and R-410A are HFC refrigerants and should be evaluated for the credit. Verify available refrigerants with manufacturers.
- E. Refrigerant: **R-407C or other HFC compliant refrigerant.**
  - 1. Classified as Safety Group A1 according to ASHRAE 34.
  - 2. Provide unit with operating charge of refrigerant.
- F. Refrigeration System Specialties:
  - 1. Expansion valve with replaceable thermostatic element.
  - 2. Refrigerant dryer.
  - 3. High-pressure switch.
  - 4. Low-pressure switch.
  - 5. Thermostat for coil freeze-up protection during low ambient temperature operation or loss of air.
  - 6. Brass service valves installed in discharge and liquid lines.
- G. Capacity Control:
  - 1. Hot-gas bypass refrigerant control for capacity control with continuous dehumidification on a single compressor.
  - 2. Patented, Rawal APR control with zero to 100 percent modulating capacity control using hot-gas bypass. Evaporator coil shall be continuously active for dehumidification.
  - 3. Single compressor with evaporator and condenser coil within the refrigerant section to provide initial pre-cooling and to reheat for humidity control.

4. Heat-pipe heat exchanger wrapped around the evaporator coil to pre-cool the air entering the evaporator coil and reheat the air leaving the evaporator coil to control humidity.

H. Refrigerant **condenser and reheat condenser** coils:

1. Capacity Ratings: Complying with ASHRAE 33 and ARI 410
2. Tube Material: Copper.
3. Fin Material: **Copper**.
4. Fin and Tube Joint: Mechanical bond.
5. Leak Test: Coils shall be leak tested with air underwater.
6. Coating: Phenolic epoxy corrosion-protection coating after assembly.

I. Condenser Fan Assembly:

1. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades.
2. Fan Motors:
  - a. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
  - b. Motor Enclosure: Totally enclosed non-ventilating (TENV) or totally enclosed air over (TEAO) enclosure.
  - c. Enclosure Materials: **Cast iron**.
  - d. Motor Bearings: **Permanently lubricated bearings**
  - e. Built-in overcurrent and thermal-overload protection.
  - f. Efficiency: Premium efficient.
3. Fan Safety Guards: Steel with corrosion-resistant coating.

J. Safety Controls:

1. Compressor motor and condenser coil fan motor low ambient lockout.
2. Overcurrent protection for compressor motor.

## 2.7 INDIRECT-FIRED GAS FURNACE HEATING

A. Furnace Assembly:

1. Factory assembled, piped, and wired.
2. Comply with requirements in NFPA 54, "National Fuel Gas Code," and ANSI Z21.47, "Gas-Fired Central Furnaces."

3. AGA Approval: Designed and certified by and bearing label of AGA.
- B. Burners:
1. Heat-Exchanger Material: **Stainless steel** with a minimum thermal efficiency of 90 percent.
  2. Fuel: **Natural** gas.
  3. Ignition: Electronically controlled electric spark with flame sensor.
- C. Heat-Exchanger Drain Pan Material: Stainless steel.
- D. Venting: Gravity vented.
- E. Venting: Power vent with integral, motorized centrifugal fan interlocked with gas valve.
- F. Safety Controls:
1. Gas Control Valve: **Electronic modulating**.
  2. 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.

## 2.8 OUTDOOR-AIR INTAKE HOOD

- A. Type: Manufacturer's standard hood or louver extended 15 feet from any contaminated exhaust.
- B. Materials: Match cabinet.
- C. Bird Screen: Comply with requirements in ASHRAE 62.1.
- D. Configuration: Designed to inhibit wind-driven rain and snow from entering unit.

## 2.9 FILTERS

- A. Extended-Surface, Disposable Panel Filters:
1. Comply with NFPA 90A.
  2. Factory-fabricated, dry, extended-surface type.
  3. Thickness: **4 inches (100 mm)**.
  4. Minimum Arrestance: **90**, according to ASHRAE 52.1.
  5. Minimum Merv: **7**, according to ASHRAE 52.2.
  6. Media: Fibrous material formed into deep-V-shaped pleats **with antimicrobial agent** and held by self-supporting wire grid.
- B. Mounting Frames:

1. Panel filters arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or from access plenum.
2. Extended surface filters arranged for flat orientation, removable from access plenum.
3. Galvanized or stainless steel with gaskets and fasteners, suitable for bolting together into built-up filter banks.

## 2.10 ELECTRICAL POWER CONNECTIONS

- A. General Electrical Power Connection Requirements: Factory-installed and -wired switches, motor controllers, transformers, and other necessary electrical devices shall provide a **single-point** field power connection to unit.
- B. Enclosure: NEMA 250, **Type 4**, mounted in unit with hinged access door in unit cabinet having a lock and key or padlock and key,
- C. Wiring: Numbered and color-coded to match wiring diagram.
- D. Wiring Location: Install factory wiring outside an enclosure in a raceway.
- E. Power Interface: Field power interface shall be to **nonfused disconnect switch**.
- F. Factory Wiring: Branch power circuit to each motor and to controls with one of the following disconnecting means:
  1. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
  2. NEMA KS 1, heavy-duty, nonfusible switch.
  3. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
- G. Factory-Mounted, Overcurrent-Protection Service: For each motor.
- H. Transformer: Factory mounted with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
- I. Controls: Factory wire unit-mounted controls where indicated.
- J. Lights: Factory wire unit-mounted lights.
- K. Receptacle: Factory wire unit-mounted, ground fault interrupt (GFI) duplex receptacle.
- L. Control Relays: Auxiliary and adjustable time-delay relays.

## 2.11 CONTROLS

- A. Control equipment and sequence of operation are specified in Division 23 Section "Instrumentation and Control for HVAC."
- B. Control Valves: Comply with requirements in Division 23 Section "Instrumentation and Control for HVAC."
- C. Control Wiring: Factory wire connection for controls' power supply.
- D. Control Devices: Sensors, transmitters, relays, switches, detectors, operators, actuators, and valves shall be manufacturer's standard items to accomplish indicated control functions.
- E. **Remote and Unit-Mounted Status Panel:**
  - 1. Cooling/Off/Heating Controls: Control operational mode.
  - 2. Damper Position: Indicate position of outdoor-air dampers in terms of percentage of outdoor air.
  - 3. Status Lights:
    - a. Filter dirty.
    - b. Fan operating.
    - c. Cooling operating.
    - d. Heating operating.
    - e. Smoke alarm.
    - f. General alarm.
  - 4. Digital Numeric Display:
    - a. Outdoor airflow.
    - b. Supply airflow.
    - c. Outdoor dry-bulb temperature.
    - d. Outdoor dew point temperature.
    - e. Space temperature.
    - f. Supply temperature.
    - g. Space relative humidity.
    - h. Space carbon dioxide level.
- F. Control Dampers:
  - 1. Damper Location: Factory installed inside unit for ease of blade axle and bushing service. Arrange dampers located in a mixing box to achieve convergent airflow to minimize stratification.
  - 2. Damper Leakage: Comply with requirements in AMCA 500-D. Leakage shall not exceed **6.5 cfm per sq. ft. (33 L/s per sq. m)** at a static-pressure differential of **4.0 inches water column (1000 Pa)** when a torque of **5 inch pounds per sq. ft. (30.1 Newton meters per sq. m)** is applied to the damper jackshaft.

3. Damper Rating: Rated for close-off pressure equal to the fan shutoff pressure.
4. Damper Label: Bear the AMCA seal for both air leakage and performance.
5. Blade Configuration: Unless otherwise indicated, use parallel blade configuration for two-position control and equipment isolation service and use modulating control when mixing two airstreams. For other applications, use an opposed-blade configuration.
6. Damper Frame Material: **Extruded aluminum, galvanized steel or stainless steel.**
7. Blade Type: **Single-thickness metal reinforced with multiple V-grooves or hollow-shaped airfoil.**
8. Blade Material: **Extruded aluminum, galvanized steel, or stainless steel.**
9. Maximum Blade Width: **6 inches (150 mm).**
10. Maximum Blade Length: **48 inches (1200 mm).**
11. Blade Seals: Replaceable, continuous perimeter vinyl seals and jambs with stainless-steel compression-type seals.
12. Bearings: Thrust bearings for vertical blade axles.
13. Airflow Measurement:
  - a. Monitoring System: Complete and functioning system of airflow monitoring as an integral part of the damper assembly where indicated.
  - b. Remote Monitoring Signal: 0-10 volt or 4-20 mA scaled signal.
  - c. Accuracy of flow measurement: Within **5** percent of the actual flow rate between the range of the scheduled minimum and maximum airflow. For units with a large range between minimum and maximum airflow, configure the damper sections and flow measurement assembly as necessary to comply with accuracy.
  - d. Straightening Device: Integral to the flow measurement assembly if required to achieve the specified accuracy as installed.
  - e. Flow measuring device: Suitable for operation in untreated and unfiltered outdoor air. If necessary, include temperature and altitude compensation and correction to maintain the accuracy.

G. Damper Operators:

1. Factory-installed electric operator for each damper assembly with one operator for each damper assembly mounted to the damper frame.
2. Operator capable of shutoff against fan pressure and able to operate the damper with sufficient reserve power to achieve smooth modulating action and proper speed of response at the velocity and pressure conditions to which the damper is subjected.
3. Maximum Operating Time: Open or close damper 90 degrees in **60** seconds.
4. Adjustable Stops: For both maximum and minimum positions.
5. Position Indicator and Graduated Scale: Factory installed on each actuator with words "OPEN" and "CLOSED," or similar identification, at travel limits.
6. Spring-return operator to fail-safe; either closed or open as required by application.
7. Operator Type: Direct coupled, designed for minimum 60,000 full-stroke cycles at rated torque.

8. Position feedback Signal: For remote monitoring of damper position.
9. Coupling: V-bolt and V-shaped, toothed cradle.
10. Circuitry: Electronic overload or digital rotation-sensing circuitry.

H. Refrigeration System Controls:

1. Relative-humidity sensor energizes dehumidifier operation when relative humidity is more than **65** percent.

I. Furnace Controls:

1. **Factory-mounted sensor in supply** with sensor adjustment located in control panel to modulate gas furnace burner to maintain discharge air temperature.
2. Staged Burner Control: Minimum of **Four** steps of control.
3. Electromechanical or Electronic Burner Control: minimum of 20 to 100 percent modulation of the firing rate; 10 to 100 percent with dual-furnace units.

J. Integral Smoke Alarm: Smoke detector installed in outside air intake.

K. DDC Temperature Control: Standalone control module for link between unit controls and DDC temperature-control system. Control module shall be compatible with control system specified in Division 23 Section "Instrumentation and Control for HVAC." Links shall include the following:

1. Start/stop interface relay, and relay to notify DDC temperature-control system alarm condition.
2. Hardware interface or additional sensors for the following:
  - a. Room temperature.
  - b. Discharge-air temperature.
  - c. Refrigeration system operating.
  - d. Furnace operating.
  - e. Constant and variable motor loads.
  - f. Variable-frequency-controller operation.
  - g. Cooling load.
  - h. Economizer cycles.
  - i. Air-distribution static pressure and ventilation-air volumes.

## 2.12 ACCESSORIES

- A. Duplex Receptacle: Factory mounted in unit supply-fan section **and refrigeration section**, with 20 amp 120 V GFI duplex receptacle and weatherproof cover.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.
- C. Examine roof curbs and equipment supports for suitable conditions where units will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Comply with manufacturer's rigging and installation instructions for unloading units and moving to final locations.
- B. Curb Support: Install roof curb on roof structure according to "The NRCA Roofing Manual."
  - 1. Install and secure units on curbs and coordinate roof penetrations and flashing with roof construction.
  - 2. Coordinate size, installation, and structural capacity of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."
  - 3. Coordinate size, location, and installation of unit manufacturer's roof curbs and equipment supports with roof Installer.
- C. Comply with requirements for gas-fired furnace installation in NFPA 54, "National Fuel Gas Code."
- D. Install separate devices furnished by manufacturer and not factory installed.
- E. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.
- F. Install drain pipes from unit drain pans to sanitary drain.
  - 1. Drain Piping: Drawn-temper copper water tubing complying with **ASTM B 88, Type L (ASTM B 88M, Type B)**, with soldered joints.
  - 2. Pipe Size: Same size as condensate drain pan connection.



### 3.3 CONNECTIONS

- A. Where installing piping adjacent to units, allow space for service and maintenance.
- B. Gas Piping Connections:
  - 1. Comply with requirements in Division 23 Section "**Facility Natural-Gas Piping.**"
  - 2. Connect gas piping to furnace, full size of gas train inlet, and connect with union, **pressure regulator (when required)**, and shutoff valve with sufficient clearance for burner removal and service.
  - 3. Install AGA-approved flexible connectors.
- C. Duct Connections:
  - 1. Comply with requirements in Division 23 Section "Metal Ducts."
  - 2. Drawings indicate the general arrangement of ducts.
  - 3. Connect ducts to units with flexible duct connectors. Comply with requirements for flexible duct connectors in Division 23 Section "Air Duct Accessories."
- D. Electrical Connections: Comply with requirements for power wiring, switches, and motor controls in Division 26 Sections.
  - 1. Install electrical devices furnished by unit manufacturer but not factory mounted.

### 3.4 STARTUP SERVICE

- A. **Engage a factory-authorized service representative to perform** startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.
  - 2. Inspect units for visible damage to furnace combustion chamber.
  - 3. Perform the following operations for both minimum and maximum firing and adjust burner for peak efficiency:
    - a. Measure gas pressure at manifold.
    - b. Measure combustion-air temperature at inlet to combustion chamber.
    - c. Measure flue-gas temperature at furnace discharge.
    - d. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
    - e. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
  - 4. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
    - a. High-limit heat exchanger.
    - b. Alarms.

5. Inspect units for visible damage to refrigerant compressor, condenser and evaporator coils, and fans.
  6. Start refrigeration system when outdoor-air temperature is within normal operating limits and measure and record the following:
    - a. Cooling coil leaving-air, dry- and wet-bulb temperatures.
    - b. Cooling coil entering-air, dry- and wet-bulb temperatures.
    - c. Condenser coil entering-air dry-bulb temperature.
    - d. Condenser coil leaving-air dry-bulb temperature.
  7. Simulate maximum cooling demand and inspect the following:
    - a. Compressor refrigerant suction and hot-gas pressures.
    - b. Short-circuiting of air through outside coil or from outside coil to outdoor-air intake.
  8. Inspect casing insulation for integrity, moisture content, and adhesion.
  9. Verify that clearances have been provided for servicing.
  10. Verify that controls are connected and operable.
  11. Verify that filters are installed.
  12. Clean coils and inspect for construction debris.
  13. Clean furnace flue and inspect for construction debris.
  14. Inspect operation of power vents.
  15. Purge gas line.
  16. Inspect and adjust vibration isolators and seismic restraints.
  17. Verify bearing lubrication.
  18. Clean fans and inspect fan-wheel rotation for movement in correct direction without vibration and binding.
  19. Adjust fan belts to proper alignment and tension.
  20. Start unit.
  21. Inspect and record performance of interlocks and protective devices including response to smoke detectors by fan controls and fire alarm.
  22. Operate unit for run-in period.
  23. Calibrate controls.
  24. Adjust and inspect high-temperature limits.
  25. Inspect outdoor-air dampers for proper stroke.
  26. Verify operational sequence of controls.
  27. Measure and record the following airflows. Plot fan volumes on fan curve.
    - a. Supply-air volume.
    - b. Return-air flow.
    - c. Outdoor-air flow.
- B. After startup, change filters, verify bearing lubrication, and adjust belt tension.
- C. Remove and replace components that do not properly operate and repeat startup procedures as specified above.

- D. Prepare written report of the results of startup services.

### 3.5 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Occupancy Adjustments: When requested within **12** months 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.

### 3.6 DEMONSTRATION

- A. **Engage a factory-authorized service representative to train** Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 237433

## SECTION 238219 - FAN COIL UNITS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes fan-coil units and accessories.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

#### 1.4 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, based on input from installers of the items involved:
  - 1. Ceiling suspension components.
  - 2. Structural members to which fan-coil units 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. Field quality-control test reports.
- C. Warranty: Special warranty specified in this Section.

## 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fan-coil units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
  - 1. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

## 1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Fan-Coil-Unit Filters: Furnish 2 spare filters for each filter installed.
  - 2. Fan Belts: Furnish: 2 spare fan belts for each unit installed.

## 1.7 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. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

## 1.8 COORDINATION

- A. Coordinate layout and installation of fan-coil units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
- B. Coordinate size and location of wall sleeves for outdoor-air intake.

## 1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of condensing units that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Compressor failure.

- b. Condenser coil leak.
2. Warranty Period: **Five** years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 DUCTED FAN-COIL UNITS

- A. Basis-of-Design Product: Daikin as specified on drawings or a comparable product by one of the following:
- B. **Available** Manufacturers:
  - 1. Carrier Corporation.
  - 2. Engineered Air Ltd.
  - 3. Environmental Technologies, Inc.
  - 4. First Co.
  - 5. International Environmental Corporation.
  - 6. Marlo Coil; Subsidiary of Engineered Support Systems, Inc.
  - 7. Marshall Engineered Products Co., LLC (MEPCO); Dunham-Bush, Inc.
  - 8. McQuay International.
  - 9. Rosemex.
  - 10. Trane.
  - 11. USA Coil & Air.
  - 12. YORK International Corporation.
- C. Description: Factory-packaged and -tested units rated according to ARI 440, ASHRAE 33, and UL 1995.
- D. Coil Section Insulation: **1/2-inch (13-mm)** thick **foil-faced** glass fiber complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
  - 1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
  - 2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- E. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
- F.
  - 1. Pleated Cotton-Polyester Media: 90 percent arrestance and 11 MERV.
- G. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with fuses in terminal box for overcurrent protection and limit controls for high-temperature

protection of heaters. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.

- H. Direct-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.
- I. Belt-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the cabinet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.
  - 1. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
- J. Remote Condensing Units: Factory assembled and tested, consisting of compressors, condenser coils, fans, motors, refrigerant receiver, and operating controls. Construct, test, and rate condensing units according to ARI 210/240 and ASHRAE 15.
  - 1. Casing: Steel with baked-enamel finish, removable panels for access to controls, weep holes for water drainage, and mounting holes in base.
  - 2. Compressor: Hermetic, **scroll or reciprocating** type; internally isolated for vibration with factory-installed safety devices as follows:
    - a. Antirecycle timer.
    - b. High-pressure cutout.
    - c. Low-pressure cutout or loss-of-charge switch.
    - d. Internal thermal-overload protection.
    - e. Current and voltage sensitive safety devices.
  - 3. Compressor Motor: Start capacitor, relay, and contactor. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
  - 4. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IESNA 90.1, "Energy Standard for Buildings except Low-Rise Residential Buildings."
  - 5. Refrigerant Piping Materials: ASTM B 743 copper tube with wrought-copper fittings and brazed joints.
  - 6. Refrigerant: **R-410A**.
  - 7. Refrigerant: R-410A.
  - 8. Low ambient controls to permit operation down to 45 deg F (7 deg C).
  - 9. Crankcase heater.
  - 10. Charging and service fittings on exterior of casing.
  - 11. Filter dryer.
  - 12. Condenser: Copper-tube, aluminum-fin coil, with liquid subcooler.
  - 13. Condenser Fan: Direct-drive, aluminum propeller fan.
    - a. Motor: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
  - 14. Accessories: Polyethylene mounting base to provide a permanent foundation.

- K. Control devices and operational sequence are specified in Division 23 Section "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls."
- L. Basic Unit Controls:
  - 1. Control voltage transformer.
  - 2. **Wall-mounting** thermostat with the following features.
    - a. Heat-cool-off switch.
    - b. Fan on-auto switch.
    - c. Fan-speed switch.
    - d. **Manual** changeover.
    - e. Adjustable deadband.
    - f. Occupied Periods: Open damper to fixed position for **25** percent outdoor air.
    - g. Unoccupied Periods: Close damper.
  - 3. Outdoor-Air Damper Operation:
    - a. Occupied Periods:
      - 1) Outdoor-Air Temperature below Room Temperature: If room temperature is above room-temperature set point, modulate outdoor- and return-air dampers to maintain room-temperature set point (outdoor-air economizer). If room temperature is below set point, position damper to fixed minimum setting.
      - 2) Outdoor-Air Temperature above Room Temperature: Position damper to fixed minimum position for **25** percent outdoor air.
    - b. Unoccupied Periods: Close outdoor-air damper and open return-air damper.
  - 4. Controller shall have volatile-memory backup.
- M. Electrical Connection: Factory wire motors and controls for a single electrical connection.
- N. Capacities and Characteristics: See schedules

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas to receive fan-coil units for compliance with requirements for installation tolerances and other conditions affecting performance.



- B. Examine roughing-in for piping and electrical connections to verify actual locations before fan-coil-unit installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install fan-coil units level and plumb.
- B. Install fan-coil units to comply with NFPA 90A.
- C. Suspend fan-coil units from structure with elastomeric hangers.
- D. Verify locations of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices **48 inches (1220 mm)** above finished floor.
- E. Install new filters in each fan-coil unit within two weeks after Substantial Completion.

### 3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
  - 1. Install piping adjacent to machine to allow service and maintenance.
  - 2. Connect piping to fan-coil-unit factory hydronic piping package. Install piping package if shipped loose.
  - 3. Connect condensate drain to indirect waste.
    - a. Install condensate trap of adequate depth to seal against the pressure of fan. Install cleanouts in piping at changes of direction.
- B. Connect supply and return ducts to fan-coil units with flexible duct connectors specified in Division 23 Section "Air Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

### 3.4 FIELD QUALITY CONTROL

- A. **Manufacturer's Field Service:** Engage a factory-authorized service representative to inspect, **test, and adjust** field-assembled components and equipment installation, including connections, **and to assist in field testing**. Report results in writing.

- B. Perform the following field tests and inspections and prepare test reports:
  - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
  - 3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.

### 3.5 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to **two** visits to Project during other than normal occupancy hours for this purpose.

### 3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fan-coil units. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 238219

## SECTION 238239

### UNIT HEATERS

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- A. Section Includes:
  - 1. Cabinet unit heaters with centrifugal fans and **electric-resistance heating** coils.
  - 2. Propeller unit heaters with **electric-resistance heating** coils.

##### 1.3 DEFINITIONS

- A. Cold working pressure.
- B. PTFE: Polytetrafluoroethylene plastic.
- C. TFE: Tetrafluoroethylene plastic.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.
- B. LEED Submittals:
  - 1. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
- C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 1. Plans, elevations, sections, and details.
  - 2. Location and size of each field connection.
  - 3. Details of anchorages and attachments to structure and to supported equipment.

4. Equipment schedules to include rated capacities, operating characteristics, furnished specialties, and accessories.
5. Location and arrangement of piping valves and specialties.
6. Location and arrangement of integral controls.
7. Wiring Diagrams: Power, signal, and control wiring.

D. Samples for Initial Selection: Finish colors for units with factory-applied color finishes.

E. Samples for Verification: Finish colors for each type of cabinet unit heater and wall and ceiling heaters indicated with factory-applied color finishes.

## 1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

## 1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Cabinet Unit Heater Filters: Furnish **one** spare filter(s) for each filter installed.

## 1.7 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. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

## PART 2 - PRODUCTS

### 2.1 CABINET UNIT HEATERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Airtherm; a Mestek Company.

UNIT HEATERS

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2. Berko Electric Heating; a division of Marley Engineered Products.
3. Carrier Corporation.
4. Chromalox, Inc.; a division of Emerson Electric Company.
5. Dunham-Bush, Inc.
6. Engineered Air Ltd.
7. Indeeco.
8. International Environmental Corporation.
9. Markel Products; a division of TPI Corporation.
10. Marley Electric Heating; a division of Marley Engineered Products.
11. McQuay International.
12. Ouellet Canada Inc.
13. QMark Electric Heating; a division of Marley Engineered Products.
14. Rosemex Products.
15. Trane.
16. USA Coil & Air.

B. Description: A factory-assembled and -tested unit complying with ARI 440.

1. Comply with UL 2021.

C. Coil Section Insulation: 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 (13 mm)**.
2. Thermal Conductivity (k-Value): **0.24 Btu x in./h x sq. ft. at 75 deg F (0.034 W/m x K at 24 deg C)** 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.

D. Cabinet: Steel with **baked-enamel finish with manufacturer's standard paint, in color selected by Architect.**

1. Vertical Unit, Exposed Front Panels: Minimum **0.0528-inch- (1.35-mm-)**thick, sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.
2. Horizontal Unit, Exposed Bottom Panels: Minimum **0.0528-inch- (1.35-mm-)** thick, sheet steel, removable panels secured with tamperproof cam fasteners and safety chain.
3. Recessing Flanges: Steel, finished to match cabinet.
4. Control Access Door: Key operated.
5. Base: Minimum **0.0528-inch- (1.35-mm-)** thick steel, finished to match cabinet, **4 inches (100 mm)** high with leveling bolts.
6. Extended Piping Compartment: **8-inch- (200-mm-)** wide piping end pocket.

7. False Back: Minimum 0.0428-inch- (1.1-mm-) thick steel, finished to match cabinet.
- E. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
  1. Washable Foam: 70 percent arrestance and 3 MERV.
  2. Glass Fiber Treated with Adhesive: 80 percent arrestance and 5 MERV.
  3. Pleated: 90 percent arrestance and 7 MERV.
- F. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.
- G. 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 Division 23 Section "Common Motor Requirements for HVAC Equipment."
  3. Wiring Terminations: Connect motor to chassis wiring with plug connection.
- H. Control devices and operational sequences are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls."
- I. Basic Unit Controls:
  1. Control voltage transformer.
  2. **Wall-mounting** thermostat with the following features.
    - a. Heat-off switch.
    - b. Fan on-auto switch.
    - c. Manual fan speed switch.
    - d. Adjustable deadband.
    - e. **Concealed** set point.
    - f. **Concealed** indication.
    - g. **Deg F** indication.
- J. Electrical Connection: Factory wire motors and controls for a single field connection.

