



JAMES BROWN ARENA

**Bell Auditorium**  
Expansion & Renovations

**Project Manual**  
Volume 2 of 2

**DOCUMENT 00 01 10**

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## SECTION 21 05 17

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

#### PART 1 - GENERAL

##### 1.1 SUMMARY

###### A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.
3. Grout.
4. Silicone sealants.

##### 1.2 ACTION SUBMITTALS

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

##### 1.3 INFORMATIONAL SUBMITTALS

- ###### A. Field quality-control reports.

#### PART 2 - PRODUCTS

##### 2.1 SLEEVES

- ###### A. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop.
- ###### B. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, anticorrosion coated or galvanized, with plain ends and integral welded waterstop collar.
- ###### C. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- ###### D. PVC Pipe Sleeves: ASTM D1785, Schedule 40.

##### 2.2 SLEEVE-SEAL SYSTEMS

- ###### A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Advance Products & Systems, Inc.
  2. CALPICO, Inc.
  3. GPT; an EnPro Industries company.

4. Metraflex Company (The).
5. Proco Products, Inc.

B. Description:

1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
2. Designed to form a hydrostatic seal of 20 psig minimum.
3. Sealing Elements: EPDM-rubber, High-temperature-silicone, or Nitrile (Buna N) interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
4. Pressure Plates: Carbon steel, Stainless steel or Stainless steel, Type 316.
5. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, ASTM B633, Stainless steel or Stainless steel, Type 316, of length required to secure pressure plates to sealing elements.

2.3 GROUT

- A. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.4 SILICONE SEALANTS

- A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C920, Type S, Grade NS, Class 25, Use NT.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. GE Construction Sealants; Momentive Performance Materials Inc.
    - b. Permathane®/Acryl-R®; ITW Polymers Sealants North America.
    - c. Polymeric Systems, Inc.
    - d. Sherwin-Williams Company (The).
    - e. The Dow Chemical Company.
- B. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT. Grade P Pourable (self-leveling) formulation is for opening in floors and other horizontal surfaces that are not fire rated.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. GE Construction Sealants; Momentive Performance Materials Inc.
    - b. Permathane®/Acryl-R®; ITW Polymers Sealants North America.
    - c. Polymeric Systems, Inc.
    - d. Sherwin-Williams Company (The).

- e. The Dow Chemical Company.

### PART 3 - EXECUTION

#### 3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
  - 1. Cut sleeves to length for mounting flush with both surfaces.
    - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
  - 2. Using grout or silicone sealant, seal space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
  - 1. Cut sleeves to length for mounting flush with both surfaces.
  - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
  - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.
- E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 07 84 13 "Penetration Firestopping."

#### 3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

#### 3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:

1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
- B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
  1. Exterior Concrete Walls above Grade:
    - a. Piping Smaller Than NPS 6: Cast-iron pipe sleeves or Steel pipe sleeves.
    - b. Piping NPS 6 and Larger: Cast-iron pipe sleeves or Steel pipe sleeves.
  2. Exterior Concrete Walls below Grade:
    - a. Piping Smaller Than NPS 6: Cast-iron pipe sleeves with sleeve-seal system or Steel pipe sleeves with sleeve-seal system.
      - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
    - b. Piping NPS 6 and Larger: Cast-iron pipe sleeves with sleeve-seal system or Steel pipe sleeves with sleeve-seal system.
      - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
  3. Concrete Slabs-on-Grade:
    - a. Piping Smaller Than NPS 6: Cast-iron pipe sleeves with sleeve-seal system or Steel pipe sleeves with sleeve-seal system.
      - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
    - b. Piping NPS 6 and Larger: Cast-iron pipe sleeves with sleeve-seal system or Steel pipe sleeves with sleeve-seal system.
      - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
  4. Concrete Slabs above Grade:
    - a. Piping Smaller Than NPS 6: Steel pipe sleeves or PVC pipe sleeves.
    - b. Piping NPS 6 and Larger: Steel pipe sleeves or PVC pipe sleeves.
  5. Interior Partitions:
    - a. Piping Smaller Than NPS 6: Steel pipe sleeves or PVC pipe sleeves.
    - b. Piping NPS 6 and Larger: Galvanized-steel sheet sleeves.

Bell Auditorium Expansion & Renovations  
Augusta, Georgia  
Issue for Permit / Bid

Perkins&Will  
222028.000  
16 January 2023

END OF SECTION

## SECTION 21 05 18

### ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

#### PART 1 - GENERAL

##### 1.1 SUMMARY

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

##### 1.2 ACTION SUBMITTALS

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

#### PART 2 - PRODUCTS

##### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. BrassCraft Manufacturing Co.; a Masco company.
  2. Dearborn Brass.
  3. Jones Stephens Corp.
  4. Keeney Manufacturing Company (The).
  5. Mid-America Fittings, Inc.
  6. ProFlo; a Ferguson Enterprises, Inc. brand.

##### 2.2 ESCUTCHEONS

- A. One-Piece, Steel Type: With polished, chrome-plated or polished brass finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped steel or brass with polished, chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
- D. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed and exposed-rivet hinge; and spring-clip fasteners.

##### 2.3 FLOOR PLATES

- A. Split Floor Plates: Steel with concealed hinge.

### 3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
  - 1. Escutcheons for New Piping:
    - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
    - b. Chrome-Plated Piping: One-piece steel, cast brass or split-plate steel with polished, chrome-plated finish.
    - c. Insulated Piping: One-piece steel with polished, chrome-plated or polished brass finish.
    - d. Insulated Piping: One-piece stamped steel or split-plate, stamped steel with concealed hinge or split-plate, stamped steel with exposed-rivet hinge with polished, chrome-plated finish.
    - e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated or polished brass finish.
    - f. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge or split-plate, stamped steel with exposed-rivet hinge with polished, chrome-plated finish.
    - g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated or polished brass finish.
    - h. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge or split-plate, stamped steel with exposed-rivet hinge with polished, chrome-plated finish.
- 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: Split floor plate.

### 3.2 FIELD QUALITY CONTROL

- A. Using new materials, replace broken and damaged escutcheons and floor plates.

**END OF SECTION**

## SECTION 21 05 23

### GENERAL-DUTY VALVES FOR WATER-BASED FIRE-SUPPRESSION PIPING

#### PART 1 - GENERAL

##### 1.1 SUMMARY

###### A. Section Includes:

1. Iron butterfly valves with indicators.
2. Check valves.
3. Iron OS&Y gate valves.
4. NRS gate valves.
5. Indicator posts.
6. Trim and drain valves.

##### 1.2 ACTION SUBMITTALS

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

#### PART 2 - PRODUCTS

##### 2.1 SOURCE LIMITATIONS

- ###### A. Obtain each type of valve from single manufacturer.

##### 2.2 PERFORMANCE REQUIREMENTS

- ###### A. UL Listed: Valves shall be listed in UL's "Online Certifications Directory" under the headings listed below and shall bear UL mark:

1. Fire Main Equipment: HAMV - Main Level.
  - a. Indicator Posts, Gate Valve: HCBZ - Level 1.
  - b. Ball Valves, System Control: HLUG - Level 3.
  - c. Butterfly Valves: HLXS - Level 3.
  - d. Check Valves: HMER - Level 3.
  - e. Gate Valves: HMRZ - Level 3.
2. Sprinkler System & Water Spray System Devices: VDGT - Main Level.
  - a. Valves, Trim and Drain: VQGU - Level 1.

- ###### B. FM Global Approved: Valves shall be listed in its "Approval Guide," under the headings listed below:



1. Automated Sprinkler Systems:

- a. Indicator posts.
- b. Valves.
  - 1) Gate valves.
  - 2) Check valves.
  - 3) Miscellaneous valves.

C. ASME Compliance:

- 1. ASME B1.20.1 for threads for threaded-end valves.
- 2. ASME B16.1 for flanges on iron valves.
- 3. ASME B31.9 for building services piping valves.

D. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

E. NFPA Compliance for valves:

- 1. Comply with NFPA 13, NFPA 14, NFPA 20, and NFPA 24.

F. Valve Pressure Ratings: Not less than the minimum pressure rating indicated or higher, as required by system pressures.

G. Valve Sizes: Same as upstream piping unless otherwise indicated.

H. Valve Actuator Types:

- 1. Worm-gear actuator with handwheel for quarter-turn valves, except for trim and drain valves.
- 2. Handwheel: For other than quarter-turn trim and drain valves.
- 3. Handlever: For quarter-turn trim and drain valves NPS 2 and smaller.

## 2.3 IRON BUTTERFLY VALVES WITH INDICATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1. ALEUM USA.
- 2. Anvil International.
- 3. Globe Fire Sprinkler Corporation.
- 4. Kennedy Valve Company; a division of McWane, Inc.
- 5. NIBCO INC.
- 6. Tyco by Johnson Controls Company.
- 7. Victaulic Company.
- 8. Zurn Industries, LLC.

B. Description:

- 1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 112.
- 2. Minimum Pressure Rating: 175 psig.
- 3. Body Material: Cast or ductile iron with nylon, EPDM, epoxy, or polyamide coating.
- 4. Seat Material: EPDM.

5. Stem: Stainless steel.
6. Disc: Ductile iron, nickel plated and EPDM or SBR coated.
7. Actuator: Worm gear.
8. Supervisory Switch: Internal or external.
9. Body Design: Lug or wafer Grooved-end connections.

## 2.4 CHECK VALVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ames Fire & Waterworks; A WATTS Brand.
2. FEBCO; A WATTS Brand.
3. Fire Protection Products, Inc.
4. Globe Fire Sprinkler Corporation.
5. Mueller Co.
6. NIBCO INC.
7. Reliable Automatic Sprinkler Co., Inc. (The).