## 2.2 PROPELLER UNIT HEATERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Airtherm; a Mestek Company.
  2. Engineered Air Ltd.
  3. McQuay International.
  4. Rosemex Products.
  5. Ruffneck Heaters; a division of Lexa Corporation.
  6. Trane.
- B. Description: An assembly including casing, coil, fan, and motor in **vertical** discharge configuration with adjustable discharge louvers.
- C. Comply with UL 2021.
- D. Comply with UL 823.
- E. Cabinet: Removable panels for maintenance access to controls.
- F. Cabinet Finish: Manufacturer's **standard** baked enamel applied to factory-assembled and -tested propeller unit heater before shipping.
- G. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- H. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.
- I. General Coil Requirements: Test and rate **hot-water** propeller unit heater coils according to ASHRAE 33.
- J. Electric-Resistance Heating Elements: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in steel or corrosion-resistant metallic sheath with fins no closer than **0.16 inch (4 mm)**. Element ends shall be enclosed in terminal box. Fin surface temperature shall not exceed **550 deg F (288 deg C)** at any point during normal operation.
1. Circuit Protection: One-time fuses in terminal box for overcurrent protection and limit controls for high-temperature protection of heaters.
  2. Wiring Terminations: Stainless-steel or corrosion-resistant material.
- K. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.
- L. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Type: Permanently lubricated, **explosion proof**
- M. Control Devices:
1. **Unit-mounted** thermostat.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas to receive unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.
- 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 Division 07 Section "Joint Sealants."
- B. Install cabinet unit heaters to comply with NFPA 90A.
- C. Install propeller unit heaters level and plumb.
- D. Suspend cabinet unit heaters from structure with elastomeric hangers
- E. Suspend propeller unit heaters from structure with all-thread hanger rods. Hanger rods and attachments to structure are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Vibration hangers are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- F. Install wall-mounting 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.
- G. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

### 3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.



- C. 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 Division 23 Section "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 unit heater. Hydronic specialties are specified in Division 23 Section "Hydronic Piping."
- G. Unless otherwise indicated, install union and gate or ball valve on steam-supply connection and union, strainer, steam trap, and gate or ball valve on condensate-return connection of unit heater. Steam specialties are specified in Division 23 Section "Steam and Condensate Heating Piping."
- H. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- I. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

#### 3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
  - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
  - 3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- B. Remove and replace malfunctioning units and retest as specified above.

#### 3.5 ADJUSTING

- A. Adjust initial temperature set points.
- B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to **two** visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cabinet unit heaters. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 238239

## SECTION 260519

### LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Building wires and cables rated 600 V and less.
  - 2. Connectors, splices, and terminations rated 600 V and less.
- B. Related Sections include the following:
  - 1. Division 27 Section "Communications Horizontal Cabling" for cabling used for voice and data circuits.

##### 1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

##### 1.4 ACTION SUBMITTALS

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

##### 1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

## PART 2 - PRODUCTS

### 2.1 CONDUCTORS AND CABLES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  1. Alcan Products Corporation; Alcan Cable Division.
  2. American Insulated Wire Corp.; a Leviton Company.
  3. General Cable Corporation.
  4. Senator Wire & Cable Company.
  5. Southwire Company.
- B. Copper Conductors: Comply with NEMA WC 70.
- C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN, and XHHW.

### 2.2 CONNECTORS AND SPLICES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  1. AFC Cable Systems, Inc.
  2. Hubbell Power Systems, Inc.
  3. O-Z/Gedney; EGS Electrical Group LLC.
  4. 3M; Electrical Products Division.
  5. Tyco Electronics Corp.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

## PART 3 - EXECUTION

### 3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper for feeders smaller than No. 4 AWG; copper for feeders No. 4 AWG and larger. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

### 3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type XHHW, single conductors in raceway.
- B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-THWN, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- E. Exposed Branch Circuits, Including in Crawlspace: Type THHN-THWN, single conductors in raceway.
- F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.
- G. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- H. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- I. Class 2 Control Circuits: Type THHN-THWN, in raceway.

### 3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

- E. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."
- F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

### 3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

### 3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 26 Section "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

### 3.6 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping."

END OF SECTION

## SECTION 260526

### GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- A. Section Includes: Grounding systems and equipment.

##### 1.3 ACTION SUBMITTALS

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

##### 1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

#### PART 2 - PRODUCTS

##### 2.1 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
  - 1. Stranded Conductors: ASTM B 8.
  - 2. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
  - 3. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; **1-5/8 inches** wide and **1/16 inch** thick.

- C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

## 2.2 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.
  - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

## 2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad; 3/4 inch by 10 feet in diameter.

## PART 3 - EXECUTION

### 3.1 APPLICATIONS

- A. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum.
  - 1. Bury at least 24 inches below grade.
  - 2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.
- B. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- C. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.



1. Install bus on insulated spacers **2 inches** minimum from wall, **6 inches** above finished floor unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down to specified height above floor; connect to horizontal bus.

D. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Structural Steel: Welded connectors.

### 3.2 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
1. Feeders and branch circuits.
  2. Receptacle circuits.
  3. Single-phase motor and appliance branch circuits.
  4. Three-phase motor and appliance branch circuits.
  5. Flexible raceway runs.
  6. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
- C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
- F. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate

conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

- G. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.
  - 1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
  - 2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-12-inch grounding bus.
  - 3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- H. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

### 3.3 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.
  - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
  - 2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
  - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
  - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
  - 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- D. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
  2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
- E. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.
- F. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

### 3.4 LABELING

- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems" Article for instruction signs. The label or its text shall be green.
- B. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.
1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

END OF SECTION

## SECTION 260529

### HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Hangers and supports for electrical equipment and systems.
  - 2. Construction requirements for concrete bases.
- B. Related Sections include the following:
  - 1. Division 26 Section "Vibration And Seismic Controls For Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

##### 1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

##### 1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For the following:
  - 1. Steel slotted support systems.

#### 1.6 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

#### 1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

### PART 2 - PRODUCTS

#### 2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Allied Tube & Conduit.
    - b. Cooper B-Line, Inc.; a division of Cooper Industries.
    - c. ERICO International Corporation.
    - d. GS Metals Corp.
    - e. Thomas & Betts Corporation.
    - f. Unistrut; Tyco International, Ltd.
    - g. Wesanco, Inc.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
  3. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
  4. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
    - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      - 1) Hilti Inc.
      - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      - 3) MKT Fastening, LLC.
      - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
  2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
    - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
      - 2) Empire Tool and Manufacturing Co., Inc.
      - 3) Hilti Inc.
      - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      - 5) MKT Fastening, LLC.
  3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.

4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Hanger Rods: Threaded steel.

## 2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

## PART 3 - EXECUTION

### 3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
  1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

### 3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified

loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb .

- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
  - 1. To New Concrete: Bolt to concrete inserts.
  - 2. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
  - 3. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
  - 4. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

### 3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

### 3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section Cast-in-Place Concrete."
- C. Anchor equipment to concrete base.
  - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.



2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

### 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 minimum dry film thickness of 2.0 mils .
- B. Touchup: Comply with requirements in Division 09 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

## SECTION 260533

### RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

###### A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Metal wireways and auxiliary gutters.
4. Surface raceways.
5. Boxes, enclosures, and cabinets.
6. Handholes and boxes for exterior underground cabling.

###### B. Related Requirements:

1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.
2. Division 27 Section "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.
3. Division 28 Section "Pathways for Electronic Safety and Security" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving electronic safety and security.

##### 1.3 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid steel conduit.
- C. IMC: Intermediate metal conduit.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. LEED Submittals:
  - 1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
  - 4. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.

### PART 2 - PRODUCTS

#### 2.1 METAL CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - 1. AFC Cable Systems, Inc.
  - 2. Allied Tube & Conduit; a Tyco International Ltd. Co.
  - 3. Anamet Electrical, Inc.
  - 4. Electri-Flex Company.
  - 5. O-Z/Gedney; a brand of EGS Electrical Group.
  - 6. Picoma Industries, a subsidiary of Mueller Water Products, Inc.
  - 7. Republic Conduit.
  - 8. Robroy Industries.
  - 9. Southwire Company.
  - 10. Thomas & Betts Corporation.
  - 11. Western Tube and Conduit Corporation.

12. Wheatland Tube Company; a division of John Maneely Company.
- B. 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.
- C. GRC: Comply with ANSI C80.1 and UL 6.
- D. IMC: Comply with ANSI C80.6 and UL 1242.
- E. EMT: Comply with ANSI C80.3 and UL 797.
- F. FMC: Comply with UL 1; zinc-coated steel or aluminum.
- G. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
  1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
  2. Fittings for EMT:
    - a. Material: Steel.
    - b. Type: Compression.
  3. 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.
- I. 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.

## 2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
  1. AFC Cable Systems, Inc.
  2. Anamet Electrical, Inc.
  3. Arnco Corporation.
  4. CANTEX Inc.
  5. CertainTeed Corp.
  6. Condux International, Inc.
  7. Electri-Flex Company.
  8. Kraloy.

9. Lamson & Sessions; Carlon Electrical Products.
  10. Niedax-Kleinhuis USA, Inc.
  11. RACO; a Hubbell company.
  12. Thomas & Betts Corporation.
- B. Listing and Labeling: Nonmetallic 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.
- C. ENT: Comply with NEMA TC 13 and UL 1653.
- D. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- E. Rigid HDPE: Comply with UL 651A.
- F. RTRC: Comply with UL 1684A and NEMA TC 14.
- G. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- H. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## 2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Cooper B-Line, Inc.
  2. Hoffman; a Pentair company.
  3. Mono-Systems, Inc.
  4. Square D; a brand of Schneider Electric.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
1. 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.
- C. 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.
- D. Wireway Covers: Hinged type unless otherwise indicated.

- E. Finish: Manufacturer's standard enamel finish.

## 2.4 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Mono-Systems, Inc.
    - b. Panduit Corp.
    - c. Wiremold / Legrand.

## 2.5 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - 1. Adalet.
  - 2. Cooper Technologies Company; Cooper Crouse-Hinds.
  - 3. EGS/Appleton Electric.
  - 4. Erickson Electrical Equipment Company.
  - 5. FSR Inc.
  - 6. Hoffman; a Pentair company.
  - 7. Hubbell Incorporated; Killark Division.
  - 8. Kraloy.
  - 9. Milbank Manufacturing Co.
  - 10. Mono-Systems, Inc.
  - 11. O-Z/Gedney; a brand of EGS Electrical Group.
  - 12. RACO; a Hubbell Company.
  - 13. Robroy Industries.
  - 14. Spring City Electrical Manufacturing Company.
  - 15. Stahlin Non-Metallic Enclosures; a division of Robroy Industries.
  - 16. Thomas & Betts Corporation.
  - 17. Wiremold / Legrand.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy aluminum, Type FD, with gasketed cover.
- E. Metal Floor Boxes:
  - 1. Material: Cast metal.
  - 2. Type: Semi-adjustable.
  - 3. Shape: Rectangular.
  - 4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb .
  - 1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- H. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- I. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.
- J. Gangable boxes are allowed.
- K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
  - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
  - 2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

## 2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. General Requirements for Handholes and Boxes:
  - 1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
  - 2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Armorcast Products Company.
  - b. Carson Industries LLC.
  - c. CDR Systems Corporation; Hubbell Power Systems.
  - d. NewBasis.
  - e. Oldcastle Precast, Inc.; Christy Concrete Products.
  - f. Synertech Moulded Products; a division of Oldcastle Precast, Inc.
2. Standard: Comply with SCTE 77.
3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, "ELECTRIC."
7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. Handholes 12 Inches Wide by 24 Inches Long and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

C. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of polymer concrete reinforced concrete.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Armorcast Products Company.
  - b. Carson Industries LLC.
  - c. CDR Systems Corporation; Hubbell Power Systems.
  - d. NewBasis.
  - e. Nordic Fiberglass, Inc.
  - f. Oldcastle Precast, Inc.; Christy Concrete Products.
  - g. Synertech Moulded Products; a division of Oldcastle Precast, Inc.
2. Standard: Comply with SCTE 77.
3. Color of Frame and Cover: Gray Green.
4. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
5. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
6. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
7. Cover Legend: Molded lettering, "ELECTRIC."
8. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
9. Handholes 12 Inches Wide by 24 Inches Long and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.



## PART 3 - EXECUTION

### 3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed Conduit: IMC.
  2. Concealed Conduit, Aboveground: IMC.
  3. Underground Conduit: RNC, Type EPC-40-PVC concrete encased.
  4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
  5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: EMT.
  2. Exposed, Not Subject to Severe Physical Damage: EMT.
  3. Exposed and Subject to Severe Physical Damage: IMC. Raceway locations include the following:
    - a. Loading dock.
    - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    - c. Mechanical rooms.
  4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
  5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
  6. Damp or Wet Locations: IMC.
  7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Raceway Size: 3/4-inch trade size. 1/2" for drops to single devices are allowed.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
  2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
  3. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.

- 4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- F. Install surface raceways only where indicated on Drawings.
- G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

### 3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical Systems" for hangers and supports.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- H. A. Support conduit within 12 inches of enclosures to which attached.
- I. Raceways Embedded in Slabs:
  - 1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
  - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
  - 3. Arrange raceways to keep a minimum of 2 inches of concrete cover in all directions.
  - 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
  - 5. Change from ENT to IMC before rising above floor.

- J. Stub-ups to Above Recessed Ceilings:
  - 1. Use EMT.
  - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- L. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- O. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- Q. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- R. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- S. Surface Raceways:
  - 1. Install surface raceway with a minimum 2-inch radius control at bend points.
  - 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- T. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

- U. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
  - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
  - 2. Where an underground service raceway enters a building or structure.
  - 3. Where otherwise required by NFPA 70.
- V. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- W. Expansion-Joint Fittings:
  - 1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet . Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet .
  - 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
    - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
    - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
    - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
    - d. Attics: 135 deg F temperature change.
  - 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.00078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
  - 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
  - 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- X. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semi-recessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
  - 1. Use LFMC in damp or wet locations subject to severe physical damage.

2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- Y. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- Z. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- AA. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- BB. Locate boxes so that cover or plate will not span different building finishes.
- CC. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- DD. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- EE. Set metal floor boxes level and flush with finished floor surface.
- FF. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

### 3.3 INSTALLATION OF UNDERGROUND CONDUIT

- A. Direct-Buried Conduit:
  1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches in nominal diameter.
  2. Install backfill as specified in Division 31 Section "Earth Moving."
  3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
  4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.

5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
  - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
  - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
6. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits but a minimum of 6 inches below grade. Align planks along centerline of conduit.
7. Underground Warning Tape: Comply with requirements in Division 26 Section "Identification for Electrical Systems."

#### 3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.
- D. Install handholes with bottom below frost line, 48 below grade.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.
- F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

#### 3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 26 Section "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

### 3.6 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

### 3.7 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
  - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
  - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

## SECTION 26 05 43

### UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Conduit, ducts, and duct accessories for concrete-encased duct banks, and in single duct runs.

##### 1.3 DEFINITION

- A. RNC: Rigid nonmetallic conduit.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
  - 1. Duct-bank materials, including separators and miscellaneous components.
  - 2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
  - 3. Warning tape.
  - 4. Warning planks.

##### 1.5 INFORMATIONAL SUBMITTALS

- A. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.
  - 1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
  - 2. Drawings shall be signed and sealed by a qualified professional engineer.



## 1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- B. Comply with ANSI C2.
- C. Comply with NFPA 70.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.
- B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
- C. Lift and support precast concrete units only at designated lifting or supporting points.

## 1.8 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
  - 1. Notify Construction Manager Owner no fewer than two days in advance of proposed interruption of electrical service.
  - 2. Do not proceed with interruption of electrical service without Construction Manager's Owner's written permission.

## 1.9 COORDINATION

- A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.
- B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions

and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

## PART 2 - PRODUCTS

### 2.1 CONDUIT

- A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.
- B. RNC: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

### 2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

- A. Duct Accessories:
  - 1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
  - 2. Warning Tape: Underground-line warning tape specified in Division 26 Section "Identification for Electrical Systems."
  - 3. Concrete Warning Planks: Nominal 12 by 24 by 3 inches in size, manufactured from 6000-psi concrete.
    - a. Color: Red dye added to concrete during batching.
    - b. Mark each plank with "ELECTRIC" in 2-inch- high, 3/8-inch- deep letters.

### 2.3 UTILITY STRUCTURE ACCESSORIES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Bilco Company (The).
  - 2. Campbell Foundry Company.
  - 3. Carder Concrete Products.
  - 4. Christy Concrete Products.
  - 5. East Jordan Iron Works, Inc.
  - 6. Elmhurst-Chicago Stone Co.
  - 7. McKinley Iron Works, Inc.
  - 8. Neenah Foundry Company.

9. NewBasis.
  10. Oldcastle Precast Group.
  11. Osburn Associates, Inc.
  12. Pennsylvania Insert Corporation.
  13. Riverton Concrete Products; a division of Cretex Companies, Inc..
  14. Strongwell Corporation; Lenoir City Division.
  15. Underground Devices, Inc.
  16. Utility Concrete Products, LLC.
  17. Utility Vault Co.
  18. Wausau Tile, Inc.
- C. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch-diameter eye, and 1-by-4-inch bolt.
1. Working Load Embedded in 6-Inch , 4000-psi Concrete: 13,000-lbf minimum tension.
- D. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch-diameter eye, rated 2500-lbf minimum tension.
- E. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch- diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.
- F. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.
1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.
- G. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.
- H. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F . Capable of withstanding temperature of 300 deg F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.
- I. Cover Hooks: Heavy duty, designed for lifts 60 lbf and greater Light duty, designed for lifts less than 60 lbf . Two required.

### PART 3 - EXECUTION

### 3.1 UNDERGROUND DUCT APPLICATION

- A. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.
- B. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.
- C. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC, installed in concrete-encased duct bank, unless otherwise indicated.

### 3.2 EARTHWORK

- A. Excavation and Backfill: Comply with Division 31 Section "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Sections "Turf and Grasses" and "Plants."
- D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting and Patching."

### 3.3 DUCT INSTALLATION

- A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.
- B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations, unless otherwise indicated.
- C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

- D. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.
1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.
  2. Grout end bells into structure walls from both sides to provide watertight entrances.
- E. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
- F. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.
- G. Pulling Cord: Install 100-lbf- test nylon cord in ducts, including spares.
- H. Concrete-Encased Ducts: Support ducts on duct separators.
1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 5 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
  2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
    - a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
    - b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.
  3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
6. Minimum Space between Ducts: 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and signal ducts.
7. Depth: Install top of duct bank at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.
8. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
  - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
  - b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.
9. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches . Space additional tapes 12 inches apart, horizontally.

### 3.4 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

#### A. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C 891, unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

#### B. Elevations:

1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.
2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
3. Install handholes with bottom below the frost line, 48" below grade.

4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
  5. Where indicated, cast handhole cover frame integrally with handhole structure.
- C. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.
- D. Manhole Access: Circular opening in manhole roof; sized to match cover size.
1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
  2. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.
- E. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Division 07 Section Elastomeric Sheet Waterproofing After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.
- F. Dampproofing: Apply dampproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Division 07 Section "Bituminous Dampproofing." After ducts have been connected and grouted, and before backfilling, dampproof joints and connections and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.
- G. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.
- H. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.
- I. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.
- J. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

### 3.5 GROUNDING

- A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

### 3.6 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
  - 1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
  - 2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
- B. Correct deficiencies and retest as specified above to demonstrate compliance.

### 3.7 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

END OF SECTION



## SECTION 260544

### SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

#### 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. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Silicone sealants.

###### B. Related Requirements:

1. Division 07 Section "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

##### 1.3 ACTION SUBMITTALS

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

###### B. LEED Submittals:

1. Product Data for Credit EQ 4.1: For sealants, documentation including printed statement of VOC content.

#### PART 2 - PRODUCTS

##### 2.1 SLEEVES

###### A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

## 2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway 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 Company (The).
    - d. Pipeline Seal and Insulator, Inc.
    - e. Proco Products, Inc.
  2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  3. Pressure Plates: Stainless steel.
  4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

## 2.3 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Presealed Systems.

## 2.4 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
  1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

2. Sealant shall have VOC content of <Insert value> g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

### PART 3 - EXECUTION

#### 3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
  1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
    - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
    - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
  2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
  3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
  4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
  5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
  1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
  2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe 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.

### 3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install 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.

### 3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION

## SECTION 260553

### IDENTIFICATION FOR ELECTRICAL SYSTEMS

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- A. Section Includes:
  - 1. Identification for raceways.
  - 2. Identification of power and control cables.
  - 3. Identification for conductors.
  - 4. Underground-line warning tape.
  - 5. Warning labels and signs.
  - 6. Instruction signs.
  - 7. Equipment identification labels.
  - 8. Miscellaneous identification products.

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each electrical identification product indicated.

##### 1.4 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and IEEE C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

## 1.5 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

## PART 2 - PRODUCTS

### 2.1 POWER RACEWAY IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Colors for Raceways Carrying Circuits at 600 V or Less:
  - 1. Black letters on an orange field.
  - 2. Legend: Indicate voltage.
- C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- D. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

### 2.2 ARMORED AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Colors for Raceways Carrying Circuits at 600 V and Less:
  - 1. Black letters on an orange field.
  - 2. Legend: Indicate voltage.

- C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- D. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches wide; compounded for outdoor use.

### 2.3 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

### 2.4 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- C. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

### 2.5 UNDERGROUND-LINE WARNING TAPE

- A. Tape:
  - 1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
  - 2. Printing on tape shall be permanent and shall not be damaged by burial operations.

3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

C. Tag:

1. Pigmented polyolefin, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Thickness: 4 mils .
3. Weight: 18.5 lb/1000 sq. ft. .
4. 3-Inch Tensile According to ASTM D 882: 30 lbf , and 2500 psi .

## 2.6 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES ."

## 2.7 INSTRUCTION SIGNS

A. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch . Overlay shall provide a weatherproof and UV-resistant seal for label.

## 2.8 EQUIPMENT IDENTIFICATION LABELS

A. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch . Overlay shall provide a weatherproof and UV-resistant seal for label.



## 2.9 CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.
  - 1. Minimum Width: 3/16 inch .
  - 2. Tensile Strength at 73 deg F , According to ASTM D 638: 12,000 psi .
  - 3. Temperature Range: Minus 40 to plus 185 deg F .
  - 4. Color: Black except where used for color-coding.

## 2.10 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- F. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- G. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
  - 1. Outdoors: UV-stabilized nylon.
  - 2. In Spaces Handling Environmental Air: Plenum rated.
- H. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished

grade. Use multiple tapes where width of multiple lines installed in a common trench [or concrete envelope ]exceeds 16 inches overall.

- I. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

### 3.2 IDENTIFICATION SCHEDULE

- A. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

1. Emergency Power.

- B. Power-Circuit Conductor Identification, 600 V or Less: For conductors in pull and junction boxes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.

- a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG.

- b. Colors for 208/120-V Circuits:

- 1) Phase A: Black.
- 2) Phase B: Red.
- 3) Phase C: Blue.

- c. Colors for 480/277-V Circuits:

- 1) Phase A: Brown.
- 2) Phase B: Orange.
- 3) Phase C: Yellow.

- d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

- C. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

- D. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

2. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- E. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
1. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- F. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
1. Comply with 29 CFR 1910.145.
  2. Identify system voltage with black letters on an orange background.
  3. Apply to exterior of door, cover, or other access.
  4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
    - a. Power transfer switches.
    - b. Controls with external control power connections.
- G. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- H. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer.
- I. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
1. Labeling Instructions:
    - a. Indoor Equipment: Adhesive film label with clear protective overlay. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.
    - b. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
    - c. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
  2. Equipment to Be Labeled:

- a. Enclosures and electrical cabinets.
- b. Access doors and panels for concealed electrical items.
- c. Switchboards.
- d. Emergency system boxes and enclosures.
- e. Enclosed switches.
- f. Enclosed circuit breakers.
- g. Enclosed controllers.
- h. Variable-speed controllers.
- i. Push-button stations.
- j. Power transfer equipment.
- k. Contactors.
- l. Remote-controlled switches, dimmer modules, and control devices.
- m. Power-generating units.
- n. Monitoring and control equipment.

END OF SECTION

**SECTION 260923**  
**LIGHTING CONTROL DEVICES**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- A. Section Includes:

- 1. Time switches.
- 2. Photoelectric switches.
- 3. Standalone daylight-harvesting switching controls.
- 4. Indoor occupancy sensors.
- 5. Outdoor motion sensors.
- 6. Lighting contactors.

- B. Related Requirements:

- 1. Division 26 Section "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Shop Drawings: Show installation details for occupancy and light-level sensors.
  - 1. Interconnection diagrams showing field-installed wiring.
  - 2. Include diagrams for power, signal, and control wiring.

**1.4 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

## PART 2 - PRODUCTS

### 2.1 TIME SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Cooper Industries, Inc.
  2. Intermatic, Inc.
  3. Leviton Mfg. Company Inc.
  4. NSi Industries LLC; TORK Products.
  5. Tyco Electronics; ALR Brand.
- B. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  2. Contact Rating: 20-A ballast load, 120-/240-V ac.
  3. Programs: 8 channels; each channel is individually programmable with eight on-off set points on a 24-hour schedule.
  4. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program on selected channels.
  5. Astronomic Time: Selected channels.
  6. Automatic daylight savings time changeover.
  7. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.

### 2.2 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Cooper Industries, Inc.
  2. Intermatic, Inc.
  3. NSi Industries LLC; TORK Products.
  4. Tyco Electronics; ALR Brand.
- B. Description: Solid state, with SPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Light-Level Monitoring Range: 1.5 to 10 fc , with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off.
3. Time Delay: Fifteen second minimum, to prevent false operation.
4. Surge Protection: Metal-oxide varistor.
5. Mounting: Twist lock complies with NEMA C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

## 2.3 DAYLIGHT-HARVESTING SWITCHING CONTROLS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
  1. Cooper Industries, Inc.
  2. Eaton Corporation.
  3. Hubbell Building Automation, Inc.
  4. Leviton Mfg. Company Inc.
  5. Lithonia Lighting; Acuity Lighting Group, Inc.
  6. NSi Industries LLC; TORK Products.
  7. Sensor Switch, Inc.
  8. Tyco Electronics; ALR Brand.
  9. Watt Stopper.
- B. Ceiling-Mounted Switching Controls: Solid-state, light-level sensor unit, with separate power pack mounted on luminaire, to detect changes in indoor lighting levels that are perceived by the eye.
- C. Electrical Components, Devices, and Accessories:
  1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F .
  3. Sensor Output: Contacts rated to operate the associated power pack, complying with UL 773A. Sensor is powered by the power pack.
  4. Power Pack: Dry contacts rated for 20A ballast load at 120- and 277-V ac, for 13A tungsten at 120-V ac, and for 1hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
  5. General Space Sensors Light-Level Monitoring Range: 10 to 200 fc , with an adjustment for turn-on and turn-off levels within that range.
  6. Atrium Space Sensors Light-Level Monitoring Range: 100 to 1000 fc , with an adjustment for turn-on and turn-off levels within that range.
  7. Skylight Sensors Light-Level Monitoring Range: 1000 to 10,000 fc , with an adjustment for turn-on and turn-off levels within that range.
  8. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling.

9. Set-Point Adjustment: Equip with deadband adjustment of 25, 50, and 75 percent above the "on" set point, or provide with separate adjustable "on" and "off" set points.
10. Test Mode: User selectable, overriding programmed time delay to allow settings check.
11. Control Load Status: User selectable to confirm that load wiring is correct.
12. Indicator: Two digital displays to indicate the beginning of on-off cycles.