- B. Description:

1. Standard: UL 312 and FM Global standard for swing check valves, Class Number 1210.
2. Minimum Pressure Rating: 175 psig.
3. Type: Single swing check.
4. Body Material: Cast iron, ductile iron, or bronze.
5. Clapper: Bronze, ductile iron, or stainless steel with elastomeric seal.
6. Clapper Seat: Brass, bronze, or stainless steel.
7. Hinge Shaft: Bronze or stainless steel.
8. Hinge Spring: Stainless steel.
9. End Connections: Flanged, grooved, or threaded.

## 2.5 IRON OS&Y GATE VALVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Cast Iron Pipe Company.
2. Hammond Valve.
3. Kennedy Valve Company; a division of McWane, Inc.
4. Mueller Co.
5. NIBCO INC.
6. Victaulic Company.
7. WATTS.
8. Zurn Industries, LLC.

- B. Description:

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig.
3. Body and Bonnet Material: Cast or ductile iron.
4. Wedge: Cast or ductile iron, or bronze with elastomeric coating.
5. Wedge Seat: Cast or ductile iron, or bronze with elastomeric coating.

6. Stem: Brass or bronze.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.
9. End Connections: Flanged, Grooved or Threaded.

## 2.6 NRS GATE VALVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Cast Iron Pipe Company.
2. Clow Valve Company; a subsidiary of McWane, Inc.
3. Kennedy Valve Company; a division of McWane, Inc.
4. Mueller Co.
5. NIBCO INC.
6. Victaulic Company.
7. Zurn Industries, LLC.

- B. Description:

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig.
3. Body and Bonnet Material: Cast or ductile iron.
4. Wedge: Cast or ductile iron with elastomeric coating.
5. Wedge Seat: Cast or ductile iron, or bronze with elastomeric coating.
6. Stem: Brass or bronze.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.
9. End Connections: Flanged, Grooved or Threaded.

## 2.7 INDICATOR POSTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Cast Iron Pipe Company.
2. Clow Valve Company; a subsidiary of McWane, Inc.
3. Kennedy Valve Company; a division of McWane, Inc.
4. Mueller Co.
5. NIBCO INC.

- B. Description:

1. Standard: UL 789 and FM Global standard for indicator posts.
2. Type: Wall, Upright per local AHJ.
3. Base Barrel Material: Cast or ductile iron.
4. Extension Barrel: Cast or ductile iron.
5. Cap: Cast or ductile iron.
6. Operation: Wrench or Handwheel.

2.8 TRIM AND DRAIN VALVES

A. Ball Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
  - b. Fire Protection Products, Inc.
  - c. Fire-End & Croker Corporation.
  - d. Jomar Valve.
  - e. KITZ Corporation.
  - f. Milwaukee Valve Company.
  - g. NIBCO INC.
  - h. Potter Roemer LLC; a Division of Morris Group International.
2. Description:
  - a. Pressure Rating: 250 psig.
  - b. Body Design: Two piece.
  - c. Body Material: Forged brass or bronze.
  - d. Port size: Full or standard.
  - e. Seats: PTFE.
  - f. Stem: Bronze or stainless steel.
  - g. Ball: Chrome-plated brass.
  - h. Actuator: Handlever.
  - i. End Connections for Valves NPS 1 through NPS 2-1/2: Threaded ends.
  - j. End Connections for Valves NPS 1-1/4 and NPS 2-1/2: Grooved ends.

B. Angle Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Fire Protection Products, Inc.
  - b. NIBCO INC.
  - c. United Brass Works, Inc.
2. Description:
  - a. Pressure Rating: 250 psig.
  - b. Body Material: Brass or bronze.
  - c. Ends: Threaded.
  - d. Stem: Bronze.
  - e. Disc: Bronze.
  - f. Packing: Asbestos free.
  - g. Handwheel: Malleable iron, bronze, or aluminum.

C. Globe Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or "EQUAL":
  - a. NIBCO INC.
  - b. United Brass Works, Inc.

2. Description:
  - a. Pressure Rating: 250 psig.
  - b. Body Material: Bronze with integral seat and screw-in bonnet.
  - c. Ends: Threaded.
  - d. Stem: Bronze.
  - e. Disc Holder and Nut: Bronze.
  - f. Disc Seat: Nitrile.
  - g. Packing: Asbestos free.
  - h. Handwheel: Malleable iron, bronze, or aluminum.

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. Comply with requirements in the following Sections for specific valve-installation requirements and applications:
  1. Section 21 11 00 "Facility Fire-Suppression Water-Service Piping" for application of valves in fire-suppression water-service piping.
  2. Section 21 12 00 "Fire-Suppression Standpipes" for application of valves in fire-suppression standpipes.
  3. Section 21 13 13 "Wet-Pipe Sprinkler Systems" for application of valves in wet-pipe, fire-suppression sprinkler systems.
  4. Section 21 13 16 "Dry-Pipe Sprinkler Systems" for application of valves in dry-pipe, fire-suppression sprinkler systems.
- 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 double-check valve assembly in each fire-protection water-supply connection.
- D. Install valves having threaded connections with unions at each piece of equipment arranged to allow easy access, service, maintenance, and equipment removal without system shutdown. Provide separate support where necessary.
- E. Install valves in horizontal piping with stem at or above the pipe center.
- F. Install valves in position to allow full stem movement.
- G. Install valve tags. Comply with requirements in Section 21 05 53 "Identification for Fire-Suppression Piping and Equipment" for valve tags and schedules and signs on surfaces concealing valves; and the NFPA standard applying to the piping system in which valves are installed. Install permanent identification signs indicating the portion of system controlled by each valve.

END OF SECTION

## SECTION 21 05 29

### HANGERS AND SUPPORTS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

#### PART 1 - GENERAL

##### 1.1 SUMMARY

###### A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Thermal hanger-shield inserts.
4. Fastener systems.
5. Equipment supports.

###### B. Related Requirements:

1. Section 05 50 00 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 21 05 48 Section 21 05 48.13 "Vibration Controls for Fire-Suppression Piping."

##### 1.2 ACTION SUBMITTALS

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

###### B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations.

##### 1.3 INFORMATIONAL SUBMITTALS

###### A. Welding certificates.

##### 1.4 QUALITY ASSURANCE

###### A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.

###### B. Pipe Welding Qualifications: Qualify procedures and operators according to "2015 ASME Boiler and Pressure Vessel Code, Section IX."

## 2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design trapeze pipe hangers and equipment supports.
- B. Structural Performance: Hangers and supports for fire-suppression 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.
- C. NFPA Compliance: Comply with NFPA 13 and NFPA 14.
- D. UL Compliance: Comply with UL 203.

## 2.2 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
  - 1. Description: Factory-fabricated components, NFPA approved, UL listed, or FM approved for fire-suppression piping support.
  - 2. Galvanized Metallic Coatings: Pregalvanized or hot dip galvanized.
  - 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.
- B. Copper Pipe and Tube Hangers:
  - 1. Description: Copper-coated-steel, factory-fabricated components, NFPA approved, UL listed, or FM approved for fire-suppression piping support.
  - 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel or stainless steel.

## 2.3 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from structural-carbon-steel shapes, with NFPA-approved, UL-listed, or FM-approved carbon-steel hanger rods, nuts, saddles, and U-bolts.

## 2.4 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: NFPA-approved, UL-listed, or FM-approved 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.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Hilti, Inc.
- b. ITW Ramset/Red Head; Illinois Tool Works, Inc.
- c. MKT Fastening, LLC.
- d. Simpson Strong-Tie Co., Inc.

B. Mechanical-Expansion Anchors: NFPA-approved, UL-listed, or FM-approved, insert-wedge-type anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. B-line; Eaton, Electrical Sector.
  - b. Empire Tool and Manufacturing Co., Inc.
  - c. Hilti, Inc.
  - d. ITW Ramset/Red Head; Illinois Tool Works, Inc.
  - e. MKT Fastening, LLC.
2. Indoor Applications: Zinc-coated or Stainless steel.
3. Outdoor Applications: Stainless steel.

## 2.5 EQUIPMENT SUPPORTS

A. Description: NFPA-approved, UL-listed, or FM-approved, welded, shop- or field-fabricated equipment support, made from structural-carbon-steel shapes.

## 2.6 MATERIALS

- A. Aluminum: ASTM B221.
- B. Carbon Steel: ASTM A1011/A1011M.
- C. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; black and galvanized.
- D. Stainless Steel: ASTM A240/A240M.
- E. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout, suitable for interior and exterior applications.
  1. Properties: Nonstaining, noncorrosive, and nongaseous.
  2. Design Mix: 5000-psi, 28-day compressive strength.

## PART 3 - EXECUTION

### 3.1 APPLICATION

A. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.



- B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

### 3.2 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with installation requirements of approvals and listings. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. 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 A36/A36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Fastener System Installation:
  - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual. Install in accordance with approvals and listings.
  - 2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions. Install in accordance with approvals and listings.
- D. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- E. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- F. 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.
- G. Install lateral bracing with pipe hangers and supports to prevent swaying.
- H. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- I. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- J. 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.

### 3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

### 3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work.

### 3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

### 3.6 PAINTING

- A. Touchup: Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded, shop-painted areas on miscellaneous metal are specified in Section 09 91 13 "Exterior Painting.", Section 09 91 23 "Interior Painting." and Section 09 96 00 "High-Performance Coatings."
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

### 3.7 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with NFPA requirements 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 finishes.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- H. Horizontal-Piping Hangers and Supports: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
  - 2. Steel Pipe Clamps (MSS Type 4): For suspension of NPS 1/2 to NPS 24 if little or no insulation is required.
  - 3. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
  - 4. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
  - 5. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
  - 6. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
  - 7. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
  - 8. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
  - 9. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
- I. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
  - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- J. Hanger-Rod Attachments: Comply with NFPA requirements.
- K. Building Attachments: Comply with NFPA requirements. 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. C-Clamps (MSS Type 23): For structural shapes.
  - 3. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

- L. Saddles and Shields: Comply with NFPA requirements. 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.
- M. Comply with NFPA requirements for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- N. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION

## SECTION 21 05 48

### VIBRATION CONTROLS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

#### PART 1 - GENERAL

##### 1.1 SUMMARY

###### A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Restraints - rigid type.
5. Restraints - cable type.
6. Restraint accessories.
7. Post-installed concrete anchors.