## 2.4 DAYLIGHT-HARVESTING DIMMING CONTROLS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
  1. Cooper Industries, Inc.
  2. Hubbell Building Automation, Inc.
  3. Leviton Mfg. Company Inc.
  4. Lithonia Lighting; Acuity Lighting Group, Inc.
  5. Watt Stopper.
- B. System Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.
  1. Lighting control set point is based on two lighting conditions:
    - a. When no daylight is present (target level).
    - b. When significant daylight is present.
  2. System programming is done with two hand-held, remote-control tools.
    - a. Initial setup tool.
    - b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.
- C. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with separate controller unit, to detect changes in lighting levels that are perceived by the eye.
  1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  2. Sensor Output: 0- to 10-V dc to operate electronic dimming ballasts. Sensor is powered by controller unit.
  3. Power Pack: Sensor has 24-V dc, Class 2 power source, as defined by NFPA 70.
  4. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc .

## 2.5 INDOOR OCCUPANCY SENSORS



- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Bryant Electric; a Hubbell company.
  2. Cooper Industries, Inc.
  3. Hubbell Building Automation, Inc.
  4. Leviton Mfg. Company Inc.
  5. Lithonia Lighting; Acuity Lighting Group, Inc.
  6. Lutron Electronics Co., Inc.
  7. Watt Stopper.
- B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
  3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
  4. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
  5. Mounting:
    - a. Sensor: Suitable for mounting in any position on a standard outlet box.
    - b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
    - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
  6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
  7. Bypass Switch: Override the "on" function in case of sensor failure.
  8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc ; turn lights off when selected lighting level is present.
- C. PIR Type: Ceiling mounted; detect occupants in coverage area by their heat and movement.
1. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. .
  2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.
  3. Detection Coverage (Corridor): Detect occupancy within 90 feet when mounted on a 10-foot- high ceiling.

- D. Ultrasonic Type: Ceiling mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy .
  - 1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s .
  - 2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. when mounted on a 96-inch- high ceiling.
  - 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.
  
- E. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
  - 1. Sensitivity Adjustment: Separate for each sensing technology.
  - 2. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. , and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s .
  - 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.

## 2.6 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - 1. Bryant Electric; a Hubbell company.
  - 2. Cooper Industries, Inc.
  - 3. Hubbell Building Automation, Inc.
  - 4. Leviton Mfg. Company Inc.
  - 5. Lightolier Controls.
  - 6. Lithonia Lighting; Acuity Lighting Group, Inc.
  - 7. Lutron Electronics Co., Inc.
  - 8. Watt Stopper.
  
- B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F .
  - 3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.

C. Wall-Switch Sensor Tag WS1:

1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft..
2. Sensing Technology: Dual technology - PIR and ultrasonic.
3. Switch Type: SP, field selectable automatic "on," or manual "on" automatic "off."
4. Voltage: 120 V.
5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc . The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
7. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

2.7 OUTDOOR MOTION SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Cooper Industries, Inc.
2. Hubbell Building Automation, Inc.
3. Leviton Mfg. Company Inc.
4. Lithonia Lighting; Acuity Lighting Group, Inc.
5. Watt Stopper.

B. General Requirements for Sensors: Solid-state outdoor motion sensors.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Dual-technology (PIR and infrared) type, weatherproof. Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. . Comply with UL 773A.
3. Switch Rating:
  - a. Lighting-Fixture-Mounted Sensor: 1000-W incandescent, 500-VA fluorescent.
  - b. Separately Mounted Sensor: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
4. Switch Type: SP, field selectable automatic "on," or manual "on" automatic "off." With bypass switch to override the "on" function in case of sensor failure.
5. Voltage: 120-V.
6. Detector Coverage:

- a. Standard Range: 210-degree field of view, with a minimum coverage area of 900 sq. ft. .
- 7. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc . The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
- 8. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
- 9. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and help eliminate false "off" switching.
- 10. Operating Ambient Conditions: Suitable for operation in ambient temperatures ranging from minus 40 to plus 130 deg F , rated as "raintight" according to UL 773A.

## 2.8 LIGHTING CONTACTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - 1. Allen-Bradley/Rockwell Automation.
  - 2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
  - 3. Eaton Corporation.
- B. Description: Electrically operated and mechanically held, combination-type lighting contactors with nonfused disconnect, complying with NEMA ICS 2 and UL 508.
  - 1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
  - 2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
  - 3. Enclosure: Comply with NEMA 250.
  - 4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

## 2.9 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

### PART 3 - EXECUTION

#### 3.1 SENSOR INSTALLATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

#### 3.2 CONTACTOR INSTALLATION

- A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

#### 3.3 WIRING INSTALLATION

- A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch .
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

#### 3.4 IDENTIFICATION

- A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."
  - 1. Identify controlled circuits in lighting contactors.
  - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

### 3.5 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
  - 1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
  - 2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
  - 3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

### 3.6 DEMONSTRATION

- A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control systems specified in Division 26 Section "Network Lighting Controls."
- B. Train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION

## SECTION 262413

### SWITCHBOARDS

#### 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. Service and distribution switchboards rated 600 V and less.
  - 2. Disconnecting and overcurrent protective devices.
  - 3. Identification.

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
- B. Shop Drawings: For each switchboard and related equipment.
  - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
  - 2. Detail enclosure types for types other than NEMA 250, Type 1.
  - 3. Detail bus configuration, current, and voltage ratings.
  - 4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
  - 5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
  - 6. Detail utility company's metering provisions with indication of approval by utility company.
  - 7. Include evidence of NRTL listing for series rating of installed devices.
  - 8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

9. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.
10. Include schematic and wiring diagrams for power, signal, and control wiring.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
  1. Routine maintenance requirements for switchboards and all installed components.
  2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
  3. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.

#### 1.5 MATERIALS MAINTENANCE SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
  2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
  3. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
  4. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
  5. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
  6. Indicating Lights: Equal to 10 percent of quantity installed for each size and type, but no fewer than one of each size and type.

#### 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
- B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.



- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. 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.
- E. Comply with NEMA PB 2.
- F. Comply with NFPA 70.
- G. Comply with UL 891.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.
- B. Remove loose packing and flammable materials from inside switchboards and install temporary electric heating (250 W per section) to prevent condensation.
- C. Handle and prepare switchboards for installation according to NEMA PB 2.1.

#### 1.8 PROJECT CONDITIONS

- A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.
- B. Environmental Limitations:
  - 1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
  - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
    - a. Ambient Temperature: Not exceeding 104 deg F .
    - b. Altitude: Not exceeding 6600 feet .
- C. Service Conditions: NEMA PB 2, usual service conditions, as follows:
  - 1. Ambient temperatures within limits specified.
  - 2. Altitude not exceeding 6600 feet .

- D. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of electric service.
  2. Indicate method of providing temporary electric service.
  3. Do not proceed with interruption of electric service without Construction Manager's written permission.
  4. Comply with NFPA 70E.

## 1.9 COORDINATION

- A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

## 1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Five years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURED UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  2. Siemens Energy & Automation, Inc.
  3. Square D; a brand of Schneider Electric.
  4. GE Energy. General Electric Company.
- B. Front-Connected, Front-Accessible Switchboards:

1. Main Devices: Fixed, individually mounted.
  2. Branch Devices: Panel mounted.
  3. Sections front and rear aligned.
- C. Nominal System Voltage: 208Y/120 V.
- D. Main-Bus Continuous: 2000A.
- E. Indoor Enclosures: Steel, NEMA 250, Type 1.
- F. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- G. Barriers: Between adjacent switchboard sections.
- H. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.
- I. Utility Metering Compartment: Fabricated, barrier compartment and section complying with utility company's requirements; hinged sealed door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.
- J. Customer Metering Compartment: A separate customer metering compartment and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks.
- K. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- L. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- M. Pull Box on Top of Switchboard:
1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
  2. Set back from front to clear circuit-breaker removal mechanism.
  3. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
  4. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
  5. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.
- N. Buses and Connections: Three phase, four wire unless otherwise indicated.

1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, with copper feeder circuit-breaker line connections.
2. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with mechanical connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
3. Ground Bus: 1/4-by-2-inch hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
4. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
5. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
6. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.

## 2.2 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
  1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
  2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
  3. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
    - a. Standard frame sizes, trip ratings, and number of poles.
    - b. Lugs: Mechanical] style, suitable for number, size, trip ratings, and conductor material.
- B. Insulated-Case Circuit Breaker (ICCB): 80 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.
  1. Fixed circuit-breaker mounting.
  2. Two-step, stored-energy closing.
  3. Standard-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
    - a. Instantaneous trip.
  4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
  5. Remote trip indication and control.

6. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
8. Control Voltage: 40-V dc.

### 2.3 IDENTIFICATION

- A. Presentation Media: Painted graphics in color contrasting with background color to represent bus and components, complete with lettered designations.
- B. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.
- B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.
- C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install switchboards and accessories according to NEMA PB 2.1.
- B. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."
  1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
  2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to switchboards.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.
- D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
- E. Install filler plates in unused spaces of panel-mounted sections.
- F. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.
  1. Set field-adjustable switches and circuit-breaker trip ranges.
- G. Comply with NECA 1.

### 3.3 CONNECTIONS

- A. Comply with requirements for terminating feeder bus specified in Division 26 Section "Enclosed Bus Assemblies." Drawings indicate general arrangement of bus, fittings, and specialties.
- B. Comply with requirements for terminating cable trays specified in Division 26 Section "Cable Trays for Electrical Systems." Drawings indicate general arrangement of cable trays, fittings, and specialties.

### 3.4 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

### 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. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- C. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  - 3. Perform the following infrared scan tests and inspections and prepare reports:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.
    - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
    - c. Instruments and Equipment:
      - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  - 4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Switchboard will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

### 3.6 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as indicated.

### 3.7 PROTECTION

- A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

### 3.8 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories.

END OF SECTION



## SECTION 262416

### PANELBOARDS

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- A. Section Includes:
  - 1. Distribution panelboards.
  - 2. Lighting and appliance branch-circuit panelboards.
  - 3. Load centers.

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
  - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
  - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
  - 3. Detail bus configuration, current, and voltage ratings.
  - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
  - 5. Include evidence of NRTL listing for series rating of installed devices.
  - 6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
  - 7. Include wiring diagrams for power, signal, and control wiring.
  - 8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
  - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
  - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

#### 1.6 MATERIALS MAINTENANCE SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Keys: Two spares for each type of panelboard cabinet lock.
  - 2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Two spares for each panelboard.
  - 3. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

#### 1.7 QUALITY ASSURANCE

- A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NEMA PB 1.
- E. Comply with NFPA 70.

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NEMA PB 1.

## 1.9 PROJECT CONDITIONS

- A. Environmental Limitations:
  - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
  - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
    - a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F .
    - b. Altitude: Not exceeding 1000 feet .
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
  - 1. Ambient temperatures within limits specified.
  - 2. Altitude not exceeding 1000 feet .
- C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
  - 1. Notify Construction Manager no fewer than two days in advance of proposed interruption of electric service.
  - 2. Do not proceed with interruption of electric service without Construction Manager's written permission.
  - 3. Comply with NFPA 70E.

## 1.10 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance

requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

#### 1.11 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

- 1. Warranty Period: Five years from date of Substantial Completion.

### PART 2 - PRODUCTS

#### 2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Enclosures: Flush- and surface-mounted cabinets.
  - 1. Rated for environmental conditions at installed location.
    - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
  - 2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
  - 3. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
  - 4. Finishes:
    - a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
    - b. Back Boxes: Same finish as panels and trim.
  - 5. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.
- B. Incoming Mains Location: Top and bottom.
- C. Phase, Neutral, and Ground Buses:
  - 1. Material: Hard-drawn copper, 98 percent conductivity.
  - 2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
- D. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Hard-drawn copper, 98 percent conductivity.
  2. Main and Neutral Lugs: Mechanical type.
  3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
  4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
  5. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
- E. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.
- F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- G. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

## 2.2 DISTRIBUTION PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  2. Siemens Energy & Automation, Inc.
  3. GE Energy. General Electric Company.
  4. Square D; a brand of Schneider Electric
- B. Panelboards: NEMA PB 1, power and feeder distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
1. For doors more than 36 inches high, provide two latches, keyed alike.
- D. Mains: Circuit breaker.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
- F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

## 2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  - 2. Siemens Energy & Automation, Inc.
  - 3. GE Energy. General Electric Company.
  - 4. Square D; a brand of Schneider Electric
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Circuit breaker.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.\
- E. Contactors can be incorporated to switch the entire panelboard or only a portion of the circuits. Coordinate with Drawings and schedules to indicate contactor connections, type, quantity of circuits controlled, current ratings, external control circuits, and number of poles. Consult manufacturers for their respective limitations on and availability of short-circuit ratings and electrically held contactors, which may not be available from all manufacturers.
- F. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
- G. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

## 2.4 LOAD CENTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  - 2. Siemens Energy & Automation, Inc.
  - 3. GE Energy. General Electric Company.
  - 4. Square D; a brand of Schneider Electric.
- B. Load Centers: Comply with UL 67.
- C. Mains: Circuit breaker.
- D. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.
- E. Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.

## 2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  - 2. Siemens Energy & Automation, Inc.
  - 3. GE Energy. General Electric Company.
  - 4. Square D; a brand of Schneider Electric.
  
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
  - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
  - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
  - 3. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
  - 4. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
  - 5. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
  - 6. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
    - a. Standard frame sizes, trip ratings, and number of poles.
    - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
    - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
  
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
  
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Equipment Mounting: Install panelboards on concrete bases, 4-inch nominal thickness. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."
  - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
  - 2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 4. Install anchor bolts to elevations required for proper attachment to panelboards.
  - 5. Attach panelboard to the vertical finished or structural surface behind the panelboard.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- D. Mount top of trim 90 inches above finished floor unless otherwise indicated.
- E. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- F. Install overcurrent protective devices and controllers not already factory installed.
  - 1. Set field-adjustable, circuit-breaker trip ranges.
- G. Install filler plates in unused spaces.
- H. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.
- I. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- J. Comply with NECA 1.

### 3.3 IDENTIFICATION



- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

### 3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- C. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  - 3. Perform the following infrared scan tests and inspections and prepare reports:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
    - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
    - c. Instruments and Equipment:
      - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

- D. Panelboards will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

### 3.5 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as indicated.
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
  - 1. Measure as directed during period of normal system loading.
  - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
  - 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
  - 4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

### 3.6 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION

**SECTION 262713**  
**ELECTRICITY METERING**

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 equipment for electricity metering by utility company.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For electricity-metering equipment.
  - 1. Dimensioned plans and sections or elevation layouts.
  - 2. Wiring Diagrams: For power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features.

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.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Receive, store, and handle modular meter center according to NECA 400.

1.6 COORDINATION

- A. Electrical Service Connections: Coordinate with utility companies and components they furnish as follows:

1. Comply with requirements of utilities providing electrical power services.
2. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

## PART 2 - PRODUCTS

### 2.1 EQUIPMENT FOR ELECTRICITY METERING BY UTILITY COMPANY

- A. Meters will be furnished by utility company.
- B. Current-Transformer Cabinets: Comply with requirements of electrical-power utility company.
- C. Meter Sockets: Comply with requirements of electrical-power utility company.
- D. Meter Sockets: Steady-state and short-circuit current ratings shall meet indicated circuit ratings.
- E. Modular Meter Center: Factory-coordinated assembly of a main service terminal box with lugs only, wireways, tenant meter socket modules, and tenant feeder circuit breakers arranged in adjacent vertical sections. Assembly shall be complete with interconnecting buses and other features as specified below.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
    - b. Siemens Energy & Automation, Inc.
    - c. GE Energy, General Electric Company.
    - d. Square D; a brand of Schneider Electric.
  2. Comply with requirements of utility company for meter center.
  3. Housing: NEMA 250, Type 1 enclosure.
  4. Minimum Short-Circuit Rating: 42,000A symmetrical at rated voltage.
  5. Tenant Feeder Circuit Breakers: Series-combination-rated molded-case units, rated to protect circuit breakers in downstream tenant and to house loadcenters and panelboards that have 10,000-A interrupting capacity.
    - a. Identification: Complying with requirements in Division 26 Section "Identification for Electrical Systems" with legend identifying tenant's address.
    - b. Physical Protection: Tamper resistant, with hasp for padlock.
  6. Meter Socket: Rating coordinated with indicated tenant feeder circuit rating.
  7. Surge Protection: For main disconnect device, comply with requirements in Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits."

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Comply with equipment installation requirements in NECA 1.
- B. Install meters furnished by utility company. Install raceways and equipment according to utility company's written requirements. Provide empty conduits for metering leads and extend grounding connections as required by utility company.
- C. Install modular meter center according to NECA 400 switchboard installation requirements.

### 3.2 IDENTIFICATION

- A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
  - 1. Series Combination Warning Label: Self-adhesive type, with text as required by NFPA 70.
  - 2. Equipment Identification Labels: Adhesive film labels with clear protective overlay. For residential meters, provide an additional card holder suitable for typewritten card with occupant's name.

END OF SECTION

## SECTION 262726

### WIRING DEVICES

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- A. Section Includes:
  - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
  - 2. Isolated-ground receptacles.
  - 3. Weather-resistant receptacles.
  - 4. Snap switches and wall-box dimmers.
  - 5. Solid-state fan speed controls.
  - 6. Wall-switch and exterior occupancy sensors.
  - 7. Pendant cord-connector devices.
  - 8. Cord and plug sets.

##### 1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.

##### 1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
  - 1. Receptacles for Owner-Furnished Equipment: Match plug configurations.
  - 2. Cord and Plug Sets: Match equipment requirements.

## 1.5 ACTION SUBMITTALS

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

## 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
  - 1. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
  - 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
  - 3. Leviton Mfg. Company Inc. (Leviton).
  - 4. Pass & Seymour/Legrand (Pass & Seymour).
- B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

### 2.2 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
  - 1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
  - 2. Devices shall comply with the requirements in this Section.

## 2.3 STRAIGHT-BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Cooper; 5351 (single), CR5362 (duplex).
    - b. Hubbell; HBL5351 (single), HBL5352 (duplex).
    - c. Leviton; 5891 (single), 5352 (duplex).
    - d. Pass & Seymour; 5361 (single), 5362 (duplex).
- B. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Cooper; IG5362RN.
    - b. Hubbell; IG5362.
    - c. Leviton; 5362-IG.
    - d. Pass & Seymour; IG5362.
  2. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

## 2.4 GFCI RECEPTACLES

- A. General Description:
1. Straight blade, feed-through type.
  2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
  3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
- B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Cooper; VGF20.
    - b. Hubbell; GFR5352L.
    - c. Pass & Seymour; 2095.
    - d. Leviton; 7590.



## 2.5 PENDANT CORD-CONNECTOR DEVICES

### A. Description:

1. Matching, locking-type plug and receptacle body connector.
2. NEMA WD 6 Configurations L5-20P and L5-20R, heavy-duty grade, and FS W-C-596.
3. Body: Nylon, with screw-open, cable-gripping jaws and provision for attaching external cable grip.
4. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

## 2.6 CORD AND PLUG SETS

### A. Description:

1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.
3. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

## 2.7 TOGGLE SWITCHES

### A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

### B. Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Single Pole:
    - 1) Cooper; AH1221.
    - 2) Hubbell; HBL1221.
    - 3) Leviton; 1221-2.
    - 4) Pass & Seymour; CSB20AC1.
  - b. Two Pole:
    - 1) Cooper; AH1222.
    - 2) Hubbell; HBL1222.
    - 3) Leviton; 1222-2.
    - 4) Pass & Seymour; CSB20AC2.

- c. Three Way:
  - 1) Cooper; AH1223.
  - 2) Hubbell; HBL1223.
  - 3) Leviton; 1223-2.
  - 4) Pass & Seymour; CSB20AC3.

C. Pilot-Light Switches, 20 A:

- 1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Cooper; AH1221PL for 120 and 277 V.
  - b. Hubbell; HBL1201PL for 120 and 277 V.
  - c. Leviton; 1221-LH1.
  - d. Pass & Seymour; PS20AC1RPL for 120 V, PS20AC1RPL7 for 277 V.
- 2. Description: Single pole, with neon-lighted handle, illuminated when switch is "off."

D. Key-Operated Switches, 120/277 V, 20 A:

- 1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Cooper; AH1221L.
  - b. Hubbell; HBL1221L.
  - c. Leviton; 1221-2L.
  - d. Pass & Seymour; PS20AC1-L.
- 2. Description: Single pole, with factory-supplied key in lieu of switch handle.

## 2.8 DECORATOR-STYLE DEVICES

A. Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, and UL 498.

- 1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Cooper; 6252.
  - b. Hubbell; DR15.
  - c. Leviton; 16252.
  - d. Pass & Seymour; 26252.

B. GFCI, [Feed] [Non-Feed]-Through Type, Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, UL 498, and UL 943 Class A.

- 1. Products: Subject to compliance with requirements, provide one of the following:

- a. Cooper; VGF15.
  - b. Hubbell; GF15LA.
  - c. Leviton; 8599.
  - d. Pass & Seymour; 1594.
- C. Toggle Switches, Square Face, 120/277 V, 15 A: Comply with NEMA WD 1, UL 20, and FS W-S-896.
- 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Cooper; 7621 (single pole), 7623 (three way).
    - b. Hubbell; DS115 (single pole), DS315 (three way).
    - c. Leviton; 5621-2 (single pole), 5623-2 (three way).
    - d. Pass & Seymour; 2621 (single pole), 2623 (three way).

## 2.9 RESIDENTIAL DEVICES

### A. Fan Speed Controls:

- 1. Modular, 120-V, full-wave, solid-state units with integral, quiet on-off switches and audible frequency and EMI/RFI filters.
- 2. Comply with UL 1917.
- 3. Continuously adjustable rotary knob, 5 A.

## 2.10 WALL PLATES

### A. Single and combination types shall match corresponding wiring devices.

- 1. Plate-Securing Screws: Metal with head color to match plate finish.
- 2. Material for Finished Spaces: Steel with white baked enamel, suitable for field painting.
- 3. Material for Unfinished Spaces: Galvanized steel.
- 4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

### B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

## 2.11 FINISHES

### A. Device Color:

- 1. Wiring Devices Connected to Normal Power System: White unless otherwise indicated or required by NFPA 70 or device listing.
- 2. Wiring Devices Connected to Emergency Power System: Red.
- 3. Isolated-Ground Receptacles: Orange.

- B. Wall Plate Color: For plastic covers, match device color.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
  - 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
  - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
  - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
  - 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
  - 1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
  - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
  - 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
  - 4. Existing Conductors:
    - a. Cut back and pigtail, or replace all damaged conductors.
    - b. Straighten conductors that remain and remove corrosion and foreign matter.
    - c. Pigtailling existing conductors is permitted, provided the outlet box is large enough.
- D. Device Installation:
  - 1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
  - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.

3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.
2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

### 3.2 GFCI RECEPTACLES

- A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

### 3.3 IDENTIFICATION

- A. Comply with Division 26 Section "Identification for Electrical Systems."

### 3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:

1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
2. Test Instruments: Use instruments that comply with UL 1436.
3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

- B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

- C. Wiring device will be considered defective if it does not pass tests and inspections.

- D. Prepare test and inspection reports.

END OF SECTION

## SECTION 262813

### FUSES

#### 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. Cartridge fuses rated 600-V ac and less for use in control circuits, and enclosed switches.
  - 2. Plug-fuse adapters for use in Edison-base, plug-fuse sockets.

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
  - 1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
    - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
    - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
  - 2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
  - 3. Current-limitation curves for fuses with current-limiting characteristics.
  - 4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
  - 5. Coordination charts and tables and related data.
  - 6. Fuse sizes for elevator feeders and elevator disconnect switches.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
  - 1. Ambient temperature adjustment information.
  - 2. Current-limitation curves for fuses with current-limiting characteristics.
  - 3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
  - 4. Coordination charts and tables and related data.

#### 1.5 MATERIALS MAINTENANCE SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

#### 1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Comply with UL 248-11 for plug fuses.

#### 1.7 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

#### 1.8 COORDINATION



- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Cooper Bussmann, Inc.
  - 2. Edison Fuse, Inc.
  - 3. Ferraz Shawmut, Inc.
  - 4. Littelfuse, Inc.

### 2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 FUSE APPLICATIONS

- A. Cartridge Fuses:

1. Motor Branch Circuits: Class RK1, time delay.

### 3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install plug-fuse adapters in Edison-base fuseholders and sockets. Ensure that adapters are irremovable once installed.

### 3.4 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION

## SECTION 262816

### ENCLOSED SWITCHES AND CIRCUIT BREAKERS

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- A. Section Includes:
  - 1. Fusible switches.
  - 2. Nonfusible switches.
  - 3. Shunt trip switches.
  - 4. Molded-case circuit breakers (MCCBs).
  - 5. Molded-case switches.
  - 6. Enclosures.

##### 1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
  - 1. Enclosure types and details for types other than NEMA 250, Type 1.
  - 2. Current and voltage ratings.
  - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
  - 4. Include evidence of NRTL listing for series rating of installed devices.
  - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.
- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
1. Wiring Diagrams: For power, signal, and control wiring.

## 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
  2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

## 1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NFPA 70.

## 1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F .
  2. Altitude: Not exceeding 6600 feet .

- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
1. Notify Construction Manager no fewer than two days in advance of proposed interruption of electric service.
  2. Indicate method of providing temporary electric service.
  3. Do not proceed with interruption of electric service without Construction Manager's written permission.
  4. Comply with NFPA 70E.

## 1.8 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

## PART 2 - PRODUCTS

### 2.1 FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  2. Siemens Energy & Automation, Inc.
  3. GE Energy, General Electric Company.
  4. Square D; a brand of Schneider Electric.
- B. Type HD, Heavy Duty, Single Throw, 240-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  2. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
  3. Lugs: Mechanical type, suitable for number, size, and conductor material.

### 2.2 NONFUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  - 2. Siemens Energy & Automation, Inc.
  - 3. GE Energy, General Electric Company.
  - 4. Square D; a brand of Schneider Electric.
- B. Type GD, General Duty, Single Throw, 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Single Throw, 240-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Accessories:
  - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  - 2. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
  - 3. Lugs: Mechanical type, suitable for number, size, and conductor material.

## 2.3 SHUNT TRIP SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Cooper Bussmann, Inc.
  - 2. Ferraz Shawmut, Inc.
  - 3. Littelfuse, Inc.
- B. General Requirements: Comply with[ ASME A17.1,] UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.
- C. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
- D. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with a control power source of enough capacity to operate shunt trip, connected pilot, and indicating and control devices.
- E. Accessories:
  - 1. Oiltight key switch for key-to-test function.

2. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
3. Form C alarm contacts that change state when switch is tripped.
4. Three-pole, double-throw, fire-safety and alarm relay; 24-V dc coil voltage.
5. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

## 2.4 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  2. Siemens Energy & Automation, Inc.
  3. GE Energy, General Electric Company.
  4. Square D; a brand of Schneider Electric.
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- E. Features and Accessories:
  1. Standard frame sizes, trip ratings, and number of poles.
  2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
  3. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

## 2.5 MOLDED-CASE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  2. Siemens Energy & Automation, Inc.
  3. GE Energy, General Electric Company.
  4. Square D; a brand of Schneider Electric.

- B. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.
- C. Features and Accessories:
  - 1. Standard frame sizes and number of poles.
  - 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
  - 3. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

## 2.6 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
  - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
  - 2. Outdoor Locations: NEMA 250, Type 3R.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Install fuses in fusible devices.
- D. Comply with NECA 1.

### 3.3 IDENTIFICATION





**SECTION 262913**  
**ENCLOSED CONTROLLERS**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes the following enclosed controllers rated 600 V and less:
  - 1. Full-voltage manual.
  - 2. Full-voltage magnetic.
  - 3. Reduced-voltage magnetic.
  - 4. Reduced-voltage solid state.
  - 5. Multispeed.
- B. Related Section:
  - 1. Division 26 Section "Variable-Frequency Motor Controllers" for general-purpose, ac, adjustable-frequency, pulse-width-modulated controllers for use on variable torque loads in ranges up to 200 hp.

1.3 DEFINITIONS

- A. CPT: Control power transformer.
- B. MCCB: Molded-case circuit breaker.
- C. MCP: Motor circuit protector.
- D. N.C.: Normally closed.
- E. N.O.: Normally open.
- F. OCPD: Overcurrent protective device.
- G. SCR: Silicon-controlled rectifier.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.
- B. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.
  - 1. Show tabulations of the following:
    - a. Each installed unit's type and details.
    - b. Factory-installed devices.
    - c. Nameplate legends.
    - d. Short-circuit current rating of integrated unit.
    - e. Listed and labeled for integrated short-circuit current (withstand) rating of OCPDs in combination controllers by an NRTL acceptable to authorities having jurisdiction.
    - f. Features, characteristics, ratings, and factory settings of individual OCPDs in combination controllers.
  - 2. Wiring Diagrams: For power, signal, and control wiring.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
  - 1. Routine maintenance requirements for enclosed controllers and installed components.
  - 2. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
  - 3. Manufacturer's written instructions for setting field-adjustable overload relays.
  - 4. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage solid-state controllers.

## 1.7 MATERIALS MAINTENANCE SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
  - 2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
  - 3. Indicating Lights: Two of each type and color installed.
  - 4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
  - 5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

## 1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
  - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NFPA 70.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install temporary electric heating, with at least 250 W per controller.

## 1.10 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
  - 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F .

2. Altitude: Not exceeding 6600 feet .
- B. Interruption of Existing Electrical Systems: Do not interrupt electrical systems in facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
1. Notify Construction Manager no fewer than two days in advance of proposed interruption of electrical systems.
  2. Indicate method of providing temporary utilities.
  3. Do not proceed with interruption of electrical systems without Construction Manager's written permission.
  4. Comply with NFPA 70E.

#### 1.11 COORDINATION

- A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

### PART 2 - PRODUCTS

#### 2.1 FULL-VOLTAGE CONTROLLERS

- A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.
- B. Motor-Starting Switches: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
    - b. Rockwell Automation, Inc.; Allen-Bradley brand.
    - c. Siemens Energy & Automation, Inc.
    - d. GE Energy, General Electric Company.
    - e. Square D; a brand of Schneider Electric.
  2. Configuration: Nonreversing.
  3. Surface mounting.
  4. Red pilot light.
- C. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
    - b. Rockwell Automation, Inc.; Allen-Bradley brand.
    - c. Siemens Energy & Automation, Inc.
    - d. GE Energy, General Electric Company.
    - e. Square D; a brand of Schneider Electric.
  2. Configuration: Nonreversing.
  3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.
  4. Surface mounting.
  5. Red pilot light.
- D. Integral Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
    - b. Rockwell Automation, Inc.; Allen-Bradley brand.
    - c. Siemens Energy & Automation, Inc.
    - d. GE Energy, General Electric Company.
    - e. Square D; a brand of Schneider Electric.
  2. Configuration: Nonreversing.
  3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters and sensors in each phase, matched to nameplate full-load current of actual protected motor and having appropriate adjustment for duty cycle; external reset push button; bimetallic type.
  4. Surface mounting.
  5. Red pilot light.
  6. N.O./N.C. auxiliary contact.
- E. Magnetic Controllers: Full voltage, across the line, electrically held.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
    - b. Rockwell Automation, Inc.; Allen-Bradley brand.
    - c. Siemens Energy & Automation, Inc.
    - d. GE Energy, General Electric Company.
    - e. Square D; a brand of Schneider Electric.
  2. Configuration: Nonreversing.

3. Contactor Coils: Pressure-encapsulated type.
    - a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
  4. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
  5. Control Circuits: 24V ac; obtained from integral CPT, with primary and secondary fuses control power source of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
    - a. CPT Spare Capacity: 50 VA.
  6. Solid-State Overload Relay:
    - a. Switch or dial selectable for motor running overload protection.
    - b. Sensors in each phase.
    - c. Class 10 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
    - d. Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
    - e. Analog communication module.
  7. N.C./N.O., isolated overload alarm contact.
  8. External overload reset push button.
- F. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following: or comparable product by one of the following:
    - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
    - b. Rockwell Automation, Inc.; Allen-Bradley brand.
    - c. Siemens Energy & Automation, Inc.
    - d. GE Energy, General Electric Company.
    - e. Square D; a brand of Schneider Electric.
  2. MCCB Disconnecting Means:
    - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
    - b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
    - c. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

- d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
- e. [N.C.] [N.O.] alarm contact that operates only when MCCB has tripped.

## 2.2 REDUCED-VOLTAGE MAGNETIC CONTROLLERS

- A. General Requirements for Reduced-Voltage Magnetic Controllers: Comply with NEMA ICS 2, general purpose, Class A; closed-transition; adjustable time delay on transition.
- B. Combination Reduced-Voltage Magnetic Controller: Factory-assembled combination of reduced-voltage magnetic controller, OCPD, and disconnecting means.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
    - b. Rockwell Automation, Inc.; Allen-Bradley brand.
    - c. Siemens Energy & Automation, Inc.
    - d. GE Energy, General Electric Company.
    - e. Square D; a brand of Schneider Electric.
  - 2. MCCB Disconnecting Means:
    - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
    - b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
    - c. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
    - d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
    - e. [N.C.] [N.O.] alarm contact that operates only when MCCB has tripped.

## 2.3 REDUCED-VOLTAGE SOLID-STATE CONTROLLERS

- A. General Requirements for Reduced-Voltage Solid-State Controllers: Comply with UL 508.
- B. Combination Reduced-Voltage Solid-State Controller: Factory-assembled combination of reduced-voltage solid-state controller, OCPD, and disconnecting means.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:



- a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
- b. Rockwell Automation, Inc.; Allen-Bradley brand.
- c. Siemens Energy & Automation, Inc.
- d. GE Energy, General Electric Company.
- e. Square D; a brand of Schneider Electric.

2. MCCB Disconnecting Means:

- a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
- b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- c. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
- d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
- e. [N.C.] [N.O.] alarm contact that operates only when MCCB has tripped.

## 2.4 MULTISPEED MAGNETIC CONTROLLERS

- A. General Requirements for Multispeed Magnetic Controllers: Comply with NEMA ICS 2, general purpose, Class A.
- B. Combination Multispeed Magnetic Controller: Factory-assembled combination of reduced-voltage magnetic controller, OCPD, and disconnecting means.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
- b. Rockwell Automation, Inc.; Allen-Bradley brand.
- c. Siemens Energy & Automation, Inc.
- d. GE Energy, General Electric Company.
- e. Square D; a brand of Schneider Electric.

2. MCCB Disconnecting Means:

- a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
- b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- c. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
- d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.

- e. N.C./N.O. alarm contact that operates only when MCCB has tripped.

## 2.5 ENCLOSURES

- A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.
  - 1. Dry and Clean Indoor Locations: Type 1.
  - 2. Outdoor Locations: Type 3R.

## 2.6 ACCESSORIES

- A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
  - 1. Push Buttons, Pilot Lights, and Selector Switches: Standard-duty, type.
    - a. Push Buttons: Unguarded types; momentary as indicated.
    - b. Pilot Lights: LED types; colors as indicated; push to test.
    - c. Selector Switches: Rotary.
- B. N.C./N.O. auxiliary contact(s).
- C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.
- D. Cover gaskets for Type 1 enclosures.
- E. Spare control wiring terminal blocks, quantity as indicated; unwired.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on

lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Install fuses in each fusible-switch enclosed controller.
- D. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses."
- E. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- F. Comply with NECA 1.

### 3.3 IDENTIFICATION

- A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
  - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
  - 2. Label each enclosure with engraved nameplate.
  - 3. Label each enclosure-mounted control and pilot device.

### 3.4 CONTROL WIRING INSTALLATION

- A. Install wiring between enclosed controllers and remote devices. Comply with requirements in Division 26 Section "Control-Voltage Electrical Power Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic-control selection devices where applicable.
  - 1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
  - 2. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

### 3.5 ADJUSTING

- A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- B. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.
- C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Construction Manager before increasing settings.
- D. Set the taps on reduced-voltage autotransformer controllers at 50 percent.
- E. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage solid-state controllers.

### 3.6 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.
- B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

### 3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers, and to use and reprogram microprocessor-based, reduced-voltage solid-state controllers.

END OF SECTION

**SECTION 265100**  
**INTERIOR LIGHTING**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Interior lighting fixtures, lamps, and ballasts.
- 2. Exit signs.
- 3. Lighting fixture supports.

B. Related Sections:

- 1. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting
- 2. Division 26 Section "Wiring Devices" for manual wall-box dimmers for incandescent lamps.

1.3 DEFINITIONS

- A. BF: Ballast factor.
- B. CCT: Correlated color temperature.
- C. CRI: Color-rendering index.
- D. HID: High-intensity discharge.
- E. LER: Luminaire efficacy rating.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting fixture, including ballast housing if provided.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
1. Physical description of lighting fixture including dimensions.
  2. Ballast, including BF.
  3. Energy-efficiency data.
  4. Air and Thermal Performance Data: For air-handling lighting fixtures. Furnish data required in "Action Submittals" Article in Division 23 Section "Diffusers, Registers, and Grilles."
  5. Sound Performance Data: For air-handling lighting fixtures. Indicate sound power level and sound transmission class in test reports certified according to standards specified in Division 23 Section "Diffusers, Registers, and Grilles."
  6. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.
  7. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
    - a. Testing Agency Certified Data: For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by manufacturer.
    - b. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Shop Drawings: For nonstandard or custom lighting fixtures. Include plans, elevations, sections, details, and attachments to other work.
1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  2. Wiring Diagrams: For power, signal, and control wiring.
- C. Installation instructions.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

#### 1.6 MATERIALS MAINTENANCE SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
  2. Plastic Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
  3. Fluorescent-fixture-mounted, emergency battery pack: One for every 20 emergency lighting unit.
  4. Ballasts: One for every 100 of each type and rating installed. Furnish at least one of each type.
  5. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

#### 1.7 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NFPA 70.
- D. FM Global Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

#### 1.8 COORDINATION

- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

### PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide product indicated on Drawings.

## 2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
- C. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.
- D. Metal Parts: Free of burrs and sharp corners and edges.
- E. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- G. Diffusers and Globes:
  - 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
    - a. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
    - b. UV stabilized.
  - 2. Glass: Annealed crystal glass unless otherwise indicated.
- H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
  - 1. Label shall include the following lamp and ballast characteristics:
    - a. "USE ONLY" and include specific lamp type.
    - b. Lamp diameter code (T-4, T-5, T-8, T-12, etc.), tube configuration (twin, quad, triple, etc.), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
    - c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.



- d. Start type (preheat, rapid start, instant start, etc.) for fluorescent and compact fluorescent luminaires.
  - e. ANSI ballast type (M98, M57, etc.) for HID luminaires.
  - f. CCT and CRI for all luminaires.
- I. Air-Handling Fluorescent Fixtures: For use with plenum ceiling for air return and heat extraction and for attaching an air-diffuser-boot assembly specified in Division 23 Section "Diffusers, Registers, and Grilles."
- 1. Air-Supply Units: Slots in one or both side trims join with air-diffuser-boot assemblies.
  - 2. Heat-Removal Units: Air path leads through lamp cavity.
  - 3. Combination Heat-Removal and Air-Supply Unit: Heat is removed through lamp cavity at both ends of the fixture door with air supply same as for air-supply units.
  - 4. Dampers: Operable from outside fixture for control of return-air volume.
  - 5. Static Fixture: Air-supply slots are blanked off, and fixture appearance matches active units.

## 2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS

- A. General Requirements for Electronic Ballasts:
- 1. Comply with UL 935 and with ANSI C82.11.
  - 2. Designed for type and quantity of lamps served.
  - 3. Ballasts shall be designed for full light output unless another BF, dimmer, or bi-level control is indicated.
  - 4. Sound Rating: Class A.
  - 5. Total Harmonic Distortion Rating: Less than 10 percent.
  - 6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
  - 7. Operating Frequency: 42 kHz or higher.
  - 8. Lamp Current Crest Factor: 1.7 or less.
  - 9. BF: 0.88 or higher.
  - 10. Power Factor: 0.95 or higher.
  - 11. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.
- B. Luminaires controlled by occupancy sensors shall have programmed-start ballasts.
- C. Electronic Programmed-Start Ballasts for T8, T5 and T5HO Lamps: Comply with ANSI C82.11 and the following:
- 1. Lamp end-of-life detection and shutdown circuit for T5 diameter lamps.
  - 2. Automatic lamp starting after lamp replacement.

- D. Ballasts for Residential Applications: Fixtures designated as "Residential" may use low-power-factor electronic ballasts having a Class B sound rating and total harmonic distortion of approximately 30 percent.
- E. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.
  - 1. Dimming Range: 100 to 5 percent of rated lamp lumens.
  - 2. Ballast Input Watts: Can be reduced to 20 percent of normal.
  - 3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.
  - 4. Control: Coordinate wiring from ballast to control device to ensure that the ballast, controller, and connecting wiring are compatible.

## 2.4 BALLASTS FOR COMPACT FLUORESCENT LAMPS

- A. Description: Electronic-programmed rapid-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:
  - 1. Lamp end-of-life detection and shutdown circuit.
  - 2. Automatic lamp starting after lamp replacement.
  - 3. Sound Rating: Class A.
  - 4. Total Harmonic Distortion Rating: Less than 20 percent.
  - 5. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
  - 6. Operating Frequency: 20 kHz or higher.
  - 7. Lamp Current Crest Factor: 1.7 or less.
  - 8. BF: 0.95 or higher unless otherwise indicated.
  - 9. Power Factor: 0.95, except fixtures designated as "Residential" may use low-power-factor electronic ballasts or higher.
  - 10. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.

## 2.5 BALLASTS FOR HID LAMPS

- A. Electromagnetic Ballast for Metal-Halide Lamps: Comply with ANSI C82.4 and UL 1029. Include the following features unless otherwise indicated:
  - 1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
  - 2. Minimum Starting Temperature: Minus 22 deg F for single-lamp ballasts.
  - 3. Rated Ambient Operating Temperature: 104 deg F .
  - 4. Open-circuit operation that will not reduce average life.
  - 5. Low-Noise Ballasts: Manufacturers' standard epoxy-encapsulated models designed to minimize audible fixture noise.

- B. Electronic Ballast for Metal-Halide Lamps: Include the following features unless otherwise indicated:
1. Minimum Starting Temperature: Minus 20 deg F for single-lamp ballasts.
  2. Rated Ambient Operating Temperature: 130 deg F .
  3. Lamp end-of-life detection and shutdown circuit.
  4. Sound Rating: Class A.
  5. Total Harmonic Distortion Rating: Less than 20 percent.
  6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
  7. Lamp Current Crest Factor: 1.5 or less.
  8. Power Factor: 0.90 or higher.
  9. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
  10. Protection: Class P thermal cutout.

## 2.6 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
1. Lamps for AC Operation: Fluorescent, two for each fixture, 20,000 hours of rated lamp life.
  2. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
  3. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
    - a. Battery: Sealed, maintenance-free, nickel-cadmium type.
    - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
    - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
    - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
  4. Master/Remote Sign Configurations:
    - a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in LED power supply for power connection to remote unit.
    - b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery, and test features. Arrange to receive

full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

## 2.7 FLUORESCENT LAMPS

- A. T8 rapid-start lamps, rated 32 W maximum, nominal length of 48 inches , 2800 initial lumens (minimum), CRI 75 (minimum), color temperature 3500K, and average rated life 20,000 hours unless otherwise indicated.
- B. T8 rapid-start lamps, rated 17 W maximum, nominal length of 24 inches , 1300 initial lumens (minimum), CRI 75 (minimum), color temperature 3500 K, and average rated life of 20,000 hours unless otherwise indicated.
- C. T5 rapid-start lamps, rated 28 W maximum, nominal length of 45.2 inches , 2900 initial lumens (minimum), CRI 85 (minimum), color temperature 3000 value> K, and average rated life of 20,000 hours unless otherwise indicated.
- D. T5HO rapid-start, high-output lamps, rated 54 W maximum, nominal length of 45.2 inches , 5000 initial lumens (minimum), CRI 85 (minimum), color temperature 4100 K, and average rated life of 20,000 hours unless otherwise indicated.
- E. Compact Fluorescent Lamps: 4-Pin, CRI 80 (minimum), color temperature 3500 K, average rated life of 10,000 hours at three hours operation per start, and suitable for use with dimming ballasts unless otherwise indicated.
  - 1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum).
  - 2. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).
  - 3. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
  - 4. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).
  - 5. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).

## 2.8 HID LAMPS

- A. Metal-Halide Lamps: ANSI C78.43, with minimum CRI 65, and color temperature 4000 K.
- B. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and color temperature 4000 K.
- C. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80, and color temperature 4000 K.

## 2.9 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- D. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Lighting fixtures:
  - 1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
  - 2. Install lamps in each luminaire.
- B. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.
- C. Remote Mounting of Ballasts: Distance between the ballast and fixture shall not exceed that recommended by ballast manufacturer. Verify, with ballast manufacturers, maximum distance between ballast and luminaire.
- D. Lay-in Ceiling Lighting Fixture Supports: Use grid as a support element.
  - 1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches from lighting fixture corners.
  - 2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
  - 3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
- E. Suspended Lighting Fixture Support:
  - 1. Pendants and Rods: Where longer than 48 inches , brace to limit swinging.
  - 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
  - 3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.
- F. Air-Handling Lighting Fixtures: Install with dampers closed and ready for adjustment.
- G. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

### 3.2 IDENTIFICATION

- A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

### 3.3 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.
  1. Adjust aimable luminaires in the presence of Architect.

END OF SECTION

**SECTION 265600**  
**EXTERIOR LIGHTING**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Exterior luminaires with lamps and ballasts.
- 2. Luminaire-mounted photoelectric relays.
- 3. Poles and accessories.

B. Related Sections:

- 1. Division 26 Section "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color-rendering index.
- C. HID: High-intensity discharge.
- D. LER: Luminaire efficacy rating.
- E. Luminaire: Complete lighting fixture, including ballast housing if provided.
- F. Pole: Luminaire support structure, including tower used for large area illumination.
- G. Standard: Same definition as "Pole" above.

1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

- A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4-M.
- B. Live Load: Single load of 500 lbf , distributed as stated in AASHTO LTS-4-M.
- C. Ice Load: Load of 3 lbf/sq. ft. , applied as stated in AASHTO LTS-4-M Ice Load Map.
- D. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.
  - 1. Basic wind speed for calculating wind load for poles 50 feet high or less is 90 mph.
    - a. Wind Importance Factor: 1.0.
    - b. Minimum Design Life: 25 years.
    - c. Velocity Conversion Factors: 1.0.

## 1.5 ACTION SUBMITTALS

- A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
  - 1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
  - 2. Details of attaching luminaires and accessories.
  - 3. Details of installation and construction.
  - 4. Luminaire materials.
  - 5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
    - a. Testing Agency Certified Data: For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
    - b. Manufacturer Certified Data: Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
  - 6. Photoelectric relays.
  - 7. Ballasts, including energy-efficiency data.
  - 8. Lamps, including life, output, CCT, CRI, lumens, and energy-efficiency data.
  - 9. Materials, dimensions, and finishes of poles.
  - 10. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
  - 11. Anchor bolts for poles.
  - 12. Manufactured pole foundations.



- 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. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
  - 3. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.
  - 4. Wiring Diagrams: For power, signal, and control wiring.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations by a professional engineer.
- B. Warranty: Sample of special warranty.

#### 1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.

#### 1.8 MATERIALS MAINTENANCE SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Lamps: [One for every 100 of each type and rating installed. Furnish at least one of each type.
  - 2. Glass and Plastic Lenses, Covers, and Other Optical Parts: One for every 100 of each type and rating installed. Furnish at least one of each type.
  - 3. Ballasts: One for every 100 of each type and rating installed. Furnish at least one of each type.
  - 4. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

#### 1.9 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with IEEE C2, "National Electrical Safety Code."
- E. Comply with NFPA 70.

#### 1.10 DELIVERY, STORAGE, AND HANDLING

- A. Package aluminum poles for shipping according to ASTM B 660.
- B. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- C. Handle wood poles so they will not be damaged. Do not use pointed tools that can indent pole surface more than 1/4 inch deep. Do not apply tools to section of pole to be installed below ground line.
- D. Retain factory-applied pole wrappings on fiberglass and laminated wood poles until right before pole installation. Handle poles with web fabric straps.
- E. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

#### 1.11 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
  - 1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
  - 2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
  - 3. Warranty Period for Color Retention: Five years from date of Substantial Completion.
  - 4. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide product indicated on Drawings.

### 2.2 GENERAL REQUIREMENTS FOR LUMINAIRES

- A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
  - 1. LER Tests Incandescent Fixtures: Where LER is specified, test according to NEMA LE 5A.
  - 2. LER Tests Fluorescent Fixtures: Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
  - 3. LER Tests HID Fixtures: Where LER is specified, test according to NEMA LE 5B.
- B. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
- G. Exposed Hardware Material: Stainless steel.
- H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

- I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
- J. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
  - 1. White Surfaces: 85 percent.
  - 2. Specular Surfaces: 83 percent.
  - 3. Diffusing Specular Surfaces: 75 percent.
- K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
- M. Factory-Applied Finish for Steel luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
  - 1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
  - 2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
    - a. Color: As selected from manufacturer's standard catalog of colors.
    - b. Color: Match Architect's sample of manufacturer's standard color.
    - c. Color: As selected by Architect from manufacturer's full range.
- N. Factory-Applied Finish for Aluminum luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
  - 1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
  - 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
  - 3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
  - 4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural

Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

- a. Color: Medium bronze.
- O. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
1. Label shall include the following lamp and ballast characteristics:
    - a. "USES ONLY" and include specific lamp type.
    - b. Lamp diameter code (T-4, T-5, T-8, T-12), tube configuration (twin, quad, triple), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
    - c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
    - d. Start type (preheat, rapid start, instant start) for fluorescent and compact fluorescent luminaires.
    - e. ANSI ballast type (M98, M57, etc.) for HID luminaires.
    - f. CCT and CRI for all luminaires.

## 2.3 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS

- A. Comply with UL 773 or UL 773A.
- B. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc and off at 4.5 to 10 fc with 15-second minimum time delay. Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff.
  1. Relay with locking-type receptacle shall comply with ANSI C136.10.
  2. Adjustable window slide for adjusting on-off set points.

## 2.4 FLUORESCENT BALLASTS AND LAMPS

- A. Ballasts for Low-Temperature Environments:
  1. Temperatures 0 Deg F and Higher: Electronic or electromagnetic type rated for 0 deg F starting and operating temperature with indicated lamp types.
  2. Temperatures Minus 20 Deg F and Higher: Electromagnetic type designed for use with indicated lamp types.
- B. Ballast Characteristics:
  1. Power Factor: 90 percent, minimum.
  2. Sound Rating: Class A.

3. Total Harmonic Distortion Rating: Less than 10 percent.
  4. Electromagnetic Ballasts: Comply with ANSI C82.1, energy-saving, high power factor, Class P, automatic-reset thermal protection.
  5. Case Temperature for Compact Lamp Ballasts: 65 deg C, maximum.
  6. Transient-Voltage Protection: Comply with IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
- C. Low-Temperature Lamp Capability: Rated for reliable starting and operation with ballast provided at temperatures 0 deg F and higher.

## 2.5 BALLASTS FOR HID LAMPS

- A. Comply with ANSI C82.4 and UL 1029 and capable of open-circuit operation without reduction of average lamp life. Include the following features unless otherwise indicated:
1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
  2. Minimum Starting Temperature: Minus 22 deg F .
  3. Normal Ambient Operating Temperature: 104 deg F .
  4. Ballast Fuses: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by ballast manufacturer.

## 2.6 HID LAMPS

- A. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and CCT color temperature 4000 K.
- B. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80, and CCT color temperature 4000 K.

## 2.7 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

- A. Structural Characteristics: Comply with AASHTO LTS-4-M.
1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.
  2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

- B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.
- C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
  - 1. Materials: Shall not cause galvanic action at contact points.
  - 2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
  - 3. Anchor-Bolt Template: Plywood or steel.
- D. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches , with cover secured by stainless-steel captive screws. Provide on all, except wood poles.
- E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."
- F. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.
- G. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4-M.

## 2.8 ALUMINUM POLES

- A. Poles: Seamless, extruded structural tube complying with ASTM B 429/B 429M, Alloy 6063-T6 with access handhole in pole wall.
- B. Poles: ASTM B 209 , 5052-H34 marine sheet alloy with access handhole in pole wall.
  - 1. Shape: Round, tapered.
  - 2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
- C. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
- D. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

- E. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.
  - 1. Tapered oval cross section, with straight tubular end section to accommodate luminaire.
  - 2. Finish: Same as pole.
- F. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.

### PART 3 - EXECUTION

#### 3.1 LUMINAIRE INSTALLATION

- A. Install lamps in each luminaire.
- B. Fasten luminaire to indicated structural supports.
- C. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

#### 3.2 POLE INSTALLATION

- A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
- B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:
  - 1. Fire Hydrants and Storm Drainage Piping: 60 inches .
  - 2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet .
  - 3. Trees: 15 feet from tree trunk.
- C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
  - 1. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
  - 2. Install base covers unless otherwise indicated.
  - 3. Use a short piece of 1/2-inch- diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.



- E. Raise and set poles using web fabric slings (not chain or cable).