###### B. Related Requirements:

1. Section 22 05 48.13 "Vibration Controls for Plumbing Piping and Equipment" for devices for plumbing equipment and systems.
2. Section 23 05 48.13 "Vibration Controls for HVAC" for devices for HVAC equipment and systems.

##### 1.2 ACTION SUBMITTALS

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

###### B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

##### 1.3 INFORMATIONAL SUBMITTALS

###### A. Coordination Drawings: Show coordination of vibration isolation device installation for fire-suppression piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

###### B. Welding certificates.

###### C. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 ELASTOMERIC ISOLATION PADS

- A. Elastomeric Isolation Pads:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. CADDY; nVent.
    - b. Isolation Technology, Inc.
    - c. Kinetics Noise Control, Inc.
    - d. Mason Industries, Inc.
    - e. Vibration Isolation.
    - f. Vibration Management Corp.
    - g. Vibration Mountings & Controls, Inc.
  - 2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
  - 3. Size: Factory or field cut to match requirements of supported equipment.
  - 4. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.
  - 5. Surface Pattern: Smooth, ribbed, or waffle pattern.
  - 6. Infused nonwoven cotton or synthetic fibers.
  - 7. Load-bearing metal plates adhered to pads.
  - 8. Sandwich-Core Material: Resilient and elastomeric.
    - a. Surface Pattern: Smooth, ribbed, or waffle pattern.
    - b. Infused nonwoven cotton or synthetic fibers.

2.2 ELASTOMERIC ISOLATION MOUNTS

- A. Double-Deflection, Elastomeric Isolation Mounts:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. CADDY; nVent.
    - b. Isolation Technology, Inc.
    - c. Kinetics Noise Control, Inc.
    - d. Mason Industries, Inc.
    - e. Vibration Eliminator Co., Inc.
    - f. Vibration Isolation.

- g. Vibration Management Corp.
    - h. Vibration Mountings & Controls, Inc.
  2. Mounting Plates:
    - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
    - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
  3. Elastomeric Material: Molded, oil and water-resistant neoprene rubber, silicone rubber, or other elastomeric material.

## 2.3 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

### A. Restrained Elastomeric Isolation Mounts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. CADDY; nVent.
  - b. Isolation Technology, Inc.
  - c. Kinetics Noise Control, Inc.
  - d. Mason Industries, Inc.
  - e. Vibration Eliminator Co., Inc.
  - f. Vibration Isolation.
  - g. Vibration Management Corp.
  - h. Vibration Mountings & Controls, Inc.
2. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
  - a. Housing: Cast-ductile iron or welded steel.
  - b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

## 2.4 RESTRAINTS - RIGID TYPE

### A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. B-line; Eaton, Electrical Sector.
2. CADDY; nVent.
3. California Dynamics Corporation.
4. Hilti, Inc.
5. Isolation Technology, Inc.
6. TOLCO.
7. Unistrut; Atkore International.
8. Vibration Mountings & Controls, Inc.

- B. Description: Shop- or field-fabricated bracing assembly made of AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

## 2.5 RESTRAINTS - CABLE TYPE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. B-line; Eaton, Electrical Sector.
  - 2. CADDY; nVent.
  - 3. Loos & Co.
  - 4. Vibration Mountings & Controls, Inc.
- B. Restraint cable assembly with cable fittings must comply with ASCE/SEI 19. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

## 2.6 RESTRAINT ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. B-line; Eaton, Electrical Sector.
  - 2. CADDY; nVent.
  - 3. Hilti, Inc.
  - 4. Loos & Co.
  - 5. Mason Industries, Inc.
  - 6. TOLCO.
  - 7. Unistrut; Atkore International.
- B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or Reinforcing steel angle clamped to hanger rod. Non-metallic stiffeners are unacceptable.
- C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
- D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.
- E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.
- F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.



## 2.7 POST-INSTALLED CONCRETE ANCHORS

### A. Mechanical Anchor Bolts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. B-line; Eaton, Electrical Sector.
  - b. Mason Industries, Inc.
  - c. Powers Fasteners.
  - d. Simpson Strong-Tie Co., Inc.
  - e. Unistrut; Atkore International.
2. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

### B. Provide post-installed concrete anchors that have been prequalified for use in wind-load applications. Post-installed concrete anchors must comply with all requirements of ASCE/SEI 7-05, Ch. 13, ASCE/SEI 7-10, Ch. 13 and ASCE/SEI 7-16, Ch. 13.

1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

### C. Expansion-type anchor bolts are not permitted for equipment more than 10 hp that is not vibration isolated.

1. Undercut expansion anchors are permitted.

## PART 3 - EXECUTION

### 3.1 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES, OSHPD or an agency acceptable to authorities having jurisdiction.
- B. Hanger-Rod Stiffeners: Install where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to high wind forces.
- C. Strength of Support and Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry static and wind load within specified loading limits.

### 3.2 INSTALLATION OF VIBRATION-CONTROL DEVICES

- A. Provide vibration-control devices for systems and equipment where indicated in Equipment Schedules or Fire-Suppression Vibration Isolation Schedule, where indicated on Drawings, or where the Specifications indicate they are to be installed on specific equipment and systems.

- B. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 03 30 00 "Cast-in-Place Concrete."
- C. Installation of vibration isolators must not cause any stresses, misalignment, or change of position of equipment or piping.
- D. Equipment Restraints:
  - 1. Install snubbers on fire-suppression equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
  - 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
- E. Piping Restraints:
  - 1. Comply with all requirements in NFPA 13.
  - 2. Design piping sway bracing according to NFPA 13.
    - a. Maximum spacing of all sway bracing to be no greater than indicated in NFPA 13.
    - b. Design loading of all sway bracing not to exceed values indicated in NFPA 13.
- F. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- G. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- H. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- I. Post-Installed Concrete Anchors:
  - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
  - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
  - 3. Mechanical-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
  - 4. Set anchors to manufacturer's recommended torque, using a torque wrench.
  - 5. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

### 3.3 ACCOMMODATION OF DIFFERENTIAL STRUCTURAL MOTION

- A. Install flexible connections in piping where they cross structural construction joints and other points where differential movement may occur, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one

supporting the connections as they approach equipment. Comply with requirements in Section 21 12 00 "Fire-Suppression Standpipes," Section 21 13 13 "Wet-Pipe Sprinkler Systems," and Section 21 13 16 "Dry-Pipe Sprinkler Systems" for piping flexible connections.

### 3.4 ADJUSTING

- A. Adjust isolators after system is at operating weight.
- B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

### 3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
  - 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
  - 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days' advance notice.
  - 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
  - 4. Test at no fewer than four of each type and size of installed anchors and fasteners selected by Architect.
  - 5. Test to 90 percent of rated proof load of device.
  - 6. Measure isolator restraint clearance.
  - 7. Measure isolator deflection.
  - 8. Verify snubber minimum clearances.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Units will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

END OF SECTION

## SECTION 21 05 53

### IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

#### PART 1 - GENERAL

##### 1.1 SUMMARY

- A. Section Includes:
1. Equipment labels.
  2. Warning signs and labels.
  3. Pipe labels.

##### 1.2 ACTION SUBMITTALS

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

#### PART 2 - PRODUCTS

##### 2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Brady Corporation.
    - b. Brimar Industries, Inc.
    - c. Champion America.
    - d. Craftmark Pipe Markers.
    - e. Kolbi Pipe Marker Co.
    - f. LEM Products Inc.
    - g. Marking Services, Inc.
  2. Material and Thickness: Brass, 0.032-inch, stainless steel, 0.025-inch aluminum, 0.032 inch or anodized aluminum, 0.032 inch thick, with predrilled or stamped holes for attachment hardware.
  3. Letter and Background Color: As indicated for specific application under Part 3.
  4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
  5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for

greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

6. Fasteners: Stainless steel rivets or self-tapping screws.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

## 2.2 WARNING SIGNS AND LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Brady Corporation.
2. Brimar Industries, Inc.
3. Carlton Industries, LP.
4. Champion America.
5. Craftmark Pipe Markers.
6. LEM Products Inc.
7. Marking Services Inc.
8. National Marker Company.

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Arc-Flash Warning Signs: Provide arc-flash warning signs in locations and with content in accordance with requirements of OSHA and NFPA 70E, and other applicable codes and standards.

J. Label Content: Include caution and warning information, plus emergency notification instructions.

## 2.3 PIPE LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Brady Corporation.
2. Brimar Industries, Inc.

3. Champion America.
  4. Craftmark Pipe Markers.
  5. Kolbi Pipe Marker Co.
  6. LEM Products Inc.
  7. Marking Services Inc.
- B. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.
- C. Letter and Background Color: As indicated for specific application under Part 3.
- D. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover or cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- E. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- F. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include the following:
1. Pipe size.
  2. Flow-Direction Arrows: Include flow-direction arrows on main distribution piping. Arrows may be either integral with label or applied separately.
  3. Lettering Size: Size letters in accordance with ASME A13.1 for piping At least 1/2 inch for viewing distances of up to 72 inches and proportionately larger lettering for greater viewing distances.

## PART 3 - EXECUTION

### 3.1 PREPARATION

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

### 3.2 INSTALLATION GENERAL REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be installed.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.
- D. Locate identifying devices so that they are readily visible from the point of normal approach.