### 3.3 BOLLARD LUMINAIRE INSTALLATION

- A. Align units for optimum directional alignment of light distribution.
- B. Install on concrete base with top 4 inches above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

### 3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

- A. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

### 3.5 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

### 3.6 GROUNDING

- A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
  - 1. Install grounding electrode for each pole unless otherwise indicated.
  - 2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.
- B. Ground nonmetallic poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
  - 1. Install grounding electrode for each pole.
  - 2. Install grounding conductor and conductor protector.
  - 3. Ground metallic components of pole accessories and foundations.

### 3.7 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
  - 1. Verify operation of photoelectric controls.
- C. Illumination Tests:
  - 1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):
    - a. IESNA LM-5, "Photometric Measurements of Area and Sports Lighting Installations."
    - b. IESNA LM-50, "Photometric Measurements of Roadway Lighting Installations."
    - c. IESNA LM-52, "Photometric Measurements of Roadway Sign Installations."
    - d. IESNA LM-64, "Photometric Measurements of Parking Areas."
    - e. IESNA LM-72, "Directional Positioning of Photometric Data."
- D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION

## SECTION 270528

### PATHWAYS FOR COMMUNICATIONS SYSTEMS

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

###### A. Section Includes:

1. Metal conduits and fittings.
2. Metal wireways and auxiliary gutters.
3. Surface pathways.
4. Boxes, enclosures, and cabinets.
5. Handholes and boxes for exterior underground cabling.

###### B. Related Requirements:

1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.
2. Division 26 Section "Raceways and Boxes for Electrical Systems" for conduits, wireways, surface raceways, boxes, enclosures, cabinets, handholes, and faceplate adapters serving electrical systems.
3. Division 28 Section "Pathways for Electronic Safety and Security" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving electronic safety and security.

##### 1.3 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid steel conduit.
- C. IMC: Intermediate metal conduit.

## 1.4 ACTION SUBMITTALS

- A. Product Data: For surface pathways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

## PART 2 - PRODUCTS

### 2.1 METAL CONDUITS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - 1. AFC Cable Systems, Inc.
  - 2. Allied Tube & Conduit; a Tyco International Ltd. Co.
  - 3. Alpha Wire Company.
  - 4. Anamet Electrical, Inc.
  - 5. Electri-Flex Company.
  - 6. O-Z/Gedney; a brand of EGS Electrical Group.
  - 7. Picoma Industries; Subsidiary of Mueller Water Products, Inc.
  - 8. Republic Conduit.
  - 9. Robroy Industries.
  - 10. Southwire Company.
  - 11. Thomas & Betts Corporation.
  - 12. Western Tube and Conduit Corporation.
  - 13. Wheatland Tube Company; a division of John Maneely Company.
- B. General Requirements for Metal Conduits and Fittings:
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 2. Comply with TIA-569-B.
- C. IMC: Comply with ANSI C80.6 and UL 1242.
- D. PVC-Coated Steel Conduit: PVC-coated IMC.
  - 1. Comply with NEMA RN 1.
  - 2. Coating Thickness: 0.040 inch , minimum.
- E. EMT: Comply with ANSI C80.3 and UL 797.
- F. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
  2. Fittings for EMT:
    - a. Material: Steel.
    - b. Type: Compression.
  3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.
  4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch , with overlapping sleeves protecting threaded joints.
- G. 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.

## 2.2 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Cooper B-Line, Inc.
  2. Hoffman; a Pentair company.
  3. Mono-Systems, Inc.
  4. Square D; a brand of Schneider Electric.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
1. 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. Comply with TIA-569-B.
- C. 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.
- D. Wireway Covers: Hinged type unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

## 2.3 SURFACE PATHWAYS

- A. General Requirements for Surface Pathways:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  2. Comply with TIA-569-B.
- B. Surface Metal Pathways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Mono-Systems, Inc.
    - b. Niedax-Kleinhuis USA, Inc.
    - c. Panduit Corp.
    - d. Wiremold / Legrand.

## 2.4 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Adalet.
  2. Cooper Technologies Company; Cooper Crouse-Hinds.
  3. EGS/Appleton Electric.
  4. Erickson Electrical Equipment Company.
  5. Hoffman; a Pentair company.
  6. Hubbell Incorporated; Killark Division.
  7. Lamson & Sessions; Carlon Electrical Products.
  8. Milbank Manufacturing Co.
  9. Molex; Woodhead Brand.
  10. Mono-Systems, Inc.
  11. O-Z/Gedney; a brand of EGS Electrical Group.
  12. RACO; a Hubbell company.
  13. Robroy Industries.
  14. Spring City Electrical Manufacturing Company.
  15. Stahlin Non-Metallic Enclosures; a division of Robroy Industries.
  16. Thomas & Betts Corporation.
  17. Wiremold / Legrand.
- B. General Requirements for Boxes, Enclosures, and Cabinets:
1. Comply with TIA-569-B.
  2. Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet-Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

- E. Metal Floor Boxes:
  - 1. Material: Cast metal.
  - 2. Type: Fully adjustable.
  - 3. Shape: Rectangular.
  - 4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Device Box Dimensions: 4 inches square by 2-1/8 inches deep .
- H. Gangable boxes are allowed.
- I. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
  - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
  - 2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

## 2.5 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND CABLING

- A. General Requirements for Handholes and Boxes:
  - 1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
  - 2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 3. Comply with TIA-569-B.
- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Armorcast Products Company.
    - b. Carson Industries LLC.
    - c. CDR Systems Corporation; Hubbell Power Systems.
    - d. NewBasis.
    - e. Oldcastle Precast, Inc.; Christy Concrete Products.
    - f. Synertech Moulded Products; a division of Oldcastle Precast, Inc.
  - 2. Standard: Comply with SCTE 77.

3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, "COMMUNICATIONS."
7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. Handholes 12 Inches Wide by 24 Inches Long and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

### PART 3 - EXECUTION

#### 3.1 PATHWAY APPLICATION

- A. Outdoors: Apply pathway products as specified below unless otherwise indicated:
  1. Underground Conduit: RNC, Type EPC-40-PVC concrete encased.
  2. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply pathway products as specified below unless otherwise indicated:
  1. Exposed, Not Subject to Physical Damage: EMT.
  2. Exposed and Subject to Severe Physical Damage: IMC. Pathway locations include the following:
    - a. Loading dock.
    - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    - c. Mechanical rooms.
  3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
  4. Damp or Wet Locations: IMC.
  5. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: EMT.
  6. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: EMT.
  7. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: EMT.
  8. Boxes and Enclosures: NEMA 250 Type 1, except use NEMA 250 Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Pathway Size: 3/4-inch trade size. Minimum size for optical-fiber cables is 1 inch .
- D. Pathway Fittings: Compatible with pathways and suitable for use and location.



1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
  2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
  3. EMT: Use compression steel fittings. Comply with NEMA FB 2.10.
- E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- F. Install surface pathways only where indicated on Drawings.

### 3.2 INSTALLATION

- A. Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- B. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- C. Complete pathway installation before starting conductor installation.
- D. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical Systems" for hangers and supports.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.
- G. Support conduit within 12 inches of enclosures to which attached.
- H. Pathways Embedded in Slabs:
1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot intervals.
  2. Arrange pathways to cross building expansion joints at right angles with expansion fittings.
  3. Arrange pathways to keep a minimum of 2 inches of concrete cover in all directions.
  4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
  5. Change from ENT to RNC, Type EPC-40-PVC, before rising above floor.

- I. Stub-ups to Above Recessed Ceilings:
  - 1. Use EMT, IMC, or RMC for pathways.
  - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- J. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.
- K. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.
- L. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.
- M. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- N. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- O. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.
- P. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground pathways designated as spare above grade alongside pathways in use.
- Q. Surface Pathways:
  - 1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
  - 2. Install surface pathway with a minimum 2-inch radius control at bend points.
  - 3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- R. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway sealing fittings according to NFPA 70.
- S. Install devices to seal pathway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
  2. Where an underground service pathway enters a building or structure.
  3. Where otherwise required by NFPA 70.
- T. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.
- U. Expansion-Joint Fittings:
1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F , and that has straight-run length that exceeds 25 feet . Install in each run of aboveground RMC[ and EMT] conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet .
  2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
    - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
    - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
    - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F] temperature change.
    - d. Attics: 135 deg F temperature change.
  3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
  4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
  5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- V. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- W. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- X. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

- Y. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- Z. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- AA. Set metal floor boxes level and flush with finished floor surface.
- BB. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

### 3.3 INSTALLATION OF UNDERGROUND CONDUIT

#### A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Division 31 Section "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
  - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
  - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
6. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits, but a minimum of 6 inches below grade. Align planks along centerline of conduit.
7. Underground Warning Tape: Comply with requirements in Division 26 Section "Identification for Electrical Systems."

### 3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.
- D. Install handholes with bottom below frost line, below grade.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.
- F. Field cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

### 3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 27 Section "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

### 3.6 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

### 3.7 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage or deterioration.
  - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

## SECTION 280528

### PATHWAYS 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. Metal conduits, tubing, and fittings.
2. Metal wireways and auxiliary gutters.
3. Surface pathways.
4. Boxes, enclosures, and cabinets.
5. Handholes and boxes for exterior underground cabling.

###### B. Related Requirements:

1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.
2. Division 26 Section "Raceways and Boxes for Electrical Systems" for conduits, wireways, surface raceways, boxes, enclosures, cabinets, handholes, and faceplate adapters serving electrical systems.
3. Division 27 Section "Pathways for Communications Systems" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving communications systems.

##### 1.3 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid steel conduit.
- C. IMC: Intermediate metal conduit.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For surface pathways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

### PART 2 - PRODUCTS

#### 2.1 METAL CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, **provide products by the following:**
  - 1. AFC Cable Systems, Inc.
  - 2. Allied Tube & Conduit; a Tyco International Ltd. Co.
  - 3. Alpha Wire Company.
  - 4. Anamet Electrical, Inc.
  - 5. Electri-Flex Company.
  - 6. O-Z/Gedney; a brand of EGS Electrical Group.
  - 7. Picoma Industries; Subsidiary of Mueller Water Products, Inc.
  - 8. Republic Conduit.
  - 9. Robroy Industries
  - 10. Southwire Company.
  - 11. Thomas & Betts Corporation.
  - 12. Western Tube and Conduit Corporation.
  - 13. Wheatland Tube Company; a division of John Maneely Company.
- B. General Requirements for Metal Conduits and Fittings:
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 2. Comply with TIA-569-B.
- C. IMC: Comply with ANSI C80.6 and UL 1242.
- D. EMT: Comply with ANSI C80.3 and UL 797.
- E. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- F. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
  - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
  - 2. Fittings for EMT:



- a. Material: **Steel**.
- b. Type: **compression**.
- 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 467, rated for environmental conditions where installed, and including flexible external bonding jumper.
- 4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of **0.040 inch** , with overlapping sleeves protecting threaded joints.
- G. 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.

## 2.2 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, **provide products by the following**:
  - 1. Cooper B-Line, Inc.
  - 2. Hoffman; a Pentair company.
  - 3. Mono-Systems, Inc.
  - 4. Square D; a brand of Schneider Electric.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, **Type 1** unless otherwise indicated, and sized according to NFPA 70.
  - 1. 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. Comply with TIA-569-B.
- C. Fittings and Accessories: Include 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.
- D. Wireway Covers: **Hinged type** unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

## 2.3 SURFACE PATHWAYS

- A. General Requirements for Surface Pathways:
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 2. Comply with TIA-569-B.

B. Surface Metal Pathways: Galvanized steel with snap-on covers complying with UL 5. **Manufacturer's standard enamel finish in color selected by Architect.**

1. Manufacturers: Subject to compliance with requirements, **provide products by the following:**

- a. Mono-Systems, Inc.
- b. Niedax-Kleinhuis USA, Inc.
- c. Panduit Corp.
- d. Wiremold / Legrand.

## 2.4 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, **provide products by the following:**

1. Adalet.
2. Cooper Technologies Company; Cooper Crouse-Hinds.
3. EGS/Appleton Electric.
4. Erickson Electrical Equipment Company.
5. Hoffman; a Pentair company.
6. Hubbell Incorporated; Killark Division.
7. Lamson & Sessions; Carlon Electrical Products.
8. Milbank Manufacturing Co.
9. Molex, Woodhead Brand
10. Mono-Systems, Inc.
11. O-Z/Gedney; a brand of EGS Electrical Group.
12. RACO; a Hubbell Company.
13. Robroy Industries.
14. Spring City Electrical Manufacturing Company.
15. Stahlin Non-Metallic Enclosures; a division of Robroy Industries.
16. Thomas & Betts Corporation.
17. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets:

1. Comply with TIA-569-B.
2. Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet-Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

E. Metal Floor Boxes:

1. Material: **Cast metal.**

2. Type: **Fully adjustable.**
  3. Shape: Rectangular.
  4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Device Box Dimensions: **4-inches square by 2-1/8 inches deep.**
- H. Gangable boxes **are allowed.**
- I. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, **Type 1** with continuous-hinge cover with flush latch unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
  2. Nonmetallic Enclosures:
    - a. Material: **Plastic.**
    - b. Finished inside with radio-frequency-resistant paint.
  3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

## 2.5 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND CABLING

- A. General Requirements for Handholes and Boxes:
1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
  2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  3. Comply with TIA-569-B.
- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass or a combination of the two.
1. Manufacturers: Subject to compliance with requirements, **provide products by the following:**
    - a. Armorcast Products Company.
    - b. Carson Industries LLC.
    - c. CDR Systems Corporation; Hubbell Power Systems.
    - d. NewBasis.
    - e. Oldcastle Precast, Inc.; Christy Concrete Products.
    - f. Synertech Moulded Products; a division of Oldcastle Precast, Inc.

2. Standard: Comply with SCTE 77.
  3. Configuration: Designed for flush burial with **open** bottom unless otherwise indicated.
  4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
  5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
  6. Cover Legend: Molded lettering, "**ELECTRIC.**".
  7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
  8. Handholes **12 Inches Wide by 24 Inches Long** and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.
- C. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of **polymer concrete**.
1. Manufacturers: Subject to compliance with requirements, **provide products by the following**:
    - a. Armorcast Products Company.
    - b. Carson Industries LLC.
    - c. CDR Systems Corporation; Hubbell Power Systems.
    - d. NewBasis.
    - e. Nordic Fiberglass, Inc.
    - f. Oldcastle Precast, Inc.; Christy Concrete Products.
    - g. Synertech Moulded Products; a division of Oldcastle Precast, Inc.
  2. Standard: Comply with SCTE 77.
  3. Color of Frame and Cover: **Gray**.
  4. Configuration: Designed for flush burial with **open** bottom unless otherwise indicated.
  5. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
  6. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
  7. Cover Legend: Molded lettering, "**ELECTRIC.**".
  8. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
  9. Handholes **12 Inches Wide by 24 Inches Long** and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

## PART 3 - EXECUTION

### 3.1 PATHWAY APPLICATION

- A. Outdoors: Apply pathway products as specified below unless otherwise indicated:
1. Exposed Conduit: **IMC**.
  2. Boxes and Enclosures, Aboveground: NEMA 250.

- B. Indoors: Apply pathway products as specified below unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: **EMT**.
  2. Exposed and Subject to Severe Physical Damage: **IMC**. Pathway locations include the following:
    - a. Loading dock.
    - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    - c. Mechanical rooms.
  3. Concealed in Ceilings and Interior Walls and Partitions: **EMT**.
  4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric-Solenoid, or Motor-Driven Equipment): **FMC**, except use **LFMC** in damp or wet locations.
  5. Damp or Wet Locations: **IMC**.
  6. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: **EMT**.
  7. Boxes and Enclosures: **NEMA 250, Type 1**, except use **NEMA 250, Type 4 stainless steel** in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Pathway Size: **3/4-inch** trade size. Minimum size for optical-fiber cables is **1 inch**.
- D. Pathway Fittings: Compatible with pathways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with **NEMA FB 2.10**.
  2. **EMT**: Use **compression steel** fittings. Comply with **NEMA FB 2.10**.
  3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with **NEMA FB 2.20**.
- E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- F. Install surface pathways only where indicated on Drawings.
- G. Do not install nonmetallic conduit where ambient temperature exceeds **120 deg F**.

### 3.2 INSTALLATION

- A. Comply with **NECA 1, NECA 101, and TIA-569-B** for installation requirements except where requirements on Drawings or in this article are stricter. Comply with **NECA 102** for aluminum pathways. Comply with **NFPA 70** limitations for types of pathways allowed in specific occupancies and number of floors.
- B. Keep pathways at least **6 inches** away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

- C. Complete pathway installation before starting conductor installation.
- D. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical Systems" for hangers and supports.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications wiring conduits for which only two 90-degree bends are allowed. Support within **12 inches** of changes in direction.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- H. Support conduit within **12 inches** of enclosures to which attached.
- I. Pathways Embedded in Slabs:
  - 1. Run conduit larger than **1-inch** trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum **10-foot** intervals.
  - 2. Arrange pathways to cross building expansion joints at right angles with expansion fittings.
  - 3. Arrange pathways to keep a minimum of **2 inches** of concrete cover in all directions.
  - 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
- J. Stub-ups to Above Recessed Ceilings:
  - 1. Use EMT, IMC, or RMC for pathways.
  - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.
- L. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.
- M. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- N. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to conduit assembly to assure a continuous ground path.

- O. Cut conduit perpendicular to the length. For conduits of **2-inch** trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.
- P. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than **200-lb** tensile strength. Leave at least **12 inches** of slack at each end of pull wire. Cap underground pathways designated as spare above grade alongside pathways in use.
- Q. Surface Pathways:
1. Install surface pathway for surface electrical outlet boxes only where indicated on Drawings.
  2. Install surface pathway with a minimum **2-inch** radius control at bend points.
  3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding **48 inches** and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- R. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway sealing fittings according to NFPA 70.
- S. Install devices to seal pathway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
  2. Where an underground service pathway enters a building or structure.
  3. Where otherwise required by NFPA 70.
- T. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.
- U. Expansion-Joint Fittings:
1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed **30 deg F** , and that has straight-run length that exceeds **25 feet** . Install in each run of aboveground RMC **and EMT** conduit that is located where environmental temperature change may exceed **100 deg F** and that has straight-run length that exceeds **100 feet** .
  2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
    - a. Outdoor Locations Not Exposed to Direct Sunlight: **125 deg F** temperature change.

- b. Outdoor Locations Exposed to Direct Sunlight: **155 deg F** temperature change.
  - c. Indoor Spaces Connected with Outdoors without Physical Separation: **125 deg F** temperature change.
  - d. Attics: **135 deg F** temperature change.
3. Install fitting(s) that provide expansion and contraction for at least **0.00041 inch per foot of length of straight run per deg F** of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least **0.000078 inch per foot of length of straight run per deg F** of temperature change for metal conduits.
  4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
  5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- V. Flexible Conduit Connections: Comply with NEMA RV 3. Use maximum of **72 inches** of flexible conduit for **recessed and semirecessed luminaires**, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
  2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- W. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to **center of box** unless otherwise indicated.
- X. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- Y. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- Z. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- AA. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- BB. Set metal floor boxes level and flush with finished floor surface.

### 3.3 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES



- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.
- D. Install handholes with bottom below frost line, 48" below grade.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.
- F. Field cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

### 3.4 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRONIC SAFETY AND SECURITY PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 28 Section "Sleeves and Sleeve Seals for Electronic Safety and Security Pathways and Cabling."

### 3.5 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

### 3.6 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
  - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
  - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

## SECTION 283111

### DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

#### 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. Fire-alarm control unit.
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Nonsystem smoke detectors.
5. Heat detectors.
6. Notification appliances.
7. Firefighters' two-way telephone communication service.
8. Magnetic door holders.
9. Remote annunciator.
10. Addressable interface device.
11. Digital alarm communicator transmitter.
12. Radio alarm transmitter.
13. System printer.

##### 1.3 DEFINITIONS

- A. LED: Light-emitting diode.
- B. NICET: National Institute for Certification in Engineering Technologies.

##### 1.4 SYSTEM DESCRIPTION

- A. Noncoded, UL-certified addressable system, with multiplexed signal transmission, dedicated to fire-alarm service only.
- B. Noncoded addressable system, with automatic sensitivity control of certain smoke detectors and multiplexed signal transmission, dedicated to fire-alarm service only.

## 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
  - 2. Include voltage drop calculations for notification appliance circuits.
  - 3. Include battery-size calculations.
  - 4. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
  - 5. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
  - 6. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
  - 7. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.
- C. Delegated-Design Submittal: For smoke and heat detectors 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. Drawings showing the location of each smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the detector.
  - 2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72.

## 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.

## 1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in

Division 01 Section "Operation and Maintenance Data," deliver copies to authorities having jurisdiction and include the following:

1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
3. Record copy of site-specific software.
4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:
  - a. Frequency of testing of installed components.
  - b. Frequency of inspection of installed components.
  - c. Requirements and recommendations related to results of maintenance.
  - d. Manufacturer's user training manuals.
5. Manufacturer's required maintenance related to system warranty requirements.
6. Abbreviated operating instructions for mounting at fire-alarm control unit.
7. Copy of NFPA 25.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

## 1.8 MATERIALS MAINTENANCE SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.
2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.
3. Smoke Detectors, Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than 1 unit of each type.
4. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but no fewer than 1 unit of each type.
5. Keys and Tools: One extra set for access to locked and tamperproofed components.
6. Audible and Visual Notification Appliances: One of each type installed.
7. Fuses: Two of each type installed in the system.

## 1.9 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
- B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level II technician.
- C. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer. Components shall be compatible with, and operate as, an extension of existing system.
- D. 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.
- E. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL.
- F. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.
- G. NFPA Certification: Obtain certification according to NFPA 72 in the form of a placard by an FMG-approved alarm company.

## 1.10 PROJECT CONDITIONS

- A. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:
  - 1. Notify Construction Manager no fewer than two days in advance of proposed interruption of fire-alarm service.
  - 2. Do not proceed with interruption of fire-alarm service without Construction Manager's written permission.

## 1.11 SEQUENCING AND SCHEDULING

- A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.
- B. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

## 1.12 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning with Substantial Completion, provide software support for two years.
- C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
  - 1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Bosch Security Systems.
  - 2. Fire Lite Alarms; a Honeywell company.
  - 3. Gamewell; a Honeywell company.
  - 4. NOTIFIER; a Honeywell company.
  - 5. Silent Knight; a Honeywell company.
  - 6. SimplexGrinnell LP; a Tyco International company.

### 2.2 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire-alarm signal initiation shall be by one or more of the following devices[ and systems]:
  - 1. Manual stations.
  - 2. Heat detectors.
  - 3. Flame detectors.
  - 4. Smoke detectors.
  - 5. Duct smoke detectors.
  - 6. Verified automatic alarm operation of smoke detectors.
  - 7. Automatic sprinkler system water flow.
  - 8. Heat detectors in elevator shaft and pit.
  - 9. Fire-extinguishing system operation.
  - 10. Fire standpipe system.
- B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances.
  2. Identify alarm at fire-alarm control unit and remote annunciators.
  3. Transmit an alarm signal to the remote alarm receiving station.
  4. Unlock electric door locks in designated egress paths.
  5. Release fire and smoke doors held open by magnetic door holders.
  6. Activate voice/alarm communication system.
  7. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
  8. Activate smoke-control system (smoke management) at firefighter smoke-control system panel.
  9. Activate stairwell and elevator-shaft pressurization systems.
  10. Close smoke dampers in air ducts of designated air-conditioning duct systems.
  11. Recall elevators to primary or alternate recall floors.
  12. Activate emergency lighting control.
  13. Activate emergency shutoffs for gas and fuel supplies.
  14. Record events in the system memory.
  15. Record events by the system printer.
- C. Supervisory signal initiation shall be by one or more of the following devices and actions:
1. Valve supervisory switch.
  2. Low-air-pressure switch of a dry-pipe sprinkler system.
  3. Elevator shunt-trip supervision.
- D. System trouble signal initiation shall be by one or more of the following devices and actions:
1. Open circuits, shorts, and grounds in designated circuits.
  2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
  3. Loss of primary power at fire-alarm control unit.
  4. Ground or a single break in fire-alarm control unit internal circuits.
  5. Abnormal ac voltage at fire-alarm control unit.
  6. Break in standby battery circuitry.
  7. Failure of battery charging.
  8. Abnormal position of any switch at fire-alarm control unit or annunciator.
  9. Fire-pump power failure, including a dead-phase or phase-reversal condition.
  10. Low-air-pressure switch operation on a dry-pipe or preaction sprinkler system.
- E. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciators. Record the event on system printer.

## 2.3 FIRE-ALARM CONTROL UNIT

- A. General Requirements for Fire-Alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.
    - a. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
    - b. Include a real-time clock for time annotation of events on the event recorder and printer.
  2. Addressable initiation devices that communicate device identity and status.
    - a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at fire-alarm control unit.
    - b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.
  3. Addressable control circuits for operation of mechanical equipment.
- B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
1. Annunciator and Display: Liquid-crystal type, 3 of 40 characters, minimum.
  2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.
- C. Circuits:
1. Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class B.
    - a. Initiating Device Circuits: Style A.
    - b. Notification Appliance Circuits: Style W.
    - c. Signaling Line Circuits: Style 0.5.
    - d. Install no more than 50 addressable devices on each signaling line circuit.
  2. Serial Interfaces: Two RS-232 ports for printers.
- D. Stairwell Pressurization: Provide an output signal using an addressable relay to start the stairwell pressurization system. Signal shall remain on until alarm conditions are cleared and fire-alarm system is reset. Signal shall not stop in response to alarm acknowledge or signal silence commands.
1. Pressurization starts when any alarm is received at fire-alarm control unit.
  2. Alarm signals from smoke detectors at pressurization air supplies have a higher priority than other alarm signals that start the system.



E. Smoke-Alarm Verification:

1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
2. Activate an NRTL-listed and -approved "alarm-verification" sequence at fire-alarm control unit and detector.
3. Record events by the system printer.
4. Sound general alarm if the alarm is verified.
5. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.

F. Elevator Recall:

1. Smoke detectors at the following locations shall initiate automatic elevator recall. Alarm-initiating devices, except those listed, shall not start elevator recall.
  - a. Elevator lobby detectors except the lobby detector on the designated floor.
  - b. Smoke detector in elevator machine room.
  - c. Smoke detectors in elevator hoistway.
2. Elevator lobby detectors located on the designated recall floors shall be programmed to move the cars to the alternate recall floor.
3. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.
  - a. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.

G. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke barrier walls shall be connected to fire-alarm system.

H. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values on system printer.

I. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

J. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided in a separate cabinet located in the fire command center.

1. Indicated number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711 and be listed by an NRTL.
    - a. Allow the application of and evacuation signal to indicated number of zones and, at same time, allow voice paging to the other zones selectively or in any combination.
    - b. Programmable tone and message sequence selection.
    - c. Standard digitally recorded messages for "Evacuation" and "All Clear."
    - d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification appliance circuits of fire-alarm control unit.
  2. Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighters' two-way telephone communication zones.
  3. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.
- K. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.
- L. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.
1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.
- M. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
1. Batteries: Sealed lead calcium.
- N. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.
- 2.4 MANUAL FIRE-ALARM BOXES
- A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color;

shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

1. Single-action mechanism, breaking-glass or plastic-rod pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
2. Station Reset: Key- or wrench-operated switch.

## 2.5 SYSTEM SMOKE DETECTORS

### A. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Detectors shall be four wire type.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.
7. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
  - a. Rate-of-rise temperature characteristic shall be selectable at fire-alarm control unit for 15 or 20 deg F per minute.
  - b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F .
  - c. Provide multiple levels of detection sensitivity for each sensor.

### B. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
  - a. Primary status.
  - b. Device type.
  - c. Present average value.
  - d. Present sensitivity selected.
  - e. Sensor range (normal, dirty, etc.).

### C. Ionization Smoke Detector:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
  - a. Primary status.
  - b. Device type.
  - c. Present average value.
  - d. Present sensitivity selected.
  - e. Sensor range (normal, dirty, etc.).

D. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
  - a. Primary status.
  - b. Device type.
  - c. Present average value.
  - d. Present sensitivity selected.
  - e. Sensor range (normal, dirty, etc.).
3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
4. Each sensor shall have multiple levels of detection sensitivity.
5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
6. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

## 2.6 NONSYSTEM SMOKE DETECTORS

A. Single-Station Smoke Detectors:

1. Comply with UL 217; suitable for NFPA 101, residential occupancies; operating at 120-V ac with 9-V dc battery as the secondary power source. Provide with "low" or "missing" battery chirping-sound device.
2. Auxiliary Relays: One Form A and one Form C, both rated at 0.5 A].
3. Audible Notification Appliance: Piezoelectric sounder rated at 90 dBA at 10 feet according to UL 464.
4. Visible Notification Appliance: 177-cd strobe.
5. Heat sensor, 135 deg F combination rate-of-rise and fixed temperature.
6. Test Switch: Push to test; simulates smoke at rated obscuration.
7. Tandem Connection: Allow tandem connection of number of indicated detectors; alarm on one detector shall actuate notification on all connected detectors.

8. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
9. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
10. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.

## 2.7 HEAT DETECTORS

- A. General Requirements for Heat Detectors: Comply with UL 521.
- B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.
  1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
  2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
- C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F .
  1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
  2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

## 2.8 NOTIFICATION APPLIANCES

- A. General Requirements for Notification Appliances: Individually addressed, connected to a signaling line circuit, equipped for mounting as indicated and with screw terminals for system connections.
- B. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated and with screw terminals for system connections.
  1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.
- C. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.

- D. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- high letters on the lens.
1. Rated Light Output:
    - a. 15/30/75/110 cd, selectable in the field.
  2. Mounting: Wall mounted unless otherwise indicated.
  3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
  4. Flashing shall be in a temporal pattern, synchronized with other units.
  5. Strobe Leads: Factory connected to screw terminals.
  6. Mounting Faceplate: Factory finished, red.
- E. Voice/Tone Notification Appliances:
1. Appliances shall comply with UL 1480 and shall be listed and labeled by an NRTL.
  2. High-Range Units: Rated 2 to 15 W.
  3. Low-Range Units: Rated 1 to 2 W.
  4. Mounting: Semirecessed.
  5. Matching Transformers: Tap range matched to acoustical environment of speaker location.

## 2.9 FIREFIGHTERS' TWO-WAY TELEPHONE COMMUNICATION SERVICE

- A. Dedicated, two-way, supervised, telephone voice communication links between fire-alarm control unit, the fire command center, and remote firefighters' telephone stations. Supervised telephone lines shall be connected to talk circuits by controls in a control module. Provide the following:
1. Selective-talk type for use by firefighters and fire wardens.
  2. Controls to disconnect phones from talk circuits if too many phones are in use simultaneously.
  3. Audible Pulse and Tone Generator, and High-Intensity Lamp: When a remote telephone is activated, it causes audible signal to sound and high-intensity lamp to flash.
  4. Selector panel controls shall provide for simultaneous operation of up to six telephones in selected zones. Indicate ground faults and open or shorted telephone lines on the panel front by individual LEDs.
  5. Display: Liquid-crystal digital to indicate location of caller.
  6. Remote Telephone Cabinet: Flush- or surface-mounted cabinet as indicated, factory-standard red finish, with handset.
    - a. Install one-piece handset to cabinet with vandal-resistant armored cord. Silk-screened or engraved label on cabinet door, designating "Fire Warden Phone" or "Fire Emergency Phone."
    - b. With "break-glass" type door access lock.

7. Remote Telephone Jack Stations: Single-gang, stainless-steel-plate mounted plug, engraved "Fire Warden Phone" or "Fire Emergency Phone."
8. Handsets: 2 push-to-talk-type sets with noise-canceling microphone stored in a cabinet adjacent to fire-alarm control unit in the fire command center.

## 2.10 MAGNETIC DOOR HOLDERS

- A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
  1. Electromagnet: Requires no more than 3 W to develop 25-lbf holding force.
  2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
  3. Rating: 24-V ac or dc.
  4. Rating: 120-V ac.
- B. Material and Finish: Match door hardware.

## 2.11 REMOTE ANNUNCIATOR

- A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.
  1. Mounting: Flush cabinet, NEMA 250, Type 1.
- B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

## 2.12 ADDRESSABLE INTERFACE DEVICE

- A. Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.
- B. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall and to circuit-breaker shunt trip for power shutdown.

## 2.13 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632 and be listed and labeled by an NRTL.
- B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture one telephone line(s) and dial a

preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

C. Local functions and display at the digital alarm communicator transmitter shall include the following:

1. Verification that both telephone lines are available.
2. Programming device.
3. LED display.
4. Manual test report function and manual transmission clear indication.
5. Communications failure with the central station or fire-alarm control unit.

D. Digital data transmission shall include the following:

1. Address of the alarm-initiating device.
2. Address of the supervisory signal.
3. Address of the trouble-initiating device.
4. Loss of ac supply or loss of power.
5. Low battery.
6. Abnormal test signal.
7. Communication bus failure.

E. Secondary Power: Integral rechargeable battery and automatic charger.

F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

## 2.14 RADIO ALARM TRANSMITTER

A. Transmitter shall comply with NFPA 1221 and shall be listed and labeled by an NRTL.

B. Comply with 47 CFR 90.

C. Description: Manufacturer's standard commercial product; factory assembled, wired, tested, and ready for installation and operation.

1. Packaging: A single, modular, NEMA 250, Type 1 metal enclosure with a tamper-resistant flush tumbler lock.
2. Signal Transmission Mode and Frequency: VHF or UHF 2-W power output, coordinated with operating characteristics of the established remote alarm receiving station designated by Owner.
3. Normal Power Input: 120-V ac.



4. Secondary Power: Integral-sealed, rechargeable, 12-V battery and charger. Comply with NFPA 72 requirements for battery capacity; submit calculations.
  5. Antenna: Omnidirectional, coaxial half-wave, dipole type with driving point impedance matched to transmitter and antenna cable output impedance. Wind-load strength of antenna and mounting hardware and supports shall withstand 100 mph with a gust factor of 1.3 without failure.
  6. Antenna Cable: Coaxial cable with impedance matched to the transmitter output impedance.
  7. Antenna-Cable Connectors: Weatherproof.
  8. Alarm Interface Devices: Circuit boards, modules, and other auxiliary devices, integral to the transmitter, matching fire-alarm and other system outputs to message-generating inputs of the transmitter that produce required message transmissions.
- D. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit or from its own internal sensors or controls and shall automatically transmit signal along with a unique code that identifies the transmitting station to the remote alarm receiving station. Transmitted messages shall correspond to standard designations for fire-reporting system to which the signal is being transmitted and shall include separately designated messages in response to the following events or conditions:
1. Transmitter Low-Battery Condition: Sent when battery voltage is below 85 percent of rated value.
  2. System Test Message: Initiated manually by a test switch within the transmitter cabinet, or automatically at an optionally preselected time, once every 24 hours, with transmission time controlled by a programmed timing device integral to transmitter controls.
  3. Transmitter Trouble Message: Actuated by failure, in excess of one-minute duration, of the transmitter normal power source, derangement of the wiring of the transmitter, or any alarm input interface circuit or device connected to it.
  4. Local Fire-Alarm-System Trouble Message: Initiated by events or conditions that cause a trouble signal to be indicated on the building system.
  5. Local Fire-Alarm-System Alarm Message: Actuated when the building system goes into an alarm state. Identifies device that initiated the alarm.
  6. Local Fire-Alarm-System Supervisory-Alarm Message: Actuated when the building alarm system indicates a supervisory alarm.

## 2.15 SYSTEM PRINTER

- A. Printer shall be listed and labeled by an NRTL as an integral part of fire-alarm system.

## 2.16 DEVICE GUARDS

- A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.

1. Factory fabricated and furnished by manufacturer of device.
2. Finish: Paint of color to match the protected device.

## PART 3 - EXECUTION

### 3.1 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72 for installation of fire-alarm equipment.
- B. Install wall-mounted equipment, with tops of cabinets not more than 72 inches above the finished floor.
- C. Smoke- or Heat-Detector Spacing:
  1. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.
  2. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.
  3. Smooth ceiling spacing shall not exceed 30 feet .
  4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A in NFPA 72.
  5. HVAC: Locate detectors not closer than 5 feet from air-supply diffuser or return-air opening.
  6. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture.
- D. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.
- E. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.
- F. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.
- G. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.
- H. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.
- I. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling.

- J. Device Location-Indicating Lights: Locate in public space near the device they monitor.
- K. Fire-Alarm Control Unit: Surface mounted, with tops of cabinets not more than 72 inches above the finished floor.
- L. Annunciator: Install with top of panel not more than 72 inches above the finished floor.
- M. Antenna for Radio Alarm Transmitter: Mount to building structure where indicated. Use mounting arrangement and substrate connection that will resist 100-mph wind load with a gust factor of 1.3 without damage.

### 3.2 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 08 Section "Door Hardware." Connect hardware and devices to fire-alarm system.
  - 1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
  - 1. Alarm-initiating connection to smoke-control system (smoke management) at firefighter smoke-control system panel.
  - 2. Alarm-initiating connection to stairwell and elevator-shaft pressurization systems.
  - 3. Smoke dampers in air ducts of designated air-conditioning duct systems.
  - 4. Alarm-initiating connection to elevator recall system and components.
  - 5. Alarm-initiating connection to activate emergency lighting control.
  - 6. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
  - 7. Supervisory connections at valve supervisory switches.
  - 8. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
  - 9. Supervisory connections at elevator shunt trip breaker.
  - 10. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.
  - 11. Supervisory connections at fire-pump engine control panel.

### 3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- B. Install framed instructions in a location visible from fire-alarm control unit.

3.4 GROUNDING

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION

## SECTION 31 1000

### SITE CLEARING

#### PART 1 - GENERAL

##### 1.1 SUMMARY

- A. This Section includes the following:
  - 1. Protecting existing trees shrubs plants and grass to remain.
  - 2. Removing existing trees shrubs plants and grass.
  - 3. Clearing and grubbing.
  - 4. Stripping and stockpiling topsoil.
  - 5. Removing above- and below-grade site improvements.
  - 6. Disconnecting and capping or sealing site utilities.
  - 7. Temporary erosion and sedimentation control measures.

##### 1.2 MATERIAL OWNERSHIP

- A. Except for stripped topsoil or other materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

##### 1.3 PROJECT 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 traffic ways if required by authorities having jurisdiction.
- B. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.
- C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
- D. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

## **PART 2 - PRODUCTS**

### **2.1 SOIL MATERIALS**

- A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Division 31 Section "Earth Moving".
  - 1. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site.

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Locate and clearly flag trees and vegetation to remain or to be relocated.
- 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 requirements of authorities having jurisdiction and erosion and sediment control drawings.
- B. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- C. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

### **3.3 TREE PROTECTION**

- A. Erect and maintain temporary fencing around tree protection zones before starting site clearing. Remove fence when construction is complete.
- B. Do not excavate within tree protection zones, unless otherwise indicated.
- C. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Architect.

### 3.4 UTILITIES

- A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.
  - 1. Arrange with utility companies to shut off indicated utilities.
- B. 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 Architect not less than two days in advance of proposed utility interruptions.
  - 2. Do not proceed with utility interruptions without Architect's written permission.
- C. Removal of underground utilities is included in Division 2 Sections covering site utilities.

### 3.5 CLEARING AND GRUBBING

- A. 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, and compact each layer to a density required for the proposed condition and as specified in Division 31 Section "Earth Moving".

### 3.6 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.
- C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.
  - 1. Limit height of topsoil stockpiles to 72 inches
  - 2. Dispose of excess topsoil as specified for waste material disposal
  - 3. Do not stockpile topsoil within drip line of trees to remain.

### 3.7 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.

3.8 DISPOSAL

- A. Disposal: 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.
  - 1. 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.

**END OF SECTION 31 1000**



**SECTION 31 2000  
EARTH MOVING**

**PART 1 - GENERAL**

1.1 SUMMARY

A. This Section includes the following:

1. Preparing subgrades for walks, pavements, lawns and grasses and exterior plants.
2. Base course for concrete walks and pavements.
3. Base course for asphalt paving.
4. Excavating and backfilling for utility trenches.
5. Excavating and backfilling trenches for buried mechanical, plumbing and electrical utilities and pits for buried utility structures.

B. Related Sections include the following:

1. Divisions 21, 22, 23, 26, 27, and 28 Sections for installing underground mechanical and electrical utilities and buried mechanical and electrical structures.
2. Division 31 Section "Site Clearing" for temporary erosion and sedimentation control measures, site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.

1.2 DEFINITIONS

A. Backfill: Soil 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: Course placed between the subbase course and paving.

C. Bedding Course: Course 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 Fill:

1. Course placed over the excavated subgrade before laying subdrainage pipe and placed around and over the subdrainage pipe.

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 Architect. Authorized additional

excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.
- G. Fill: Soil materials used to raise existing grades.
- H. Structures: Modular Block Retaining walls, slabs on-grade (**excluding building**), tanks, curbs, sewerage, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface **excluding building**.
- I. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below base, drainage fill, or topsoil materials.
- J. Utilities: On-site underground pipes, conduits, ducts, and cables.

### 1.3 SUBMITTALS

- A. Product Data: For the following:
1. Geotextiles.
- B. QUALITY ASSURANCE Geotechnical Testing Agency Qualifications: An independent testing agency qualified according to ASTM E 329 to conduct soil materials and rock-definition testing, as documented according to ASTM D 3740 and ASTM E 548.
1. Contractor shall be responsible for contacting the Owner's Geotechnical Testing Agency at those times required by the specifications for the appropriate materials and soils testing.
  2. Contractor shall coordinate with the Owner's Geotechnical Testing Agency as to the Testing Agency's requirements for advance notification, but allow for a minimum 24-hr notification.

### 1.4 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated.
1. Notify Architect not less than two days in advance of proposed utility interruptions.
  2. Do not proceed with utility interruptions without Architect's written permission.
  3. Contact utility-locator service for area where Project is located before excavating.
- B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

## PART 2 - PRODUCTS

### 2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: ASTM D 2487 Soil Classification Groups GW, GP, GM, GC, SC, SW, SP, ML, CL and SM, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
- C. Unsatisfactory Soils: Soil Classification Groups MH, CH, OL, OH, and PT according to ASTM D 2487, or a combination of these groups.
  - 1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
  - 2. Unsatisfactory soils hereunder are Clean Construction or Demolition Debris (CCDD) as defined by the State of Illinois Environmental Protection Agency and is acceptable as fill material at CCDD facilities.
- D. Non-special Waste Containing Soils: Either satisfactory or unsatisfactory soils that contain non-special waste that are non-liquid non-hazardous industrial process and pollution control waste and are excluded from special waste meeting all the requirements of Section 3.475 of the Illinois Environmental Protection Act.
  - 1. Are not CCDD
  - 2. Are not hazardous
  - 3. Are not a liquid (as determined by paint-filter test SW-846 Method 9095)
  - 4. Are not regulated asbestos-containing material as defined in 40 Code of Federal Regulations, Section 61.141
  - 5. Do not contain polychlorinated biphenyls (PCBs) regulated in accordance with 40 Code of Federal Regulations, Part 761
  - 6. Are not formerly hazardous waste rendered non-hazardous
  - 7. Do not result from shredding recyclable metals
- E. Non-Hazardous Special Waste Containing Soils: Either satisfactory or unsatisfactory soils that contain special waste as defined by Illinois Environmental Protection Act (Act) Section 809.103 and that has not been determined as hazardous in that Section of the Act.
- F. Hazardous Waste Containing Soils: Either satisfactory or unsatisfactory soils that contain hazardous special waste as defined by Section 3.220 of the Illinois Environmental Protection Act and as determined by Section 722.111 of Title 35 of Illinois Administrative Code.
- G. Topsoil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 4 percent organic material content; less than 3 percent stones ¾-inch or larger in any dimension and roots, plants, sod, clay lumps, and other extraneous materials harmful to plant growth.
  - 1. Topsoil shall be free of all deleterious material that may adversely affect the use of the planted surface including any metal, wood, plastic, glass or other manmade materials not intended specifically as a soil supplement.

2. Topsoil shall be free of obnoxious weeds and invasive plants or other undesirable organisms and disease-causing plant pathogens.
  3. Topsoil particle sizes shall fall in the following ranges as percentages by mass both separately and in combination:
    - a. Clay: 35 percent to 60 percent
    - b. Silt: 35 percent to 60 percent
    - c. Sand: less than 60 percent
    - d. Silt and Clay in combination: less than 65 percent
  4. Topsoil Source: Reuse surface soil stockpiled on-site. Verify suitability of stockpiled surface soil to produce topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
    - a. Supplement with imported topsoil from off-site sources when quantities are insufficient. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 6 inches deep; do not obtain from bogs or marshes.
- H. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone ASTM D 2940; conforming to State of Illinois, Dept of Transportation Gradation CA-6.
- I. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone; ASTM D 2940; conforming to State of Illinois, Dept of Transportation Gradation CA-6 or CA-7.
- J. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; conforming to State of Illinois, Dept of Transportation Gradation CA-11.
- K. Drainage Fill: Narrowly graded mixture of washed crushed stone, or washed crushed or uncrushed gravel; ASTM D 448; coarse-aggregate conforming to State of Illinois, Dept of Transportation Gradation CA-14

## 2.2 GEOTEXTILES

- A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
1. Survivability: Class 2; AASHTO M 288.
  2. Grab Tensile Strength: 248 lbf; ASTM D 4632.
  3. Sewn Seam Strength: 223 lbf ; ASTM D 4632.
  4. Tear Strength: 90 lbf; ASTM D 4533.
  5. Puncture Strength: 90 lbf ;ASTM D 4833.
  6. Apparent Opening Size: No. 60 sieve, maximum; ASTM D 4751.
  7. Water Flow Rate: 110 gpm minimum; ASTM D 4491
  8. Permittivity: 0.02 per second, minimum; ASTM D 4491.
  9. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

## **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 earthwork operations.
- B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 31 Section "Site Clearing."
- C. Protect and maintain erosion and sedimentation controls during earthwork operations.
- D. Provide protective insulating materials to protect subgrades and foundation soils against freezing temperatures or frost.

### **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. Discharge from dewatering operations must meet with local and State National Pollutant Discharge Elimination System (NPDES) requirements.
  - 1. Incorporate structural and non-structural Best Management Practices (BMP's) as necessary to meet NPDES and local requirements.
  - 2. Waste material shall be legally disposed of where mechanical means are used to separate sediments and other pollutants from dewatering discharge water
- C. 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.
  - 2. Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

### **3.3 EXPLOSIVES**

- A. Explosives: Do not use explosives.

### **3.4 EXCAVATION, GENERAL**

- A. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Architect.

1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.
  - a. Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.
2. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations 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 1/2 inch. 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. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

### 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.
- B. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit and as indicated. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits as indicated. Remove projecting stones and sharp objects along trench subgrade.

### 3.8 SUBGRADE INSPECTION

- A. Notify Owner's Geotechnical Testing Agency when excavations have reached required subgrade.
- B. If Owner's Geotechnical Testing Agency 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 heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
  2. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
  3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, 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 Architect, without additional compensation.

### 3.9 UNAUTHORIZED EXCAVATION

1. Fill unauthorized excavations under other construction or utility pipe as directed by Owner's Geotechnical Testing Agency.

### 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. Surveying locations of underground utilities for Record Documents.
  2. Testing and inspecting underground utilities.
  3. Removing concrete formwork.
  4. Removing trash and debris.
  5. Removing temporary shoring and bracing, and sheeting.
  6. 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.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
- C. Place and compact final backfill to final subgrade elevation and as indicated.
1. Under or within two feet of pavement edge or building use Engineered Fill as backfill
  2. Under non pavement areas use satisfactory soil as backfill

### 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 other slabs on grade 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 2 percent of optimum moisture content.
1. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
  2. Remove and replace, or scarify and air dry otherwise satisfactory material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

### 3.15 COMPACTION OF BACKFILLS AND FILLS

- A. Place backfill and fill materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
- C. Compact materials to not less than the following percentages of maximum dry density according to ASTM D 1557



1. Under structures, slabs on grade, and steps scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent Modified Proctor.
2. Under pavements, curbs and walks, scarify and recompact top 4 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent Modified Proctor.
3. Under lawn or unpaved areas compact each layer of backfill or fill soil material at 85 percent Modified Proctor.

### 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 Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
  1. Lawn or Unpaved Areas: Plus or minus 1 inch.
  2. Walks: Plus or minus 1/2 inch.
  3. Pavements: Plus or minus [1/2 inch.
- C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

### 3.17 SUBSURFACE DRAINAGE

- A. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade, in compacted layers 6 inches (150 mm) thick. Overlay drainage backfill with 1 layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches .
  1. Compact each material layer to **85** percent of maximum dry unit weight according to ASTM D 1557.

### 3.18 BASE COURSE

- A. Place base course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place 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. Shape base course to required crown elevations and cross-slope grades.
  3. Place base course 4 inches or less in compacted thickness in a single layer.

4. Compact base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

### 3.19 FIELD QUALITY CONTROL

- A. Geotechnical Testing Agency: Owner will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.
- B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.
- C. Testing agency will test compaction of soils in place according to ASTM D 1557 and ASTM D6938, as applicable. Tests will be performed at the following locations and frequencies:
  1. Paved Areas: At subgrade and at each compacted fill and backfill layer, at least 1 test for every 3500 sq. ft. or less of paved area, but in no case fewer than 2 tests.
  2. Trench Backfill: At each compacted initial and final backfill layer, at least 1 test for each 250 feet or less of trench length, but no fewer than 1 tests.
- D. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

### 3.20 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.

### 3.21 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

1. Remove waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

**END OF SECTION 31 2000**

**SECTION 32 1216  
ASPHALT 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.

1.2 SUMMARY

A. Section Includes:

- 1. Hot-mix asphalt paving.
- 2. Asphalt surface treatments.
- 3. Pavement-marking paint.

B. Related Sections:

- 1. Division 31 Section "Earth Moving" for aggregate subbase and base courses and for aggregate pavement shoulders.

1.3 DEFINITION

- A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

- 1. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.

- B. Material Certificates: For each paving material, from manufacturer.

- C. Material Test Reports: For each paving material.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Imprinted-asphalt manufacturer's authorized installer who is trained and approved for installation of imprinted asphalt required for this Project.

- B. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.
- C. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of IDOT for asphalt paving work.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.
  - 1. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.

#### 1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:
  - 1. HMA Temperature: Delivered between 250 deg F and 350 deg F
  - 2. Prime Coat: Minimum surface temperature of 60 deg F
  - 3. Slurry Coat: Comply with weather limitations in ASTM D 3910.
  - 4. Asphalt Base Course: Minimum surface temperature of 40 deg F in the shade and rising at time of placement.
  - 5. Asphalt Surface Course: Minimum surface temperature of 45 deg F in the shade at time of placement and rising at time of placement.
- B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 55 deg F for water-based materials, and not exceeding 95 deg F. When more restrictive, manufacturer limits shall be adhered to.

### **PART 2 - PRODUCTS**

#### 2.1 AGGREGATES

- A. General: Use materials and gradations that have performed satisfactorily in previous installations.
- B. Coarse Aggregate: ASTM D 692, sound; angular crushed stone, crushed gravel.
  - 1. Used in Surface Course: IDOT B Quality or better
  - 2. Used in Binder Course: IDOT C Quality or better

- C. Fine Aggregate: ASTM D 1073, sharp-edged natural sand or sand prepared from stone, gravel, or combinations thereof.
  - 1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.
  - 2. Quality: IDOT B Quality or better.
  
- D. Fractionated Reclaimed Asphalt Pavement (FRAP) shall consist of RAP from Class I HMA mixtures. Coarse aggregate in FRAP shall be crushed aggregate and may represent more than one aggregate type and/or quality but shall be at least C quality or as below where more stringent. All FRAP shall be fractionated prior to testing. Testing shall be per and meet all IDOT requirements.
  - 1. Used in HMA Surface Course, N50: Coarse aggregate quality B or better.
    - a. Where FRAP is used alone, or where FRAP/RAS are used in conjunction the Maximum (virgin) Asphalt Binder Replacement (ABR) shall not exceed 25%. Where ABR exceeds 20% the low and high virgin asphalt grades shall each be reduced by one grade.
  - 2. Used in HMA Binder Coarse, N50: Coarse aggregate quality C or better.
    - a. Where FRAP is used alone, or where FRAP/RAS are used in conjunction the Maximum (virgin) Asphalt Binder Replacement (ABR) shall not exceed 30%. Where ABR exceeds 20% the low and high virgin asphalt grades shall each be reduced by one grade
  
- E. Mineral Filler: ASTM D 242, rock or slag dust, hydraulic cement, or other inert material.

## 2.2 ASPHALT MATERIALS

- A. Asphalt Binder: AASHTO M 320 and AASHTO MP 1a, PG64-22, PG 58-28, PG58-22
- B. Prime Coat: ASTM D 2027, medium-curing cutback asphalt matching IDOT MC-30 per Section 1032 of the Standard Specifications for Road and Bridge construction.
- C. Tack Coat: IDOT SS-1, SS-1hP, CSS-1, CSS-1hP, emulsified asphalt or cationic emulsified asphalt, slow curing, diluted in water, per Section 1032 of the Standard Specifications for Road and Bridge Construction and of suitable grade and consistency for application.
- D. Water: Potable.

## 2.3 AUXILIARY MATERIALS

- A. Joint Sealant: ASTM D 6690 or AASHTO M 324 Type II or III , hot-applied, single-component, polymer-modified bituminous sealant.