### 3.3 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

- A. Permanently fasten labels on each item of fire-suppression equipment.
- B. Sign and Label Colors:

1. White letters on an ANSI Z535.1 safety-red background.
  - C. Locate equipment labels where accessible and visible.
  - D. Arc-Flash Warning Signs: Provide arc-flash warning signs on electrical disconnects and other equipment where arc-flash hazard exists, as indicated on Drawings, and in accordance with requirements of OSHA and NFPA 70E, and other applicable codes and standards.
- 3.4 INSTALLATION OF PIPE LABELS
- A. Piping Color Coding: Painting of piping is specified in Section 09 91 23 "Interior Painting."
  - B. Install pipe labels showing service and flow direction with permanent adhesive on pipes.
  - C. 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. Within 3 ft. of each valve and control device.
    2. At access doors, manholes, and similar access points that permit a view of concealed piping.
    3. Within 3 ft. of equipment items and other points of origination and termination.
    4. Spaced at maximum intervals of 25 ft. along each run. Reduce intervals to 10 ft. in areas of congested piping and equipment.
  - D. Flow- Direction Arrows: Provide arrows to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
  - E. Fire-Suppression Pipe Label Color Schedule:
    1. Fire-Suppression Pipe Labels: White letters on an ANSI Z535.1 safety-red background.

END OF SECTION

## SECTION 21 11 00

### FACILITY FIRE-SUPPRESSION WATER-SERVICE PIPING

#### PART 1 - GENERAL

##### 1.1 SUMMARY

- A. Section includes fire-suppression water-service piping and related components outside the building and service entrance piping through floor into the building and service entrance piping through wall into the building and the following:
  - 1. Pipes, fittings, and specialties.
  - 2. Fire-suppression specialty valves.
  - 3. Protective enclosures.
  - 4. Alarm devices.
- B. Utility-furnished products include water meters that are furnished to the site, ready for installation.
- C. Related Requirements:
  - 1. Section 21 11 16 "Facility Fire Hydrants" for AWWA and UL-listed, dry- and wet-barrel fire hydrants.
  - 2. Section 21 11 19 "Fire-Department Connections" for exposed-, flush-, and yard-type, fire-department connections.
  - 3. Section 21 12 00 "Fire-Suppression Standpipes" for fire-suppression standpipes inside the building.

##### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
  - 1. Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.
  - 2. Include diagrams for power, signal, and control wiring.

##### 1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: For piping and specialties including relation to other services in same area, drawn to scale. Show piping and specialty sizes and valves, meter and specialty locations, and elevations.
- B. Field quality-control reports.



1.4 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with requirements of utility company supplying the water. Include tapping of water mains and backflow prevention.
2. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.

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

C. 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 FM Global's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.

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

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Soft Copper Tube: ASTM B88, Type K and ASTM B88, Type L, water tube, annealed temper.

B. Hard Copper Tube: ASTM B88, Type K and ASTM B88, Type L, water tube, drawn temper.

C. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.

D. Copper, Pressure-Seal Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by the following or "EQUAL":

a. Viega LLC.

2. Standard: UL 213.
3. NPS 2 and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
4. NPS 2-1/2 to NPS 4: Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.

E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.

F. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.2 DUCTILE-IRON PIPE AND FITTINGS

A. Grooved-Joint, Ductile-Iron Pipe: AWWA C151, with cut, rounded-grooved ends.

- B. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end.
- C. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end.
- D. Grooved-End, Ductile-Iron Pipe Appurtenances:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. CPS Products, Inc.
    - b. Star Pipe Products.
    - c. Tyco by Johnson Controls Company.
    - d. Venus Fire Protection Ltd.
    - e. Victaulic Company.
    - f. Viking Corporation.
  - 2. Grooved-End, Ductile-Iron Fittings: ASTM A47/A47M, malleable-iron castings or ASTM A536, ductile-iron castings with dimensions matching pipe.
  - 3. Grooved-End, Ductile-Iron-Piping Couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.
- E. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
  - 1. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- F. Push-on-Joint, Ductile-Iron Fittings: AWWA C153, ductile-iron compact pattern.
  - 1. Gaskets: AWWA C111, rubber.
- G. Flanges: ASME B16.1, Class 125, cast iron.

## 2.3 SPECIAL PIPE FITTINGS

- A. Ductile-Iron Flexible Expansion Joints:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. EBAA Iron, Inc.
    - b. Romac Industries, Inc.
    - c. Star Pipe Products.
    - d. Zurn Industries, LLC.
  - 2. Description: Compound, ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections. Assemble components for offset and expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
  - 3. Pressure Rating: 250 psig minimum.

B. Ductile-Iron Deflection Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by the following or "EQUAL":
  - a. EBAA Iron, Inc.
2. Description: Compound, ductile-iron coupling fitting with sleeve and one or two flexing sections for up to 15-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
3. Pressure Rating: 250 psig minimum.

2.4 JOINING MATERIALS

- A. Gaskets for Ferrous Piping and Copper-Alloy Tubing: ASME B16.21, asbestos free.
- B. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series.

2.5 PIPING SPECIALTIES

- A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
- B. Tubular-Sleeve Pipe Couplings:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Cascade Waterworks Mfg. Co.
    - b. Dresser, Inc.
    - c. Ford Meter Box Company, Inc. (The).
    - d. Jay R. Smith Mfg Co; a division of Morris Group International.
    - e. JCM Industries, Inc.
    - f. Romac Industries, Inc.
    - g. Viking Johnson.
  2. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners, and with ends of same sizes as piping to be joined.
  3. Standard: AWWA C219.
  4. Center-Sleeve Material: Manufacturer's standard.
  5. Gasket Material: Natural or synthetic rubber.
  6. Pressure Rating: 150 psig minimum.
  7. Metal Component Finish: Corrosion-resistant coating or material.

2.6 DETECTOR CHECK VALVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ames Fire & Waterworks; A WATTS Brand.
2. Badger Meter, Inc.
3. FEBCO; A WATTS Brand.
4. Globe Fire Sprinkler Corporation.
5. Kennedy Valve Company; a division of McWane, Inc.
6. Mueller Co.
7. Victaulic Company.
8. Viking Corporation.
9. WATTS.
10. Zurn Industries, LLC.

- B. Description: Galvanized cast-iron body, bolted cover with air-bleed device for access to internal parts, and flanged ends. Include one-piece bronze disc with bronze bushings, pivot, and replaceable seat. Include threaded bypass taps in inlet and outlet for bypass meter connection. Set valve to allow minimal water flow through bypass meter when major water flow is required.
- C. Standards: UL 312 and FM Global's "Approval Guide."
- D. Pressure Rating: 175 psig.
- E. Water Meter: AWWA C700, disc type, at least one-fourth size of detector check valve. Include meter, bypass piping, gate valves, check valve, and connections to detector check valve.

## 2.7 BACKFLOW PREVENTERS

A. Double-Check, Backflow-Prevention Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ames Fire & Waterworks; A WATTS Brand.
  - b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
  - c. FEBCO; A WATTS Brand.
  - d. Mueller Co.
  - e. WATTS.
  - f. Zurn Industries, LLC.
2. Standard: ASSE 1015 or AWWA C510.
3. Operation: Continuous-pressure applications unless otherwise indicated.
4. Pressure Loss: 10 psig maximum, through middle one-third of flow range.
5. Size: Refer to plan.
6. Design Flow Rate: Refer to plan.
7. Body Material: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved or steel with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
8. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
9. Configuration: Designed for horizontal, straight through flow.
10. Accessories: Ball valves with threaded ends on inlet and outlet of NPS 2 and smaller; OS&Y gate valves with flanged ends on inlet and outlet of NPS 2-1/2 and larger.

B. Double-Check, Detector-Assembly Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ames Fire & Waterworks; A WATTS Brand.
  - b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
  - c. FEBCO; A WATTS Brand.
  - d. Mueller Co.
  - e. Zurn Industries, LLC.
  - f. WATTS.
2. Standards: ASSE 1048 and UL's "Fire Protection Equipment Directory" listing or FM Global's "Approval Guide."
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 10 psig maximum, through middle one-third of flow range.
5. Size: Refer to plan.
6. Design Flow Rate: Refer to plan.
7. Body Material: Cast iron with interior lining complying with AWWA C550 or that is FDA approved or Steel with interior lining complying with AWWA C550 or that is FDA approved.
8. End Connections: Flanged.
9. Configuration: Designed for horizontal, straight through, vertical inlet, horizontal center section, and vertical outlet or vertical flow.
10. Accessories:
  - a. Valves: UL 262 and FM Global's "Approval Guide" listing; OS&Y gate type with flanged ends on inlet and outlet.
  - b. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

C. Backflow Preventer Test Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ames Fire & Waterworks; A WATTS Brand.
  - b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
  - c. FEBCO; A WATTS Brand.
  - d. WATTS.
  - e. Zurn Industries, LLC.
2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.8 ALARM DEVICES

- A. General: UL 753 and FM Global's "Approval Guide" listing of types and sizes to mate and match piping and equipment.
- B. Water-Flow Indicators: Vane-type water-flow detector, rated for 250-psig working pressure; designed for horizontal or vertical installation; with two single-pole, double-throw circuit switches to provide 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 when cover is removed.

- C. Supervisory Switches: Single pole, double throw; designed to signal valve in other than fully open position.
- D. Pressure Switches: Single pole, double throw; designed to signal increase in pressure.

### PART 3 - EXECUTION

#### 3.1 EARTHWORK

- A. Comply with excavating, trenching, and backfilling requirements in Section 31 20 00 "Earth Moving."