- B. Pavement-Marking Paint: Alkyd-resin type, lead and chromate free, ready mixed, complying with AASHTO M 248, Type N Type F Type S; colors complying with FS TT-P-1952.
  - 1. Color: White
  - 2. Color: Accessible Spaces Yellow
- C. Glass Beads: AASHTO M 247, Type 1.
- D. Wheel Stops: Precast, air-entrained concrete, 3500-psi minimum compressive strength. Provide chamfered corners, drainage slots on underside, and holes for anchoring to substrate.
  - 1. Dowels: Reinforcing Bars: ASTM A 615, Grade 60; deformed

## 2.4 MIXES

- A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes designed according to the Illinois Modified Strategic Highway Research Program criteria and the IDOT Special Provision "Superpave Bituminous Concrete Mixtures".
  - 1. Binder Course Mixture N50, IL-19.0, Surface Course Mixture N50, IL-9.5, Mix "DE" designed in accordance with Sections 1030 and Sections 406 and 407 of the Standard Specifications for Road and Bridge Construction and the special provision, "Quality Control/Quality Assurance of Bituminous Concrete Mixtures."
  - 2. Provide mixes with a history of satisfactory performance in geographical area where Project is located.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that subgrade is dry and in suitable condition to begin paving.
- B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
  - 1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
  - 2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
  - 3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.
- C. Proceed with paving only after unsatisfactory conditions have been corrected.

- D. Verify that utilities, traffic loop detectors, and other items requiring a cut and installation beneath the asphalt surface have been completed and that asphalt surface has been repaired flush with adjacent asphalt prior to beginning installation of imprinted asphalt.

### 3.2 SURFACE PREPARATION

- A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.
- B. Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.15 to 0.50 gal./sq. yd and per Drawings. Apply enough material to penetrate and seal but not flood surface. Allow prime coat to cure.
  - 1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
  - 2. Protect primed substrate from damage until ready to receive paving.
- C. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.
  - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
  - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

### 3.3 HOT-MIX ASPHALT PLACING

- A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
  - 1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
  - 2. Spread mix at minimum temperature of 250 deg F.
  - 3. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
  - 4. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
- B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.
  - 1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.



- C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

### 3.4 JOINTS

- A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.
  - 1. Clean contact surfaces and apply tack coat to joints.
  - 2. Offset longitudinal joints, in successive courses, a minimum of 6 inches and not more than 12 inches.
  - 3. Offset transverse joints, in successive courses, a minimum of 24 inches.
  - 4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints according to AI MS22, for both "Ending a Lane" and "Resumption of Paving Operations."
  - 5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
  - 6. Compact asphalt at joints to a density within 2 percent of specified course density.

### 3.5 COMPACTION

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.
  - 1. Complete compaction before mix temperature cools to 195 deg F.
- B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.
- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
  - 1. Average Density: 95 percent of reference laboratory density based on AASHTO T 209 and Illinois Modified AASHTO T 166 or "In Place Nuclear Method" according to Illinois Modified ASTM D 2950 but not less than 92 percent nor greater than 98 percent.
- D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
- E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

- F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.
- G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

### 3.6 INSTALLATION TOLERANCES

- A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
  - 1. Base Course: Plus 1/2 inch, Minus 1/4 inch
  - 2. Surface Course: Plus 1/4 inch, no minus.
- B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
  - 1. Base Course: 1/4 inch.
  - 2. Surface Course: 1/8 inch.
  - 3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

### 3.7 SURFACE TREATMENTS

- A. Fog Seals: Apply fog seal at a rate of 0.10 to 0.15 gal./sq. yd. to existing asphalt pavement and allow to cure. With fine sand, lightly dust areas receiving excess fog seal.
- B. Slurry Seals: Apply slurry coat in a uniform thickness according to ASTM D 3910 and allow to cure.
  - 1. Roll slurry seal to remove ridges and provide a uniform, smooth surface.

### 3.8 PAVEMENT MARKING

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.
- B. Allow paving to age for 30 days before starting pavement marking.
- C. Sweep and clean surface to eliminate loose material and dust.

- D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

### 3.9 WHEEL STOPS

- A. Install wheel stops in bed of adhesive as recommended by manufacturer.
- B. Securely attach wheel stops to pavement with not less than two galvanized-steel dowels embedded at one-quarter to one-third points. Securely install dowels into pavement and bond to wheel stop. Recess head of dowel beneath top of wheel stop.

### 3.10 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.
- C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.
- D. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to AASHTO T 168.
  - 1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
  - 2. Field density of in-place compacted pavement to be determined by "In Place Nuclear Method" according to Illinois Modified ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.
  - 3. Average Density: 95 percent of reference laboratory density based on AASHTO T 209 and Illinois Modified AASHTO T 166 or "In Place Nuclear Method" according to Illinois Modified ASTM D 2950 but not less than 92 percent nor greater than 98 percent
- E. Replace and compact hot-mix asphalt where core tests were taken.
- F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

### 3.11 DISPOSAL

- A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

1. Do not allow milled materials to accumulate on-site.

**END OF SECTION 32 1216**

**SECTION 32 1313  
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.

1.2 SUMMARY

- A. This Section includes exterior cement concrete pavement for the following:
  - 1. Driveways and roadways.
  - 2. Parking lots.
  - 3. Curbs and gutters.
  - 4. Walkways.
- B. Related Sections include the following:
  - 1. Division 31 Section "Earth Moving" for subgrade preparation, grading, and subbase course.

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

SUBMITTALS

- B. Product Data: For each type of manufactured material and product indicated.
- C. Design Mixtures: For each concrete pavement mixture. Include alternate mixture designs when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
- D. Field quality-control test reports.
- E. Testing Agency Qualifications: An independent agency 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.

- F. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by requirements in the Contract Documents.
- G. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

#### 1.4 PROJECT CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

### **PART 2 - PRODUCTS**

#### 2.1 FORMS

- A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.
  - 1. Use flexible or curved forms for curves with a radius 100 feet or less.
- B. 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.

#### 2.2 STEEL REINFORCEMENT

- A. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.
- B. Reinforcing Bars: ASTM A 615, Grade 60; deformed.
- C. Joint Dowel Bars: Plain steel bars, ASTM A 615, Grade 60. Cut bars true to length with ends square and free of burrs.
- D. Epoxy-Coated Joint Dowel Bars: ASTM A 775; with ASTM A 615, Grade 60 , plain steel bars.

#### 2.3 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source throughout the Project:
  - 1. Portland Cement: ASTM C 150, Type I/II, gray, Supplement with the following:
    - a. Fly Ash: ASTM C 618, Class F.

- B. Normal-Weight Aggregates: ASTM C 33 Class 4S, coarse aggregate, uniformly graded. Provide aggregates from a single source.
  - 1. Maximum Coarse-Aggregate Size: 1-1/2" nominal.
  - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Water: ASTM C 94/C 94M.
- D. Air-Entraining Admixture: ASTM C 260.
- E. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
  - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.

#### 2.4 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.
- D. Clear Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.
- E. Concrete Sealer: Water based USEPA VOC compliant penetrating sealer for concrete. Cured concrete to conform to ASTM C309.
  - 1. Dries to low or medium luster, UV resistant, no color change.
  - 2. Reduction of Water absorption (NCHRP Series II): 75% minimum
  - 3. Reduction of Chloride Ion absorption (NCHRP Series II): 85% minimum.

#### 2.5 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

#### 2.6 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.
  - 1. Use a qualified independent testing agency for preparing and reporting proposed concrete mixture designs for the trial batch method.
- B. Proportion mixtures to provide normal-weight concrete with the following properties:

1. Minimum Compressive Strength (28 Days): 4000 psi.
  2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.32-0.42.
  3. Slump Limit: 4 inches , plus or minus 1/2 inch.
- C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
1. Air Content: 5 to 8 percent for 1-inch to 1-1/2-inch nominal maximum aggregate size.
- D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
1. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
- F. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements for concrete exposed to deicing chemicals.
- G. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

## 2.7 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C and ASTM C 1116. Furnish batch certificates for each batch discharged and used in the Work.
1. When air temperature is between 85 deg F 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 45 minutes.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- B. Proof-roll prepared subbase surface below concrete pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding.
1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
  2. Proof-roll with a loaded 10-wheel tandem-axle dump truck weighing not less than 15 tons.



3. Subbase with soft spots and areas of pumping or rutting exceeding depth of 1 inch require correction according to requirements in Division 31 Section "Earth Moving."

C. Proceed with concrete pavement operations only after nonconforming conditions have been corrected and subgrade is ready to receive pavement.

### 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 for pavement 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

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

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

E. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M.

F. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap of adjacent mats.

### 3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.

1. When joining existing pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.
- B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour unless pavement terminates at isolation joints.
  1. Continue steel reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.
- C. Isolation/Expansion Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
  1. Locate expansion joints at intervals of 40 feet, unless otherwise indicated.
  2. Extend joint fillers full width and depth of joint.
  3. Terminate joint filler not less than 1/2 inch or more than 3/4 inch 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. Protect top edge of joint filler during concrete placement 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. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover marks on concrete surfaces.
- E. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

### 3.6 CONCRETE PLACEMENT

- A. Inspection: Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast in. Notify other trades to permit installation of their work.
- B. Remove snow, ice, or frost from subbase surface and 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 requirements for measuring, mixing, transporting, and placing concrete.
- E. Do not add water to concrete during delivery or at Project site.
- F. Do not add water to fresh concrete after testing.
- G. 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.
- H. Consolidate concrete according to ACI 301 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.
- I. Screed pavement surfaces with a straightedge and strike off.
- J. Commence initial floating using bull floats or darbies to impart an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.
- K. Curbs and Gutters: When automatic machine placement is used for curb and gutter placement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing as specified for formed concrete. If results are not approved, remove and replace with formed concrete.
- L. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.
- M. 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 air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 75 deg F 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 mix designs.

- N. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:
1. Cool ingredients before mixing to 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. 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.

### 3.7 FLOAT FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.
- B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
1. Medium-to-Fine-Textured Broom Finish: Draw a soft bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

### 3.8 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Comply with ACI 306.1 for cold-weather protection.
- C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:
1. Moist 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. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

### 3.9 PAVEMENT TOLERANCES

A. Comply with tolerances of ACI 117 and as follows:

1. Elevation: 1/4 inch.
2. Thickness: Plus 3/8 inch , minus 1/4 inch.
3. Surface: Gap below 10-foot- long, unlevelled straightedge not to exceed 1/4 inch.
4. Lateral Alignment and Spacing of Tie Bars and Dowels: 1 inch.
5. Vertical Alignment of Tie Bars and Dowels: 1/4 inch.
6. Alignment of Tie-Bar End Relative to Line Perpendicular to Pavement Edge: 1/2 in.
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel 1/4 inch per 12 inches.
8. Joint Spacing: 3 inches.
9. Contraction Joint Depth: Plus 1/4 inch, no minus.
10. Joint Width: Plus 1/8 inch, no minus.

### 3.10 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing Services: 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 1 composite sample for each 30 cu. Yd. or fraction thereof of each concrete mix 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 mix. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
4. 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.

5. Compression Test Specimens: ASTM C 31; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C 39/C 39M; test 1 specimen at 7 days and 2 specimens at 28 days.
  - a. A compressive-strength test shall be the average compressive strength from 2 specimens obtained from same composite sample and tested at 28 days.
- C. Strength of each concrete mix will be satisfactory if average of any 3 consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 300 psi.
- D. 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.
- 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. Remove and replace concrete pavement where test results indicate that it does not comply with specified requirements.
- H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

### 3.11 REPAIRS AND PROTECTION

- A. Remove and replace concrete pavement that is broken, damaged, or defective or that does not comply with requirements in this Section.
  1. Remove and replace concrete that is discolored or non-uniform in color.
- B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to pavement with epoxy adhesive.
- C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.

- D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

**END OF SECTION 32 1313**

**SECTION 32 9100**  
**SOIL PREPARATION AND FINE GRADING**

**PART 1 - GENERAL**

1.1 DESCRIPTION

A. Section Includes

1. Furnish and placement of subsoil, topsoil and planting mixtures to meet finish grade elevations.
2. Soil testing of supplemental topsoil.
3. Excavation of landscape areas including tree pits, planting beds, turf areas, and planters to receive planting mixtures or topsoil to the specified depths.
4. Preparation and placement of topsoil and planting mixtures in landscape areas to required finished grades including all soil amendments.
5. Finished grading of all landscape areas.

1.2 RELATED SECTIONS

- A. Section 32 9300 Exterior Landscape

1.3 QUALITY ASSURANCE

A. Qualifications

1. The contractor shall be a company specializing in landscape construction with a minimum of five (5) years of experience on comparable projects.

B. Code and Standards Compliance

1. All materials and work shall comply with applicable codes, standards and with the requirements of local agencies. The Contractor shall obtain all permits required.

1.4 SUBMITTALS

A. Topsoil Data

1. Provide, to the Architect, the location(s) and name(s) of topsoil sources from which supplemental topsoil is to be obtained for the project, approximate quantities obtained at each site, depth at which soil was taken and indicate whether crops had grown on site(s).

B. Soil Testing



1. The Contractor shall submit a complete soils report to the Landscape Architect. Soils report shall include complete physical and chemical analysis of import topsoil to be used on site, including, but not limited to, the following parameters:
  - a. U.S.D.A. soil classification  
Percent of sand  
Percent of clay  
Percent of silt
  - b. Chemical analysis including:  
Exchange Capacity  
pH  
Organic Matter
  - c. Major Anions  
Soluble Sulfur  
Extractable Phosphorus  
Bray II Phosphorus
  - d. Major Cation's amounts and percentage of Base Saturation  
Calcium  
Magnesium  
Potassium  
Sodium  
Hydrogen
  - e. Extractable Minors  
Boron  
Iron  
Manganese  
Copper  
Zinc  
Aluminum
2. Report shall include recommendations for fertilization and soil amendment to provide a complete soil that will ensure vigorous growth for all plants specified. Soils report to include analysis of a minimum of three (3) soil samples from different locations.
3. Sampling Procedure:
  - a. Take a minimum of 8 cores 6" to 8" deep.
  - b. Place cores in a paper bag for shipping.

C. Other Samples

The following materials shall be submitted to the Landscape Architect for approval prior to delivery to the site.

1. Submit 1 quart samples of imported topsoil, sand, soil conditioner and mulch to be used in preparation of the plating mix for review.

## 1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

### A. Topsoil and Planting Mixtures

1. Coordinate and deliver soil to pre-approved staging areas. Inform the Landscape Architect of all delivery schedules, twenty-four (24) hours in advance of delivery.
2. All deliveries of topsoil which in any way fails to meet the requirements of these specifications will be rejected, and the Contractor shall immediately remove such rejected topsoil from the premises and supply suitable topsoil and in its place.
3. No deliveries will be permitted when weather conditions are unsatisfactory, or if the approved staging area is not in a satisfactory condition to receive soil materials. No frozen soil material will be accepted. Do not deliver or handle soil in wet, muddy or frozen conditions. Protect stockpiles from winds and disturbance with landscape fabric or other material.
4. Trucks making deliveries shall use routes as directed to avoid damage to property. The Contractor shall deliver soil materials in dump trucks having pneumatic tires and shall be unloaded from the trucks where directed. All soil material that is deposited other than in the place designated shall be moved.

### B. Other Materials

1. Handle and store all other materials according to manufacturer's recommendations.

## 1.6 JOB CONDITIONS

### A. General

1. Prior to beginning work, the Contractor shall examine and verify the acceptability of the job site and notify the Architect of unsatisfactory conditions. The Contractor shall not proceed with the work until unsatisfactory conditions have been corrected or resolved.
2. Where soil preparation occurs in close proximity to other site improvements, adequate protection shall be given to all features prior to commencing work. Any items damaged during soil preparation operations shall be promptly repaired to their original condition at no addition to the Base Contract Price.

### B. Utilities

1. Have all underground utilities located by servicing agencies. In the vicinity of utilities, hand excavate to minimize the possibility of damage to underground utilities.

### C. Excavation

1. When conditions detrimental to plant growth are encountered such as limestone, rubble fill, adverse drainage conditions, or obstruction, notify the Landscape Architect prior to placement of any soil.

**PART 2 - PRODUCTS**

**2.1 MATERIALS**

**A. Subsoil Fill**

1. Where site conditions require a layer of fill below the specified landscape area depth, provide a clean, debris-free mineral material with a brown sandy clay content and granular material with no stones measuring larger than one inch in diameter. The pH should range between 5.5 to 6.6 with no limestone present. Gray clay soils will not be accepted.

**B. At Grade Planting Mixture Materials**

**1. Topsoil**

- a. Provide imported topsoil material as required to complete work.
- b. Topsoil shall be a sandy loam mineral soil, uniform in color and texture; corresponding to native soils; containing no grass roots, sod, weeds, rocks, stiff clay, clods, or other substance undesirable to plant growth. The soil shall be loose, friable, and of good tilth. The pH shall range between 5.5 to 6.5.
- c. Nutrient data as follows. All soil sampling and testing shall comply with procedures in the USDA Ag. Handbook 60: Diagnosis and Improvement of Saline and Alkali Soils.

Phosphorus	Min. 75 lbs / ac
Potassium	Min. 300 lbs / ac
Calcium	Min. 1,500 ppm
Cation Exchange Capacity	Min. 20 meq / 100g
Soluble Salt	Max. 1,000 ppm

- d. Organic content shall not be less than 3 percent and not greater than 5 percent determined by loss of ignition.

**e. Gradation:**

<u>Sieve Designation</u>	<u>Percent Passing</u>
No. 4 (4.76 mm)	100
No. 10 (2.00 mm)	95 - 100
No. 18 (1.00 mm)	90 - 100
No. 35 (500 micron)	65 - 100
No. 60 (250 micron)	0 - 50
No. 140 (105 micron)	0 -20

No. 270 (53 micron) 0 -10

f. Textural Grades:

Fine gravel, coarse sand, medium sand	20 - 40 %
Silt	25 - 60 %
Clay	5 - 20 %

Clay content shall be determined by Bouyoucous hydrometer Test.

2. Sand shall be clean, sharp, coarse sand passing 1/4" mesh screen and free of foreign and organic matter. The pH shall range between 5.5 to 6.5.
3. Mulch and Soil Conditioner shall be MicroJungle Eco-Step or approved equal. Supplied by:

Lake Street Landscape Supply  
1810 W. Lake Street  
Chicago, IL 60612  
Phone: 312-226-0760  
Fax: 312-226-0761

C. Infiltration Planter Mix

1. Soil Matrix: Composed of the following quantities:

Coarse Sand	70 %
Approved Compost	10 %
Free draining stone or pea gravel	10 %
Screened topsoil	10 %

2. The infiltration soil shall be a uniform mix, free of stones, stumps, roots, or other similar objects. No other materials or substances shall be mixed or dumped within the bioswale area that may be harmful to plant growth, or prove a hindrance to the planting or maintenance operations. The infiltration soil shall be free of Bermuda Grass, Quackgrass, Johnson Grass, Mugwort, Nutsedge, Poison Ivy, Canadian Thistle, Tearthumb, or other noxious weeds.

D. Planting Mixtures

All landscape shrub beds and tree pits shall be backfilled with a planting mixture described below. All soil mixtures shall be mixed with amendments and other materials by hand or mechanical methods prior to placement. All topsoil shall be tested and amended per test results.

1. Shrub Beds and Tree Pits: two thirds topsoil and one third mulch and soil conditioner.
2. Infiltration Planters: Infiltration Planter Mix

E. pH Adjustment

Soil pH adjustments will be made based on soil test lab recommendations.

1. Limestone: Calcium carbonate (ground limestone) with 50% passing a No. 200 mesh sieve, 90% passing a NO. 100 mesh sieve and 100% passing a No.10 mesh sieve. Total carbonates shall not be less than 80%.
2. Sulfur: Granular sulfur.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Protection of Site Improvements: Protect all existing site improvements during excavation. If any existing improvements are damaged, replace or make arrangements with the proper authorities for repair.

#### **3.2 PERFORMANCE**

- A. Turf Bed Preparation: Distribute required soil amendments evenly and thoroughly per soil test results and incorporate fertilizer into the top layer of dry topsoil.
- B. Planting Bed Preparation: Prior to installation of any plant material, ensure all tree and shrub pits to be free of debris and not in a muddy condition prior to backfill with specified planting mixture. Loosen the bottom of the pit or bed and ensure that all stones larger than 1" diameter and that all limestone has been removed from the subgrade to a depth of 24 inches.
- C. Infiltration Planter Bed Preparation: Infiltration soil matrix shall not be delivered until the bioswale areas have been excavated or graded to the design elevations. Installation of infiltration soil matrix must be performed in a manner that will ensure adequate filtration.
  1. Placement of the infiltration soil matrix in the infiltration planters shall be in lifts of 6 inches maximum. The sand, topsoil and compost may be mixed in place in each lift with adequate rototilling. Contractor shall decrease the lift thickness to conform to the rototilling equipment limitations. Lifts are not to be compacted.
  2. Avoid over compaction by allowing time for natural compaction and settlement. No additional manual compaction of soil is necessary. Rake soil material as needed to achieve final grades.
- C. Landscape Soil Preparation and Finish Grading
  1. Keep the edge of planting beds and landscape areas flush with elevation of adjacent materials so topsoil does not spill out onto surfaces. Excavate in landscape areas as needed to maintain this relationship.
  2. Compact subgrade in planting beds and landscape areas to 85% proctor density. Where pavement and other structures have been removed, bring planting bed and

landscape areas to sub-grade with native sandy topsoil and sand material suitable subgrade fill.

3. Rough grading of all areas shall be within 1/10th of grades shown on the Construction Drawings.

### 3.3 CLEANUP AND PROTECTION

#### A. Clean Up

1. Debris and excess material shall be removed from the site immediately.
2. When an excavation or backfill area is completed, completely clean up all soil piles and sweep all walks and drives.
3. All existing sidewalks and driveways providing access to on-site buildings shall be kept clean and free of obstructions. Other paved areas shall be cleaned when work in adjacent areas is completed

#### B. Protection

1. Protect all completed work from disturbance from operations of other trades and trespassers. Replace damaged work to specified conditions.

**END OF SECTION 32 9100**

**SECTION 32 9300  
EXTERIOR LANDSCAPE**

**PART 1 – GENERAL**

1.1 SUMMARY

- A. Section Includes: Installation, maintenance and warranty of all trees, shrubs and perennials shown on the plans and specified herein.

1.2 RELATED SECTIONS

- A. Section 32 9100 – Soil Preparation and Fine Grading

1.3 QUALITY ASSURANCE

A. Qualifications

1. The Contractor shall be a company specializing in landscape installation with a minimum of five (5) years of experience on comparable projects.

B. Code and Standards Compliance

All materials and work shall comply with applicable sections of the following references:

1. American Association of Nurserymen, Inc. (MN) Standard: American Standard for Nursery Stock (ANSI Z60-.1 -2004)
2. Hortus Third, Cornell University, 1976

C. Source Quality Control

1. All landscape materials shall be from stock inspected and certified by authorized governmental agencies. The stock shall comply with governmental regulations prevailing at the supply source and the job site. The Architect reserves the right to ask for certification by authorized governmental agencies.
2. All landscape materials that have been treated with herbicides, pesticides, insecticides, fungicides, etc. should have been applied by a licensed applicator and been treated with products that comply with governmental regulations. The Architect reserves the right to ask for certification.
3. Products packaged in sealed containers shall be labeled with manufacturer's certified analysis. The composition of bulk materials shall be tested by an approved laboratory in accordance with procedures established by the Association of Official Agricultural Chemists, wherever applicable, or as specified by product specifications referenced herein.
4. Plant Material Selected by Contractor
  - a. Contractor shall locate all plant material to be supplied for the project and inform the Landscape Architect and Owner in writing of plant location(s) at least thirty (30) days prior to scheduled date of plant review and selection. Both the Landscape Architect and Owner may be present for plant review and selection. Plant review and selection shall occur at least thirty (30) days prior to installation.

- b. The plant material shall be obtained from pre-approved nurseries unless otherwise approved by the Landscape Architect. The following nurseries are pre-approved.

1.	Beaver Creek Nursery	(815) 737-8758
2.	Beeson's McHenry County	(815) 943-6382
3.	Charles J. Fiore Co.	(847) 913-1414
4.	Clavey's Nursery	(815) 943-7778
5.	D. Hill Nursery	(815) 923-2141
6.	GRO Horticultural Ent.	(847) 669-8658
7.	Hinsdale Nursery	(630) 323-1411
8.	Kaneville Tree Farms	(630) 557-2793
9.	Kendall Hill Nursery	(815) 695-9907
10.	King Nursery	(630) 554-1171
11.	Klehm Nursery	(847) 551-3710
12.	Mariani Nursery	(262) 857-6529
13.	Midwest Groundcovers	(847) 742-1790
14.	Poplar Farms	(630) 879-7202
15.	Possibility Place Nurseries	(708) 534-3988
16.	P.P. & O. Nursery	(847) 836-1437
17.	Rich's Foxwillow Pines	(815) 338-7442
18.	St. Aubin Nurseries	(815) 522-3535
19.	Stonegate Farm Nursery	(815) 765-2771
20.	Wilson Nurseries, Inc.	(847) 683-3700

- c. The Architect shall select all plant material required for the project, or reserves the right to select representative examples of individual plant species or varieties where the number of plants is too great to reasonably review and select all of the individual plants. No trees shall be delivered without the Landscape Architect's seal.
- d. For plants located more than a one hundred fifty (150) mile radius from downtown Chicago, Contractor shall forward photographs of all species and varieties of plant material to the Landscape Architect at least thirty (30) days prior to scheduled date of plant review and selection, for advance review by Architect. Photographs shall be of at least ten (10%) percent of each species and variety of small shrubs and perennials, fifty (50%) percent of all large shrubs, and one hundred (100%) percent off all shade and ornamental trees. The photographs shall be digital so they can electronically mailed to the Architect. They should also have a person with a surveyor's rod in the photograph so the size of the plants can be established.
- e. The Contractor shall be responsible for all costs related to the review of plants located outside of the one hundred fifty (150) mile radius. This includes, but is not limited to, the cost of travel, lodging, and related expenses. All plant inspections shall take place during normal working hours. The Contractor shall be responsible for giving timely notice to the Landscape Architect.
- f. In the event plant material is found to be unacceptable after review by the Landscape Architect, the Contractor shall pursue other sources until acceptable plant material is found, at no additional cost to the Owner and Landscape Architect. If additional site visits are required, the Contractor shall compensate the Landscape Architect seven hundred fifty dollars (\$920.00) per day.
- g. Selection or lack of selection at the plant source does not impair the right of the Landscape Architect to review and reject material at the time of shipping, during installation of the work, or after the installation of the work.



D. Substitutions

1. If specified landscape material is not obtainable, notify the Landscape Architect, who will identify alternate sources or substitutes. If substitutions are smaller in size than the specified material, credits to the contract will be made based on comparable cost differentials customary for materials and sizes involved.