#### 3.2 PIPING INSTALLATION

- A. Water-Main Connection: Arrange with water utility company for tap of size and in location indicated in water main.
- B. Water-Main Connection: Tap water main according to requirements of water utility company and of size and in location indicated.
- C. Make connections larger than NPS 2 with tapping machine according to the following:
  - 1. Install tapping sleeve and tapping valve according to MSS SP-60.
  - 2. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.
  - 3. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.
  - 4. Install gate valve onto tapping sleeve. Comply with MSS SP-60. Install valve with stem pointing up and with valve box.
- D. Make connections NPS 2 and smaller with drilling machine according to the following:
  - 1. Install service-saddle assemblies and corporation valves in size, quantity, and arrangement required by utility company's standards.
  - 2. Install service-saddle assemblies on water-service pipe to be tapped. Position outlets for corporation valves.
  - 3. Use drilling machine compatible with service-saddle assemblies and corporation valves. Drill hole in main. Remove drilling machine and connect water-service piping.
  - 4. Install corporation valves into service-saddle assemblies.
  - 5. Install manifold for multiple taps in water main.
  - 6. Install curb valve in water-service piping with head pointing up and with service box.
- E. Comply with NFPA 24 for fire-service-main piping materials and installation.
- F. Install copper tube and fittings according to CDA's "Copper Tube Handbook."
- G. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.
  - 1. Install encasement for piping according to ASTM A674 or AWWA C105.
- H. Install PE pipe according to ASTM D2774 and ASTM F645.
- I. Install PVC, AWWA pipe according to ASTM F645 and AWWA M23.

- J. Bury piping with depth of cover over top at least 30 inches, with top at least 12 inches below level of maximum frost penetration, and according to the following:
  - 1. Under Driveways: With at least 36 inches of cover over top.
  - 2. Under Railroad Tracks: With at least 48 inches of cover over top.
  - 3. In Loose Gravelly Soil and Rock: With at least 12 inches of additional cover.
- K. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed.
- L. Extend fire-suppression water-service piping and connect to water-supply source and building fire-suppression water-service piping systems at locations and pipe sizes indicated.
  - 1. Terminate fire-suppression water-service piping within the building at the floor slab until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building's fire-suppression water-service piping systems when those systems are installed.
- M. 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.
- N. Comply with requirements in Section 21 12 00 "Fire-Suppression Standpipes," Section 21 13 13 "Wet-Pipe Sprinkler Systems," and Section 21 13 16 "Dry-Pipe Sprinkler Systems" for fire-suppression-water piping inside the building.
- O. Comply with requirements in Section 22 11 16 "Domestic Water Piping" for potable-water piping inside the building.
- P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 21 05 17 "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 Section 21 05 17 "Sleeves and Sleeve Seals 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 rating same as or higher than systems pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in tubing NPS 2 and smaller.
- C. Install flanges, flange adaptors, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- D. Ream ends of tubes and remove burrs.
- E. Remove scale, slag, dirt, and debris from outside and inside of pipes, tubes, and fittings before assembly.
- F. Copper-Tubing, Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

- G. Copper-Tubing, Pressure-Sealed Joints: Use proprietary crimping tool and procedure recommended by copper, pressure-seal-fitting manufacturer.
- H. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.
- I. Ductile-Iron Piping, Grooved Joints: Cut-groove pipe. Assemble joints with grooved-end, ductile-iron-piping couplings, gaskets, lubricant, and bolts.
- J. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with bolts according to ASME B31.9.
- K. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure.
- L. Do not use flanges or unions for underground piping.

### 3.4 ANCHORAGE INSTALLATION

- A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
  - 1. Concrete thrust blocks.
  - 2. Locking mechanical joints.
  - 3. Set-screw mechanical retainer glands.
  - 4. Bolted flanged joints.
  - 5. Heat-fused joints.
  - 6. Pipe clamps and tie rods.
- B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches in fire-suppression water-service piping according to NFPA 24 and the following:
  - 1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.
  - 2. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.
- C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

### 3.5 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.
- B. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.
- C. UL-Listed or FM Global-Approved Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.
- D. UL-Listed or FM Global-Approved Valves Other Than Gate Valves: Comply with NFPA 24.
- E. MSS Valves: Install as component of connected piping system.



- F. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.
- G. Support valves and piping, not direct buried, on concrete piers. Comply with requirements for concrete piers in Section 03 30 00 "Cast-in-Place Concrete."

### 3.6 DETECTOR CHECK VALVE INSTALLATION

- A. Install in vault or aboveground.
- B. Install for proper direction of flow. Install bypass with water meter, gate valves on each side of meter, and check valve downstream from meter.
- C. Support detector check valves and piping on concrete piers. Comply with requirements for concrete piers in Section 03 30 00 "Cast-in-Place Concrete."

### 3.7 BACKFLOW PREVENTER INSTALLATION

- A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.
- B. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.
- C. Do not install bypass piping around backflow preventers.
- D. Support NPS 2-1/2 and larger backflow preventers and piping on concrete piers. Comply with requirements for concrete piers in Section 03 30 00 "Cast-in-Place Concrete."

### 3.8 FIRE-DEPARTMENT CONNECTION INSTALLATION

- A. Install ball drip valves at each check valve for fire-department connection to mains.
- B. Install protective pipe bollards on two sides of or on three sides of each freestanding fire-department connection. Pipe bollards are specified in Section 05 50 00 "Metal Fabrications."

### 3.9 ALARM DEVICE INSTALLATION

- A. General: Comply with NFPA 24 for devices and methods of valve supervision. Underground valves with valve box do not require supervision.
- B. Supervisory Switches: Supervise valves in open position.
  - 1. Valves: Grind away portion of exposed valve stem. Bolt switch, with plunger in stem depression, to OS&Y gate-valve yoke.
  - 2. Indicator Posts: Drill and thread hole in upper-barrel section at target plate. Install switch, with toggle against target plate, on barrel of indicator post.
- C. Locking and Sealing: Secure unsupervised valves as follows:

1. Valves: Install chain and padlock on open OS&Y gate valve.
2. Post Indicators: Install padlock on wrench on indicator post.

D. Pressure Switches: Drill and thread hole in exposed barrel of fire hydrant. Install switch.

E. Water-Flow Indicators: Install in water-service piping in vault. Select indicator with saddle and vane matching pipe size. Drill hole in pipe, insert vane, and bolt saddle to pipe.

F. Connect alarm devices to building's fire-alarm system. Wiring and fire-alarm devices are specified in Section 28 46 21.13 "Conventional Fire-Alarm Systems."

### 3.10 CONNECTIONS

A. Connect fire-suppression water-service piping to utility water main. Use tapping sleeve and tapping valve.

B. Connect fire-suppression water-service piping to interior fire-suppression piping.

### 3.11 FIELD QUALITY CONTROL

A. Use test procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described below.

B. 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.

C. Hydrostatic Tests: Test at not less than one-and-one-half times the working pressure for two hours.

1. Increase pressure in 50-psig increments and inspect each joint between increments. Hold at test pressure for one hour; decrease to zero psig. Slowly increase again to test pressure and hold for one 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.

D. Prepare test and inspection reports.

### 3.12 IDENTIFICATION

A. Install continuous underground detectable warning tape during backfilling of trench for underground fire-suppression water-service piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Section 31 20 00 "Earth Moving."

### 3.13 PIPING SCHEDULE

A. Underground fire-suppression water-service piping NPS 4 shall be one of the following:

1. Grooved-end, ductile-iron pipe; grooved-end, ductile-iron pipe appurtenances; and grooved joints.

2. Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile- or gray-iron, standard-pattern or ductile-iron, compact-pattern fittings; glands, gaskets, and bolts; and gasketed joints.
  3. Push-on-joint, ductile-iron pipe; push-on-joint, ductile-iron compact-pattern fittings; and gasketed joints.
- B. Underground fire-suppression water-service piping NPS 6 to NPS 12 shall be one of the following:
1. Grooved-end, ductile-iron pipe; grooved-end, ductile-iron pipe appurtenances; and grooved joints.
  2. Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile- or gray-iron, standard-pattern or ductile-iron, compact-pattern fittings; glands, gaskets, and bolts; and gasketed joints.
  3. Push-on-joint, ductile-iron pipe; push-on-joint, ductile-iron compact-pattern fittings; and gasketed joints.
- C. Aboveground fire-suppression water-service piping NPS 2 and smaller shall be hard copper tube, ASTM B88, Type K, ASTM B88, Type L; wrought- or cast-copper-alloy, solder-joint fittings; and brazed copper, pressure-seal fittings; and pressure-sealed joints.
- D. Aboveground fire-suppression water-service piping NPS 3 and NPS 4 shall be one of the following:
1. Grooved-end, ductile-iron pipe; grooved-end, ductile-iron pipe appurtenances; and grooved joints.
- E. Aboveground fire-suppression water-service piping NPS 5 to NPS 12 shall be grooved-end, ductile-iron pipe; grooved-end, ductile-iron pipe appurtenances; and grooved joints.
- F. Underslab fire-suppression water-service piping NPS 3 and NPS 4 shall be one of the following:
1. Grooved-end, ductile-iron pipe; grooved-end, ductile-iron pipe appurtenances; and grooved joints.
  2. Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile- or gray-iron, standard-pattern or ductile-iron, compact-pattern fittings; glands, gaskets, and bolts; and restrained, gasketed joints.
  3. Push-on-joint, ductile-iron pipe; push-on-joint, ductile-iron compact-pattern fittings; and restrained, gasketed joints.
- G. Underslab fire-suppression water-service piping NPS 6 to NPS 12 shall be one of the following:
1. Grooved-end, ductile-iron pipe; grooved-end, ductile-iron pipe appurtenances; and grooved joints.
  2. Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile- or gray-iron, standard-pattern or ductile-iron, compact-pattern fittings; glands, gaskets, and bolts; and restrained, gasketed joints.
  3. Push-on-joint, ductile-iron pipe; push-on-joint, ductile-iron compact-pattern fittings; and restrained, gasketed joints.
- 3.14 VALVE SCHEDULE
- A. Underground fire-suppression water-service shutoff valves NPS 3 and larger shall be one of the following:

1. 250-psig, AWWA, iron, nonrising-stem, resilient-seated gate valves.
  2. 250-psig, UL-listed or FM Global-approved, iron, nonrising-stem gate valves.
- B. Indicator-post underground fire-suppression water-service valves NPS 3 and larger shall be 250-psig, UL-listed or FM Global-approved, iron, nonrising-stem gate valves with indicator-post flange.
- C. Standard-pressure, aboveground fire-suppression water-service shutoff valves NPS 3 and larger shall be one of the following:
1. 250-psig, AWWA, iron, OS&Y, resilient-seated gate valves.
  2. 250-psig, UL-listed or FM Global-approved, iron, OS&Y gate valves.
  3. AWWA or UL-listed or FM Global-approved butterfly valves.
- D. Fire-suppression water-service check valves NPS 3 and larger shall be one of the following:
1. AWWA or UL-listed or FM Global-approved check valves.
  2. UL-listed or FM Global-approved detector check valves.

END OF SECTION

## SECTION 21 11 19 – FIRE DEPARTMENT CONNECTIONS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
1. Exposed-type fire-department connections.
  2. Flush-type fire-department connections.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each fire-department connection.

### PART 2 - PRODUCTS

#### 2.1 EXPOSED-TYPE FIRE-DEPARTMENT CONNECTION

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. American Fire Hose & Cabinet.
  2. Fire Protection Products, Inc.
  3. Fire-End & Croker Corporation.
  4. Guardian Fire Equipment, Inc.
  5. Venus Fire Protection Ltd.
- B. Standard: UL 405.
- C. Type: Exposed, projecting, for wall mounting.
- D. Pressure Rating: 175 psig minimum.
- E. Body Material: Corrosion-resistant metal.
- F. 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.
- G. Caps: Brass, lugged type, with gasket and chain.
- H. Escutcheon Plate: Round, brass, wall type.

- I. Outlet: Back, with pipe threads.
- J. Number of Inlets: Two or as required by local AHJ.
- K. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE."
- L. Finish: Polished chrome plated, Rough brass or bronze or Rough chrome plated.
- M. Outlet Size: NPS 4 or as required by local AHJ.

## 2.2 FLUSH-TYPE FIRE-DEPARTMENT CONNECTION

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. American Fire Hose & Cabinet.
  - 2. Elkhart Brass Mfg. Co., Inc.
  - 3. Guardian Fire Equipment, Inc.
  - 4. Potter Roemer LLC; a Division of Morris Group International.
  - 5. Venus Fire Protection Ltd.
- B. Standard: UL 405.
- C. Type: Flush, for wall mounting.
- D. Pressure Rating: 175 psig minimum.
- E. Body Material: Corrosion-resistant metal.
- F. 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.
- G. Caps: Brass, lugged type, with gasket and chain.
- H. Escutcheon Plate: Rectangular, brass, wall type.
- I. Outlet: With pipe threads.
- J. Body Style: Horizontal, Square or Vertical.
- K. Number of Inlets: Two or as required by local AHJ.
- L. Outlet Location: As required by local AHJ.
- M. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE."
- N. Finish: Polished chrome plated, Rough brass or bronze or Rough chrome plated.
- O. Outlet Size: NPS 4 or as required by local AHJ.

3.1 INSTALLATION

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

END OF SECTION

SECTION 21 12 00  
FIRE-SUPPRESSION STANDPIPES

**PART 1 - GENERAL**

1.1 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Fire-protection specialty valves.
3. Hose connections.
4. Alarm devices.
5. Pressure gauges.

B. Related Requirements:

1. Section 21 05 23 "General-Duty Valves for Water-Based Fire-Suppression Piping."
2. Section 21 11 19 "Fire Department Connections" for exposed-, flush-, and yard-type fire-department connections.
3. Section 21 13 13 "Wet-Pipe Sprinkler Systems" for wet-pipe sprinkler piping.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For fire-suppression standpipes.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

C. Delegated-Design Submittal: For standpipe 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.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, sections, and other details, drawn to scale, or BIM model, showing the items described in this Section and coordinated with all building trades.

B. Approved Standpipe Drawings: Working plans, prepared in accordance with NFPA 14, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

C. Welding certificates.

D. Fire-hydrant flow test report.



- E. 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."
- F. Field quality-control reports.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

#### 1.5 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.

### PART 2 - PRODUCTS

#### 2.1 SYSTEM DESCRIPTIONS

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

#### 2.2 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NFPA Standards: Fire-suppression standpipe equipment, specialties, accessories, installation, and testing shall comply with NFPA 14.
- C. Standard-Pressure, Fire-Suppression Standpipe System Component: Listed for 175-psig minimum working pressure.
- D. High-Pressure, Fire-Suppression Standpipe System Component: Listed for 300-psig working pressure.
- E. Delegated Design: Design fire-suppression standpipes, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1. Available fire-hydrant flow test records indicate the following conditions: Refer to flow test data on the plan.

F. 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 Hose Connections: 100 psig.

## 2.3 PIPING MATERIALS

A. Comply with requirements in Part 3 "Piping Schedule" Article for applications of pipe, tube, and fitting materials and for joining methods for specific services, service locations, and pipe sizes.

## 2.4 BLACK STEEL PIPE AND ASSOCIATED FITTINGS

A. Schedule 40: ASTM A53/A53M, Type E, Grade B, ASTM A135/A135M, Grade A or ASTM A795/A795M, Type E, Grade A, with factory- or field-formed ends to accommodate joining method.

B. Schedule 30: ASTM A53/A53M, Type E, Grade B, ASTM A135/A135M, Grade A or ASTM A795/A795M, Type E, Grade A, with factory- or field-formed ends to accommodate joining method.

C. Thinwall: ASTM A53/A53M, Type E, ASTM A135/A135M, Grade A or ASTM A795/A795M, Type E, Grade A, with wall thickness of less than Schedule 30 and equal to or greater than Schedule 10, and with factory- or field-formed ends to accommodate joining method.

D. Uncoated, Steel Couplings: ASTM A865/A865M, threaded.

E. Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

F. Malleable- or Ductile-Iron Unions: UL 860.

G. Cast-Iron Flanges: ASME B16.1, Class 125.

H. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

I. Steel Welding Fittings: ASTM A234/A234M and ASME B16.9.

J. Grooved-Joint, Steel-Pipe Appurtenances:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Anvil International.
- b. CPS Products, Inc.
- c. National Fittings, Inc.
- d. Shurjoint-Apollo Piping Products USA Inc.
- e. Smith-Cooper International.
- f. Tyco by Johnson Controls Company.
- g. Victaulic Company.

2. Pressure Rating: 250-psig minimum.

3. Galvanized and Uncoated, Grooved-End Fittings for Steel Piping: ASTM A47/A47M malleable-iron casting or ASTM A536 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.

## 2.5 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110/A21.10, rubber, flat face, 1/8 inch 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. 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.

## 2.6 SPECIALTY VALVES

- A. General Requirements:
  1. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
  2. Pressure Rating:
    - a. Standard-Pressure Piping Specialty Valves: 175-psig minimum.
    - b. High-Pressure Piping Specialty Valves: 250-psig minimum.
  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, provide products by one of the following:
    - a. Globe Fire Sprinkler Corporation.
    - b. Reliable Automatic Sprinkler Co., Inc. (The).
    - c. Tyco by Johnson Controls Company.
    - d. Venus Fire Protection Ltd.
    - e. Victaulic Company.
    - f. 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 gauges, retarding chamber, and fill-line attachment with strainer.

5. Drip Cup Assembly: Pipe drain without valves and separate from or with check valve to main drain piping.

C. Automatic (Ball Drip) Drain Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Reliable Automatic Sprinkler Co., Inc. (The).
  - b. Tyco by Johnson Controls Company.
2. Standard: UL 1726.
3. Pressure Rating: 175-psig minimum.
4. Type: Automatic draining, ball check.
5. Size: NPS 3/4.
6. End Connections: Threaded.

2.7 HOSE CONNECTIONS

A. Nonadjustable-Valve Hose Connections:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Brooks Equipment Co., Inc.
  - b. Elkhart Brass Mfg. Co., Inc.
  - c. Potter Roemer LLC; a Division of Morris Group International.
  - d. Tyco by Johnson Controls Company.
  - e. Zurn Industries, LLC.
2. Standard: UL 668 hose valve for connecting fire hose.
3. Pressure Rating: 300-psig minimum.
4. Material: Brass or bronze.
5. Size: NPS 1-1/2 or NPS 2-1/2, as indicated.
6. Inlet: Female pipe threads.
7. Outlet: Male hose threads with lugged cap, gasket, and chain. Include hose valve threads in accordance with NFPA 1963 and matching local fire-department threads.
8. Pattern: Angle or gate.
9. Finish: Polished chrome plated, Rough brass or bronze or Rough chrome plated.

2.8 ALARM DEVICES

A. Match alarm-device material and connection types to piping and equipment materials and connection types.

B. Electrically Operated Alarm Bell:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Fire-Lite Alarms; Honeywell International, Inc.
  - b. Notifier; Honeywell International, Inc.
  - c. Potter Electric Signal Company, LLC.

2. Standard: UL 464.
3. Type: Vibrating, metal alarm bell.
4. Size: 8-inch minimum diameter.
5. Finish: Red-enamel factory finish, suitable for outdoor use.

## 2.9 PRESSURE GAUGES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AMETEK, Inc.
  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 diameter.
- D. Pressure Gauge Range: Zero to 250-psig minimum.
- E. Water System Piping Gauge: Include "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 SERVICE-ENTRANCE PIPING

- A. Connect fire-suppression standpipe piping to water-service piping at service entrance into building. Comply with requirements for exterior piping in Section 21 11 00 "Facility Fire-Suppression Water-Service Piping."
- B. Install shutoff valve, pressure gauge, drain, and other accessories at connection to fire-suppression water-service piping.
- C. Install shutoff valve, check valve, pressure gauge, and drain at connection to water service.