1.4 SUBMITTALS

A. Qualifications

1. The Contractor shall submit qualifications.

B. Nursery List

1. Submit nursery list that complies with the above items under Section 1.3, Quality Assurance.

C. Samples and Product Data

1. Submit samples and/or product data for all items listed below in Section 2.1, Materials.

D. Schedule

1. Upon authorization to proceed with the work, a schedule indicating the dates of each of the following items will be prepared by the Contractor and submitted to the Landscape Architect:
  - a. Tagging of plant material in nurseries.
  - b. Staking of plant locations on the site.
  - c. Digging and preparation of plant pits and beds.
  - d. Delivery of plant material to the site.
  - e. Planting schedule.
  - f. Substantial completion of the work.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. General

1. Notify the Architect forty-eight hours in advance of all delivery times for plant material.
2. Store materials only in locations approved by the Landscape Architect.

B. Packaged Materials

1. Deliver packaged materials in unopened containers showing weight, analysis, and name of manufacturer. During shipment and storage on site, protect materials from breakage, moisture, heat, or other damage and according to manufacturer's recommendations.

C. Plant Materials

1. Schedule shipping to minimize on site storage of plants. Stock shall not be shipped until the planting preparations have been completed.
2. Label the size and variety of plant and securely attach to individual plants or to bundles of like variety and size.
3. During shipment, plants shall not be bent, stacked, or bound in a manner that damages bark, breaks branches, deforms root balls, or destroys natural shape.
4. Plant material shall be transported within enclosed trailers or covered by tarpaulin to protect the material from damage caused by drying winds, heat, freezing, or other exposure that may be harmful to the plants. Plant material arriving at the site in a damaged condition shall be rejected and removed from the site.
5. If delays beyond the Contractor's control occur after delivery, plants shall be kept watered and protected from sun, wind, and mechanical damage; root balls shall be covered with topsoil or mulch. Container-grown stock shall not be removed from containers until planting time. Keep the roots constantly moist until planted.
6. Handle plants at all times in accordance with the best horticultural practices. Lift balled and burlapped materials from the bottom of the ball only. Balled and burlapped plants which have cracked or broken balls shall be rejected and removed from the site.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

#### **A. Plant Material**

1. Provide plant materials true to name and variety established by the American Joint Committee on Horticultural Nomenclature Standardized Plant Names, Second Edition, 1942, as indicated on the Drawings.
2. All planting stock shall be nursery-grown in accordance with good horticultural practice. Plants shall be free of disease, insects, eggs, larvae, and defects such as knots, sunscald, injuries, abrasions, or disfigurement. They shall be sound, healthy and vigorous, of uniform growth, typical of the species and variety, well formed, free from irregularities, with the minimum quality conforming to American Standard for Nursery Stock.
3. Plants indicated, as "specimen plants" shall be exceptionally heavy, symmetrical, and tightly knit, cultured, to be unquestionably superior in form, branching, compactness, and symmetry.
4. The minimum acceptable sizes of all plants shall be measured before pruning and with branches in normal position. Unless otherwise designated on the drawings, all plant dimensions shall conform to those listed in ANSI A60.1, American Standard for Nursery Stock.
  - a. Where height is indicated within a range, the smaller dimension is the minimum acceptable; the larger dimension represents the maximum permissible except with approval of the Landscape Architect. The average dimension of all plants must at least equal the average of the height range specified.
  - b. Spread shall meet the minimum dimension specified in all directions and must be considered as pivoting on the center of the plant. Where range is shown between two

spread dimensions, the smaller dimension is the minimum acceptable. Spreads shall at least average on the average of the range indicated.

- c. Caliper is the trunk diameter taken at a specified distance above root collar as described in ANSI Z60.1.
- d. Branching point is the distance above ground where balanced branching occurs or where a dimension on trunk appears to form the head of the tree.
- e. Provide trees and shrubs of sizes shown or specified. Trees and shrubs of larger size may be used, if acceptable to the Landscape Architect, and if sizes of roots or root-balls are increased proportionately in accordance with ANSI Z60 standards or greater. Increased size shall result in no additional cost to the Owner.

5. Root Treatment

- a. Root treatments on all plants shall conform to the requirements of ANSI Z60.1. Plants shall be dug and prepared for shipment in a manner that will not cause damage to branches, shape, and future development after planting.
- b. Balled and burlapped (B & B) plants shall have a firm, natural ball of earth of sufficient diameter and depth to encompass the fibrous and feed root systems necessary for full recovery of the plant. Ball shall be securely wrapped with burlap and bound with cord. Ball sizes shall meet the requirements of the ANSI Z60.1.
- c. Plants furnished in containers shall have the roots well established in the soil mass and shall have grown in the container for at least one growing season. Containers shall be large enough to provide earth-root mass of adequate size to support the plant tops being grown. Plants, other than ground covers, over-established in the container, as evidenced by pot-bound root ends, will not be accepted.

- 6. Plant materials shall be subject to final approval by the Architect at the site. The Architect reserves the right to reject any plant material that does not meet project specifications at the time of planting.

B. Topsoil

- 1. Topsoil for landscape work shall be amended as specified in specification 329100 - Soil Preparation and Backfill.

C. Shredded hardwood mulch

- 1. Mulch shall be shredded hardwood mulch ranging in size from 3" to fines, free of foreign matter, sticks, stones, roots, soil and/or other unacceptable material with a pH range from 6.0-7.0.
- 2. Contractor shall provide a 1 quart (minimum) sample of mulch to the Landscape Architect for review and approval, before starting work.  
Chicago, IL 60612  
Phone: 312-226-0760  
Fax: 312-226-0761

D. Stone Cobbles

1. Stone cobbles shall be naturally occurring granite cobbles, evenly mixed range 6 inches to 12" inches diameter. Provide full color range as available from quarry. Supplied by:

Halquist Stone Company  
Sussex, WI  
800-255-8811

D. Anti – transpirant

1. Anti - transpirant shall be a protective film emulsion providing protective film over evergreen plant surfaces only, permeable to permit transpiration, as manufactured by Wilt Pruf Products, Inc. or approved equal. Mix and apply in accordance with manufacturer's instructions.

E. Herbicide

1. Herbicides shall be products with rates of application that conforms to registered uses and is applied by a licensed professional applicator.
  - a. For woody materials ten (10') feet or further from the water's edge: Garlon 4 herbicide as manufactured by DowElanco or approved equal.
  - b. For woody and/or herbaceous material ten (10') feet or further from the water's edge: Roundup Pro herbicide as manufactured by DowElanco or approved equal.
  - c. For woody and herbaceous materials within ten (10') feet of the water edge: Rodeo herbicide as supplied by DowElanco or approved equal.

F. Pesticides, Insecticides, Fungicides, etc.

1. If plant material becomes infected with any pests or insects, the most practical and environmentally benign methods should be utilized to control the problem. All products should comply with government regulations and be applied by a licensed applicator. The Landscape Architect reserves the right to ask for certification.

G. Water

1. Water supply during installation shall be the sole responsibility of the Contractor.

H. Tree Watering Bags

1. Tree watering bags shall be by Treegator or approved equal. Bags shall be installed for all trees installed from June 1 through September 15. If bags are installed, than the Contractor shall provide five (5%) percent attic stock.

J. Geotextile Fabric

1. Needle-punched 150EX geotextile fabric as supplied by Industrial Fabrics or approved equal.
  - a. Local Representative: Dan Salsinger, Erotex; P.O. Box 681341; Schaumburg, IL 60168. Telephone 1-866-4ER-OTEX, pager 1-847-992-3839.

K. Gravel

1. Gravel shall be non-limestone washed gravel with no fines. The size should range from one (1") inch to two (2") inches.

L. Guying and Staking Materials

1. Stakes for tree support shall be hardwood free from knot, rot, cross grain or other defects that would impair strength. Stakes shall be a minimum of 2" x 2" in diameter by 8'-0" long and pointed on one end.
2. Ground anchors for guying shall be 2" x 2" x 3'-0" long wood stake, pointed on one end.
3. Guying wire shall be 12 gauge annealed galvanized steel.
4. Guying cable shall be a minimum of five strands, making a 3/16" diameter steel cable.
5. Hose chafing guards shall be new or used 2-ply, one half inch reinforced rubber or plastic hose and shall be the same color on the project. Length shall be one and one-half times the circumference of the plant at its base.
6. Survey flags to be fastened to guys shall be white plastic surveyor's tape, 6" in length.
7. Turnbuckles shall be galvanized or cadmium-plated steel and have a 3" minimum lengthwise opening fitted with screw eyes.

**PART 3 - EXECUTION**

3.1 JOB CONDITIONS

A. General

1. Prior to beginning work, the Contractor shall examine and verify the acceptability of the job site and notify the Landscape Architect of unsatisfactory conditions. Do not proceed with the work until unsatisfactory conditions have been corrected or resolved.
2. Where planting occurs in close proximity to other site improvements, provide adequate protection for all site areas prior to commencing work. Any items damaged during planting operations shall be promptly replaced or repaired to their original condition at the Contractor's expense and no additional cost to the Owner.

B. Utilities

1. Contractor shall be solely responsible for determining location of all utilities. Contractor shall be responsible for obtaining site utility plans and contacting local utility locator service, and shall perform no work on site until utility locator service has marked site utilities. Perform work in a manner that will avoid possible damage. Excavate to avoid underground utilities including hand digging as required. All damage to utilities resulting from work covered in these contract documents will be repaired at the Contractor's expense and no additional cost to the Owner. No time extension will be allowed due to delay in utility location.

C. Planting Season

1. Plant material shall be dug and planted only during the planting season appropriate for each individual plant species. Pre-digging of plants with proper storage may extend the planting season. However, the installation of plant material outside the normal planting season shall be done only with the approval of the Landscape Architect.

D. Coordination With Other Work

1. Proceed with complete landscape work as rapidly as portions of the site become available, working within the season limitations for each kind of landscape work required.

3.2 PREPARATION

A. Layout

1. Individual plant locations shall be staked on the project site by the Contractor and approved by the Landscape Architect before any planting operations commence. The Landscape Architect reserves the right to adjust plant material locations to meet field conditions, without additions to the base contract price.
2. Accurately stake plant material according to the drawings. Where location or spacing dimensions are not clearly shown, request clarification from the Landscape Architect.
3. If obstructions are encountered that are not indicated, do not proceed with planting operations until alternate plant locations have been selected and approved in writing by the Landscape Architect.
4. If alternate locations are not possible, notify the Landscape Architect of the adverse conditions so the Landscape Architect can request a proposal from the Contractor for method of correction. The Contractor shall obtain approval for the additional work prior to continuing work in the affected area.

3.3 PERFORMANCE

A. General

1. Rocks/underground obstructions shall be removed and proper planting depths shall be established to conform to Section 02910 - Soil Preparation, Landscape Excavation and Backfill.
2. Plant Pit Excavation
  - a. Planting pits shall be round, with vertical sides and flat bottoms, and sized in accordance with the specification and dimensions shown on the drawings.
  - b. If rotating augers or other mechanical diggers are used to excavate holes, the vertical sides of the pits shall be scarified, fractured, or otherwise broken down to eliminate impervious surfaces.
  - c. Loosen or scarify soil in the bottom of all plant pits to a depth of four (4") inches.
3. If existing soil is to be used, it shall meet the requirements of specification for topsoil as contained in Section 329100 – Soil Preparation and Fine Grading. Beds shall be excavated to proper depths and amended as specified. Plant beds shall be brought to a smooth and even surface conforming to established grades.
4. Excavated material that does not meet specifications for topsoil will not be used for backfill in any planter or planting pit and shall be removed to an area designated by the Landscape Architect.

B. Test Drainage

1. Fill approximately two (2%) percent of the tree and large shrub pits with water. If percolation is less than one hundred (100%) percent within a period of twelve (12) hours, drill a ten (10") inch auger hole to a depth of four (4') feet below the bottom of the pit. Fill auger hole with non-limestone drainage gravel and cover with geotextile fabric. Retest pit. In case drainage is still unsatisfactory, notify Landscape Architect, in writing, of the condition before planting trees in the questionable areas. The Landscape Architect reserves the right to select the pits that will be tested.
- C. Subsoil Removal
1. Dispose of subsoil removed from landscape excavations. Do not mix with planting soil. Do not use as backfill.
- D. Planting Operations
1. When the ground is frozen, no planting activities shall occur.
  2. Balled and burlapped (B & B) trees and large shrubs:

Set the plant in the pit to the same relationship to the grade as in the original container or at the top of the burlap ball, faced to give the best appearance or relationship to one another and adjacent structures. Cut away burlap, rope, wire, or other wrapping materials one-third (1/3) of the way from the top of the ball and remove from pit. Do not remove burlap or ties from sides or bottom of ball. If plastic wrap or other non-biodegradable materials are used in lieu of burlap, completely remove them before placing of backfill. Cleanly cut off broken or frayed roots. Place approved topsoil and fertilizer around the ball and carefully compact to avoid injury to the roots and to fill the voids. Apply fertilizer at a rate recommended by the manufacturer. After backfilling planting pit approximately two-thirds full, add water and allow planting mixture to settle. After the water has been absorbed, fill the planting pit with topsoil tamp light to grade and form a watering basin of the size indicated. In tree grates, set top of root ball to allow a two inch air space between the mulch layer and the bottom of the grate.
  3. Plant container-grown shrubs as specified above for balled and burlapped plants and as modified herein. Remove containers before planting and loosen the sides of root ball in several places, freeing the roots on the outside of the ball sufficiently to encourage rapid root extension into the surrounding soil and to prevent girdling of root mass.
  4. Plant groundcover, perennials and annuals so that the top of the root mass is even with the surrounding grade. Adjust spacing as necessary to evenly fill planting bed with indicated quantity of plants. Adjust spacing so plants are within six (6") inches of edge of bed. Backfill planting with specified planting mixture and fertilizer at a rate recommended by manufacturer.
  5. Planting of shrubs, groundcovers, bulbs and annuals around tree root balls shall occur beyond the perimeter of the root ball. Do not plant directly over any root balls.
- E. Mulching
1. General
    - a. Mulching shall take place within forty-eight (48) hours after planting, using approved materials.

- b. Mulch shall be applied by hand, with appropriate tools and equipment, in such a way as to prevent and preclude damage to the plant material being mulched. Plant material damaged or destroyed due to improper mulching operations will be replaced by the contractor, at his expense.
- c. Plant material shall be mulched with approved mulch to the following depths:
  - i. Trees: Maximum depth 3 ½"; minimum 2 ½"
  - ii. Shrubs: Maximum depth 3"; minimum 2"
  - iii. Perennials and groundcover: Maximum depth 2"; minimum 1 ½"
- d. Mulch shall be applied evenly over the entire area to be mulched with the following exceptions:
  - i. Mulch shall be held back a minimum of 1" from the base of tree trunks, and tapered up to the adjacent depth.
  - ii. Mulch shall not be placed against, among or between the trunks or stems of multi-stemmed trees, shrubs, perennials, or any other plant material.
  - iii. Leafy stems of groundcover or vines shall not be buried under mulch material.
  - iv. Plant material requiring differing depths of mulch which are present in one planting bed shall be mulched to each plant type's required depth; transitions between areas of differing depths of mulch shall be accomplished as smoothly as possible.
- e. Prior to installation of new mulch, old decomposed mulch is to be removed as necessary to proper depth of new mulch.
- f. "Volcano" mulching, the practice of heaping mulch against the stems or trunks of plant material is strictly forbidden. Plant material with bark or trunk damage due to this practice will be replaced by the Contractor, at his expense.

F. Pruning

1. General

- a. Pruning is to be performed by Certified Arborists only. Plant material is to be pruned only to remove damaged or broken material. The Landscape Architect shall approve pruning techniques and appearance before proceeding with all pruning.
- b. Trimmings shall be removed from the site and legally disposed.

2. Trees

- a. Prune trees by removing all dead wood, badly formed, interfering limbs, and sufficient other growth to ensure healthy and symmetrical growth of new wood. The proportion is, in all cases, subject to the approval of the Landscape Architect. The central leader shall not be removed.



- b. In the case of multiple leaders, preserve the one which will best promote the symmetry of the tree, and remove or cut back the remainder so that they will not compete with the selected leader. Cut back surrounding top branches to conform to the leader.

3. Shrubs

- a. Prune shrubs by removing all dead wood and broken branches, thinning out canes and cutting back or removing asymmetrical branches. Pruning shall result in a loose outline conforming to the natural shape of the shrub type. Shearing to unnatural shapes will not be accepted.

G. Other Procedures

- 1. Apply anti-transpirant to all evergreen shrubs in all planting beds.
- 2. Stake or guy deciduous trees only if directed by the Landscape Architect. Landscape Architect shall approve tree bracing method.

3.4 CLEAN UP AND PROTECTION

A. Clean Up

- 1. Excess and waste material shall be removed daily. Keep pavement clean and work area in an orderly condition.
- 2. When planting in an area has been completed, the area shall be cleared of all debris, soil piles, containers and all paved areas swept.
- 3. At least one paved pedestrian access route and one paved vehicular access route to each building shall be kept clean at all times. Other paving shall be cleaned when work in adjacent areas is completed.

B. Repairs

- 1. Any damage to existing landscape, paving, or other features as a result of work related to this contract shall be repaired by the responsible Contractor to its original condition. Treat, repair, or replace damaged work at the Contractor's expense and at no additional cost to the Owner.

C. Protection

- 1. Protect landscape work and materials from damage due to landscape operations, operations by other contractors and trades, and trespassers. Maintain protection during installation and maintenance periods.

D. Insurance

- 1. Insurance on plant material and other materials stored or installed is the responsibility of the Contractor. Such insurance shall cover fire, theft, vandalism, and any other damage that may occur to the plant material. Should the Contractor elect not to provide such insurance, the Contractor will in no way hold the Owner responsible for any losses incurred during the project. The Contractor is responsible for all costs incurred in replacing materials prior to date of substantial completion.

3.5 MAINTENANCE

A. Maintenance

1. The Contractor shall be responsible for maintenance until the certificate of substantial completion. After the certificate of substantial completion, the Owner shall be responsible for all aspects of the maintenance. The Contractor should review the site periodically during warranty period to determine what changes, if any, should be made in the maintenance program. Submit all recommended changes in writing to the Landscape Architect and the Owner.

3.6 ACCEPTANCE

A. Completion of the Work

1. Upon completion of work, the Contractor shall notify the Landscape Architect and the Owner at least ten (10) days prior to requested date of substantial completion of all or portions of the work. Landscape Architect will review all of the work and prepare a punch list of work not installed or not installed in conformance with the contract documents. All work in the punch list must be completed within five (5) working days from date of issue. Where work does not comply with requirements, replace rejected work and continue specified maintenance until reviewed by Landscape Architect and found to be acceptable.

B. Certificate of Substantial Completion

1. Certificate of substantial completion will be issued for acceptable work at sole discretion of the Landscape Architect. If punch list items are issued with the certificate, they must be corrected within five (5) working days. If items are not corrected within five (5) working days than the certificate of substantial completion will be revoked and reissued when the punch list items are corrected.

C. Warranty

1. Maintain and warrant for a period of one (1) year, following the certificate of substantial completion, all work, against any defects (including death and unsatisfactory growth) as determined by the Landscape Architect. Defects resulting from neglect by the Owner, abuse or damage by others, or unusual phenomena or incidents beyond the Contractor's control are exempt. Should questions arise concerning the responsibility of replacement, the Landscape Architect shall be the sole judge of the need for replacement.
2. Remove and replace all work found to be dead or in unhealthy condition during warranty period as determined by Landscape Architect.
3. Replacements shall match adjacent specimens of same species. Replacements are subject to all requirements stated in the contract documents and are subject to review by the Landscape Architect at the project site and should be installed during appropriate planting seasons.
4. Repair grades, paving and any other damage resulting from replacement planting operations, at no additional cost to the Owner.
5. Replacements made during the warranty period or following review for final acceptance will carry an additional one (1) year warranty beginning at the time of replacement.

D. Final Acceptance

1. One (1) year after date of substantial completion the Landscape Architect and the Owner will review the work for final acceptance. Upon satisfactory completion of repairs and / or

replacements the Landscape Architect will certify, in writing, final acceptance of the work, which will serve as evidence that Contractor's one (1) year warranty obligations have been met.

**END OF SECTION 32 9300**

**SECTION 33 4100  
STORM UTILITY DRAINAGE PIPING**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes gravity-flow, non-pressure storm drainage outside the building.
- B. Related Sections include the following:
  - 1. Division 15 Sections.

1.3 DEFINITIONS

- A. PVC: Polyvinyl chloride plastic

1.4 PERFORMANCE REQUIREMENTS

- A. Gravity-Flow, Nonpressure, Drainage-Piping Pressure Ratings: At least equal to system test pressure.

1.5 SUBMITTALS

- A. Product Data: For the following:
  - 1. Piping materials.
  - 2. Structures.
- B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic structures, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.

- C. Handle precast concrete manholes and other structures according to manufacturer's written rigging instructions.

#### 1.7 PROJECT CONDITIONS

- A. Site Information: Perform site survey and verify existing utility locations.
- B. Locate existing structures and piping to be closed and abandoned.
- C. Existing Storm Drainage Service: 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 Architect no fewer than two days in advance of proposed interruption of service.
  - 2. Do not proceed with utility interruptions without Architect's written permission.

### **PART 2 - PRODUCTS**

#### 2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with the requirements of the Drawings and Authorities Having Jurisdiction.

#### 2.2 PIPES AND FITTINGS

- A. PVC Pressure Pipe: AWWA C900/C905, Class 150, for gasketed joints.
  - 1. PVC Pressure Fittings: AWWA C907, for gasketed joints.
  - 2. Gaskets for PVC Piping: ASTM F 477, elastomeric seals.
- B. PVC Sewer Pipe and Fittings:
  - 1. PVC Sewer Pipe and Fittings, 15" and Smaller: ASTM D 3034, SDR 26, gasketed joints.
    - a. Gaskets: ASTM F 477, elastomeric seals.

#### 2.3 PERFORATED-WALL PIPES AND FITTINGS

- A. Perforated PVC Sewer Pipe and Fittings: AASHTO M 278, bell-and-spigot ends.

#### 2.4 SPECIAL PIPE COUPLINGS AND FITTINGS

- 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 corrosion-resistant-metal tension band and tightening mechanism on each end.
- B. Sleeve Materials: ASTM C 1173, rubber or elastomeric sleeve and band assembly fabricated to mate with OD of pipes to be joined, for nonpressure joints.
  - 1. Sleeve Material for Plastic Pipe: ASTM F 477, elastomeric seal.
  - 2. Sleeve Material for Dissimilar Pipe: Compatible with pipe materials being joined.

## 2.5 MANHOLES

- A. Normal-Traffic Precast Concrete Manholes: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for rubber gasketed joints.
- B. Steps: Steel Reinforced Plastic, individual steps. Wide enough to allow worker to place both feet on one step and is designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 48 inches
- C. Manhole Frames and Covers: ASTM A 48, Class 35 gray-iron castings designed for heavy-duty service. Include indented top design with lettering "STORM SEWER" cast into cover.
- D. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and diameter matching manhole frame and cover. Include sealant recommended by ring manufacturer.

## 2.6 CATCH BASINS

- A. Normal-Traffic, Precast Concrete Catch Basins: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for rubber gasketed joints.
  - 1. Gaskets: ASTM C 443, rubber.
  - 2. Steps: Fiberglass, individual steps or ladder. of a width that allows worker to place both feet on one step and is designed to prevent lateral slippage off step.
- B. Steps: Steel Reinforced Plastic individual steps. Wide enough to allow worker to place both feet on one step and is designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from invert to finished grade is less than 60 inches
- C. Frames and Covers: ASTM A 48, Class 35 gray-iron castings designed for heavy-duty service.
- D. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and diameter matching manhole frame and cover. Include sealant recommended by ring manufacturer.

## 2.7 CONCRETE

- A. General: Cast-in-place concrete according to ACI 318, ACI 350R, and the following:
  - 1. Cement: ASTM C 150, Type II.
  - 2. Fine Aggregate: ASTM C 33, sand.
  - 3. Coarse Aggregate: ASTM C 33, crushed gravel.
  - 4. Water: Potable.
  
- B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water-cementitious ratio.
  - 1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
  - 2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

### **PART 3 - EXECUTION**

#### **3.1 EARTHWORK**

- A. Excavating, trenching, and backfilling are specified in Division 2 Section "Earthwork."

#### **3.2 PIPING APPLICATIONS**

- A. Refer to Part 2 of this Section for detailed specifications for pipe and fitting products listed below. Use pipe, fittings, and joining methods according to applications indicated.

#### **3.3 INSTALLATION, GENERAL**

- 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 design considerations into account. Install piping as indicated, to extent practical.
  
- 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. Maintain swab or drag in line, and pull past each joint as it is completed.
  
- C. Use manholes for changes in direction, unless fittings are indicated. Use fittings for branch connections, unless direct tap into existing sewer is indicated.
  
- D. Use 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.
  
- E. Install gravity-flow piping and connect to building's storm drains, of sizes and in locations indicated. Terminate piping as indicated.
  
- F. Extend storm drainage piping and connect to building's storm drains, of sizes and in locations indicated. Terminate piping as indicated.

### 3.4 PIPE JOINT CONSTRUCTION AND INSTALLATION

- A. General: Join and install pipe and fittings according to installations indicated.
- B. PVC Sewer Pipe and Fittings:
  - 1. Join pipe and gasketed fittings with gaskets according to ASTM D 2321.
- C. Join piping made of different materials or dimensions with couplings made for this application. Use couplings that are compatible with and that fit both systems' materials and dimensions.

### 3.5 MANHOLE INSTALLATION

- A. General: Install manholes, complete with appurtenances and accessories indicated.
- B. Set tops of frames and covers flush with finished surface. Install precast concrete manhole sections with gaskets according to ASTM C 891.

### 3.6 CATCH-BASIN INSTALLATION

- A. Construct catch basins to sizes and shapes indicated.
- B. Set frames and grates to elevations indicated.

### 3.7 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318 and ACI 350R.

### 3.8 CLOSING ABANDONED STORM DRAINAGE SYSTEMS

- A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
  - 1. Close open ends of piping with at least 8-inch- thick, brick masonry bulkheads.
- B. Abandoned Structures: Excavate around structure as required and use one procedure below:
  - 1. Remove structure and close open ends of remaining piping.

### 3.9 FIELD QUALITY CONTROL

- A. Clear interior of piping and structures of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed.



1. In large, accessible piping, brushes and brooms may be used for cleaning.
  2. Place plug in end of incomplete piping at end of day and when work stops.
  3. Flush piping between manholes and other structures to remove collected debris, if required by authorities having jurisdiction.
- B. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of 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. Crushed, broken, cracked, or otherwise damaged 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.
- C. 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 authorities having jurisdiction.
  3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
  4. Submit separate reports for each test.
  5. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

### 3.10 CLEANING

- A. Clean interior of piping of dirt and superfluous materials.

**END OF SECTION 33 4100**