### 3.3 WATER-SUPPLY CONNECTIONS

- A. Connect fire-suppression standpipe piping to building's interior water-distribution piping. Comply with requirements for interior piping in Section 22 11 16 "Domestic Water Piping."
- B. Install shutoff valve, pressure gauge, drain, and other accessories at connection to water-distribution piping.

### 3.4 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 in accordance with NFPA 14. Comply with requirements in NFPA 13 for hanger materials.
- I. Install pressure gauges on riser or feed main and at top of each standpipe. Include pressure gauges with connection of not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gauge and valve. Install gauges to permit removal and install where they are not subject to freezing.
- J. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 21 05 17 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- K. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 21 05 17 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- L. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 21 05 18 "Escutcheons for Fire-Suppression Piping."

### 3.5 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 and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 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 in accordance with ASME B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads in accordance with 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 in accordance with AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings in accordance with AWWA C606 for steel-pipe joints.
- I. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe in accordance with AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings in accordance with 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. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

### 3.6 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties in accordance with NFPA 14, authorities having jurisdiction and manufacturer's instructions.
- B. Install listed fire-protection supervised-open shutoff valves, 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.

### 3.7 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 hose connections with quick-disconnect NPS 2-1/2 by NPS 1-1/2 reducer adapter and flow-restricting device.

### 3.8 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping in accordance with NFPA 14 requirements.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "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 in accordance with NFPA 14, "System Acceptance" chapter.
  - 4. Coordinate with fire-alarm tests. Operate as required.
  - 5. Coordinate with fire-pump tests. Operate as required.
  - 6. 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.

### 3.11 PIPING SCHEDULE

- A. Standard-pressure, wet-type fire-suppression standpipe piping, NPS 4 and smaller, shall be one of the following:
  - 1. Schedule 40 or Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
  - 2. Schedule 40 or Schedule 30, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
  - 3. Schedule 40 or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.



4. Thinwall, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
  5. Thinwall, black-steel pipe with plain ends; welding fittings; and welded joints.
- B. Standard-pressure, wet-type fire-suppression standpipe piping, NPS 5 to NPS 8, shall be one of the following:
1. Schedule 40 Schedule 30 or thinwall, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
  2. Schedule 40 or Schedule 30, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
  3. Schedule 40 or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
  4. Thinwall, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
  5. Thinwall, black-steel pipe with plain ends; welding fittings; and welded joints.

END OF SECTION

## SECTION 21 13 13

### PART 1 -

## WET-PIPE SPRINKLER SYSTEMS

### PART 2 - GENERAL

#### 2.1 SUMMARY

##### A. Section Includes:

1. Pipes, fittings, and specialties.
2. Cover system for sprinkler piping.
3. Specialty valves.
4. Sprinklers.
5. Manual control stations.
6. Pressure gauges.

##### B. Related Requirements:

1. Section 21 11 19 "Fire Department Connections" for exposed-, flush-, and yard-type fire department connections.
2. Section 23 05 23 "General-Duty Valves for Water-Based Fire-Suppression Piping" for ball, butterfly, check, gate, post-indicator, and trim and drain valves.

#### 2.2 ACTION SUBMITTALS

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

##### B. Shop Drawings: For wet-pipe sprinkler systems.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

##### C. Delegated-Design Submittal: For wet-pipe 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.

#### 2.3 INFORMATIONAL SUBMITTALS

##### A. Coordination Drawings: Sprinkler systems, or BIM model, drawn to scale, on which items of other systems and equipment are shown and coordinated with each other, using input from installers of the items involved.

##### B. Qualification Data: For qualified Installer and professional engineer.

C. Design Data:

1. 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. Field Test Reports: 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."

- E. Field quality-control reports.

2.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

2.5 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.

PART 3 - PRODUCTS

3.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with NFPA 13.
- C. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
- D. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design wet-pipe sprinkler systems.
1. Available fire-hydrant flow test records indicate the following conditions: Refer to plan for flow test data.
  2. Sprinkler system design shall be approved by authorities having jurisdiction.
    - a. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
    - b. Sprinkler Occupancy Hazard Classifications:
      - 1) Electrical Equipment Rooms: Ordinary Hazard, Group 1.

- 2) Elevator Machine Room and Hoistway: Ordinary Hazard, Group 1. Refer to NFPA Section 8.15.5.2 & 3.
  - 3) General Storage Areas: Ordinary Hazard, Group 1.
  - 4) Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
  - 5) Office and Public Areas: Light Hazard.
3. Minimum Density for Automatic-Sprinkler Piping Design:
    - a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
    - b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
    - c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. area.
  4. Maximum protection area per sprinkler according to UL listing.
  5. Maximum Protection Area per Sprinkler:
    - a. Office Spaces: 230 sq. ft.
    - b. Storage Areas: 130 sq. ft.
    - c. Mechanical & Electrical Equipment Rooms: 130 sq. ft.
    - d. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.

### 3.2 STEEL PIPE AND FITTINGS

- A. Standard-Weight Galvanized- and Black-Steel Pipe: ASTM A53/A53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.
- B. Schedule 30, Galvanized- and Black-Steel Pipe: ASTM A135/A135M; ASTM A795/A795M, 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 A135/A135M or ASTM A795/A795M, 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 A135/A135M or ASTM A795/A795M, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10, plain end.
- E. Galvanized- and Black-Steel Pipe Nipples: ASTM A733, made of ASTM A53/A53M, standard-weight, seamless steel pipe with threaded ends.
- F. Galvanized- and Uncoated-Steel Couplings: ASTM A865/A865M, threaded.
- G. Galvanized and Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- H. Malleable- or Ductile-Iron Unions: UL 860.
- I. Cast-Iron Flanges: ASME 16.1, Class 125.
- J. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
  1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8-inch thick ASME B16.21, nonmetallic and asbestos free or EPDM rubber gasket.
    - a. Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
    - b. Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.

- K. Grooved-Joint, Steel-Pipe Appurtenances:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Anvil International.
    - b. CPS Products, Inc.
    - c. National Fittings, Inc.
    - d. Smith-Cooper International.
    - e. Tyco by Johnson Controls Company.
    - f. Victaulic Company.
  2. Pressure Rating: 250-psig minimum.
  3. Galvanized, Painted or Uncoated Grooved-End Fittings for Steel Piping: ASTM A47/A47M, malleable-iron casting or ASTM A536, 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.
- L. Steel Pressure-Seal Fittings: UL 213, FM Global-approved, 175-psig 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, provide products by the following or "EQUAL":
    - a. Victaulic Company.

### 3.3 COVER SYSTEM FOR SPRINKLER PIPING

- A. Manufacturers: Subject to compliance with requirements, provide products by the following or "EQUAL":
1. DecoShield Systems, Inc.
- B. Description: System of support brackets and covers made to protect sprinkler piping.
- C. Brackets: Glass-reinforced nylon.

### 3.4 SPECIALTY VALVES

- A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
- B. Specialty Valves Pressure Rating: 175-psig minimum.
- C. Body Material: Cast or ductile iron.
- D. Size: Same as connected piping.
- E. End Connections: Flanged or grooved.
- F. Alarm Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Globe Fire Sprinkler Corporation.
  - b. Reliable Automatic Sprinkler Co., Inc. (The).
  - c. Tyco by Johnson Controls Company.
  - d. Venus Fire Protection Ltd.
  - e. Victaulic Company.
  - f. 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 gauges, retarding chamber, and fill-line attachment with strainer.
5. Drip cup assembly pipe drain without valves and separate from main drain piping with check valve to main drain piping.

G. Automatic (Ball Drip) Drain Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Reliable Automatic Sprinkler Co., Inc. (The).
  - b. Tyco by Johnson Controls Company.
2. Standard: UL 1726.
3. Pressure Rating: 175-psig minimum.
4. Type: Automatic draining, ball check.
5. Size: NPS 3/4.
6. End Connections: Threaded.

3.5 AIR VENT

A. Manual Air Vent/Valve:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. AGF Manufacturing, Inc.
  - b. National Fittings, Inc.
  - c. Shurjoint; a part of Aalberts Integrated piping Systems.
  - d. Victaulic Company.
2. Description: Ball valve that requires human intervention to vent air.
3. Body: Forged brass.
4. Ends: Threaded.
5. Minimize Size: 1/2 inch.
6. Minimum Water Working Pressure Rating: 300 psig.

B. Automatic Air Vent:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. AGF Manufacturing, Inc.
  - b. CLA-VAL.
  - c. Engineered Corrosion Solutions.
  - d. Metraflex Company (The).
  - e. Val-Matic Valve & Manufacturing Corp.
2. Description: Automatic air vent that automatically vents trapped air without human intervention.
  3. Standard: UL listed or FM Global approved for wet-pipe fire sprinkler systems.
  4. Vent oxygen continuously from system.
  5. Float valve to prevent water discharge.
  6. Minimum Water Working Pressure Rating: 175 psig.
- C. Automatic Air Vent Assembly:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. AGF Manufacturing, Inc.
    - b. Engineered Corrosion Solutions.
    - c. Potter Electric Signal Company, LLC.
    - d. South-Tek Systems, LLC.
  2. Description: Automatic dual air vent assembly that automatically vents trapped air without human intervention, including Y-strainer and ball valve in a prepped assembly.
  3. Standard: UL listed or FM Global approved for use in wet-pipe fire sprinkler system.
  4. Vent oxygen continuously from system.
  5. Float valve to prevent water discharge.
  6. Minimum Water Working Pressure Rating: 175 psig.

### 3.6 SPRINKLER PIPING SPECIALTIES

- A. Branch Outlet Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. AGF Manufacturing, Inc.
    - b. Anvil International.
    - c. National Fittings, Inc.
    - d. Tyco by Johnson Controls Company.
    - e. Victaulic Company.
  2. Standard: UL 213.
  3. Pressure Rating: 175-psig minimum.
  4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
  5. Type: Mechanical-tee 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, provide products by one of the following:
    - a. AGF Manufacturing, Inc.
    - b. Reliable Automatic Sprinkler Co., Inc. (The).
    - c. Tyco by Johnson Controls Company.
    - d. Victaulic Company.
  2. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
  3. Pressure Rating: 175-psig minimum.
  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 or grooved.
- C. Branch Line Testers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. AGF Manufacturing, Inc.
    - b. Elkhart Brass Mfg. Co., Inc.
    - c. Fire-End & Croker Corporation.
    - d. Potter Electric Signal Company, LLC.
    - e. Potter Roemer LLC; a Division of Morris Group International.
  2. Standard: UL 199.
  3. Pressure Rating: 175 psig.
  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, provide products by one of the following:
    - a. AGF Manufacturing, Inc.
    - b. Triple R Specialty.
    - c. Tyco by Johnson Controls Company.
    - d. Victaulic Company.
    - e. Viking Corporation.
  2. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
  3. Pressure Rating: 175-psig minimum.
  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, provide products by one of the following:
  - a. Aegis Technologies, Inc.
  - b. CECA, LLC.
  - c. CPS Products, Inc.
  - d. Merit Manufacturing.
2. Standard: UL 1474.
3. Pressure Rating: 250-psig minimum.
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.

F. Flexible Sprinkler Hose Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ALEUM USA.
  - b. FlexHead Industries, Inc.
  - c. Gateway Tubing, Inc.
  - d. Victaulic Company.
2. Standard: UL 1474.
3. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
4. Pressure Rating: 175-psig minimum.
5. Size: Same as connected piping, for sprinkler.

3.7 SPRINKLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Globe Fire Sprinkler Corporation.
2. Reliable Automatic Sprinkler Co., Inc. (The).
3. Tyco by Johnson Controls Company.
4. Venus Fire Protection Ltd.
5. Victaulic Company.
6. Viking Corporation.

B. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

C. Pressure Rating for Residential Sprinklers: 175-psig maximum.

D. Pressure Rating for Automatic Sprinklers: 175-psig minimum.

E. Automatic Sprinklers with Heat-Responsive Element:

1. Early-Suppression, Fast-Response Applications: UL 1767.
2. Nonresidential Applications: UL 199.

3. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

F. Sprinkler Finishes: Chrome plated, bronze or painted.

G. Special Coatings: Wax, lead and corrosion-resistant paint.

H. 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 or Chrome-plated steel, two pieces, with 1-inch vertical adjustment.
2. Sidewall Mounting: Chrome-plated steel, one piece, flat.

I. Sprinkler Guards:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Reliable Automatic Sprinkler Co., Inc. (The).
- b. Tyco by Johnson Controls Company.
- c. Victaulic Company.
- d. Viking Corporation.

2. Standard: UL 199.

3. Type: Wire cage with fastening device for attaching to sprinkler.

### 3.8 MANUAL CONTROL STATIONS

A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide" for hydraulic operation, with union, NPS 1/2 pipe nipple, and bronze ball valve.

B. Include metal enclosure labeled "MANUAL CONTROL STATION," with operating instructions and cover held closed by breakable strut to prevent accidental opening.

### 3.9 PRESSURE GAUGES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AGF Manufacturing, Inc.
2. AMETEK, Inc.
3. Ashcroft Inc.
4. Brecco Corporation.
5. WIKA Instrument Corporation.

B. Standard: UL 393.

C. Dial Size: 3-1/2- to 4-1/2-inch diameter.

- D. Pressure Gauge Range: 0- to 250-psig minimum.
- E. Label: Include "WATER" label on dial face.

#### PART 4 - EXECUTION

##### 4.1 SERVICE-ENTRANCE PIPING

- A. Connect sprinkler piping to water-service piping for service entrance to building. Comply with requirements for exterior piping in Section 21 11 00 "Facility Fire-Suppression Water-Service Piping" for exterior piping.
- B. Install shutoff valve, backflow preventer, pressure gauge, drain, and other accessories indicated at connection to water-service piping. Comply with requirements for backflow preventers in Section 21 11 00 "Facility Fire-Suppression Water-Service Piping."
- C. Install shutoff valve, check valve, pressure gauge, and drain at connection to water service.

##### 4.2 WATER-SUPPLY CONNECTIONS

- A. Connect sprinkler piping to building's interior water-distribution piping. Comply with requirements for interior piping in Section 22 11 16 "Domestic Water Piping."
- B. Install shutoff valve, backflow preventer, pressure gauge, drain, and other accessories indicated at connection to water-distribution piping. Comply with requirements for backflow preventers in Section 21 11 00 "Facility Fire-Suppression Water-Service Piping."
- C. Install shutoff valve, check valve, pressure gauge, and drain at connection to water supply.

##### 4.3 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.
  - 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.
  - 2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.
- B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.
- C. Install seismic restraints on piping. Comply with NFPA 13 requirements for seismic-restraint device materials and installation.
- 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 and smaller.

- F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 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. Refer to Section 21 05 48 "Vibration and Controls for Fire-Suppression Piping and Equipment."
- M. Install pressure gauges on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gauges with connection not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gauge and valve. Install gauges to permit removal and install where they are not subject to freezing.
- N. Pressurize and check pre-action sprinkler system piping and air-pressure maintenance devices and air compressors.
- O. Fill sprinkler system piping with water.
- P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 21 05 17 "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 Section 21 05 17 "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 Section 21 05 18 "Escutcheons for Fire-Suppression Piping."

#### 4.4 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 and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 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. 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.
- K. 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.
- L. Extruded-Tee Connections: Form tee in copper tube according to ASTM F2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
- M. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

#### 4.5 INSTALLATION OF COVER SYSTEM FOR SPRINKLER PIPING

- A. Install cover system, brackets, and cover components for sprinkler piping according to manufacturer's "Installation Manual" and NFPA 13 for supports.

#### 4.6 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. Install valves in vertical position for proper direction of flow, in main supply to system.
2. Install alarm valves with bypass check valve and retarding chamber drain-line connection.
3. Install deluge valves 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 gauges, priming chamber attachment, and fill-line attachment.

E. Air Vent:

1. Provide at least one air vent in each wet pipe sprinkler system in accordance with NFPA 13 requirements. Connect vent into top of fire sprinkler piping.
2. Provide dielectric union for dissimilar metals, ball or globe valve, and strainer upstream of automatic air vent.
3. Pipe from outlet of air vent to drain.

4.7 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.
- C. Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid.

4.8 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 Section 26 05 53 "Identification for Electrical Systems."

4.9 FIELD QUALITY CONTROL

- A. Perform the following 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.
- B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

4.10 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

4.11 PIPING SCHEDULE

- A. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends, cast-iron threaded fittings, and threaded or grooved ends, grooved-end fittings, grooved-end-pipe couplings, and grooved joints.
- B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
- C. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be one of the following:
  - 1. Standard-weight or Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
  - 2. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
  - 3. Standard-weight or Schedule 30, black-steel pipe with plain ends; uncoated, plain-end-pipe fittings; and twist-locked joints.
  - 4. Standard-weight or Schedule 30, galvanized-steel pipe with plain ends; galvanized, plain-end-pipe fittings; and twist-locked joints.
  - 5. Standard-weight or Schedule 30, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
  - 6. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
- D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 4, shall be one of the following:
  - 1. Standard-weight or Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
  - 2. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
  - 3. Standard-weight or Schedule 30, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
  - 4. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
- E. Standard-pressure, wet-pipe sprinkler system, NPS 5 and larger, shall be one of the following:
  - 1. Standard-weight or Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
  - 2. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.

3. Standard-weight or Schedule 30, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
4. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

#### 4.12 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 or Pendent, recessed, flush, and concealed sprinklers as indicated.
3. Wall Mounting: Sidewall sprinklers.
4. Spaces Subject to Freezing: Upright sprinklers, Pendent, dry sprinklers, Sidewall, dry sprinklers, or Upright, pendent, dry sprinklers; and sidewall, dry sprinklers as indicated.
5. Special Applications: Extended-coverage, flow-control, and quick-response sprinklers where indicated, Combustible concealed space sprinklers or Institutional space 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; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION 21 13 13



## SECTION 21 31 13

### PART 1 -

## ELECTRIC-DRIVE, CENTRIFUGAL FIRE PUMPS

### PART 2 - GENERAL

#### 2.1 SUMMARY

- A. Section Includes:
1. End-suction fire pumps.
  2. In-line fire pumps.
  3. Fire-pump accessories and specialties.

#### 2.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For fire pumps, motor drivers, and fire-pump accessories and specialties.
1. Include plans, elevations, sections, and mounting and attachment details.
  2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  3. Include diagrams for power, signal, and control wiring.

#### 2.3 INFORMATIONAL SUBMITTALS

- A. Qualification Certificates: For fire pumps, accessories, and components, from manufacturer.
- B. Field quality-control reports.

#### 2.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

### PART 3 - PRODUCTS

#### 3.1 PERFORMANCE REQUIREMENTS

- A. NFPA Compliance: Comply with NFPA 20.

- B. Pump Equipment, Accessory, and Specialty Pressure Rating: 175 psig minimum unless higher pressure rating is indicated.
- 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.

### 3.2 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.

### 3.3 END-SUCTION FIRE PUMPS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. A-C Fire Pump; a Xylem brand.
  - 2. CPS Products, Inc.
  - 3. Patterson Pump Company; a Gorman-Rupp company.
  - 4. Peerless Pump Company.
  - 5. Reddy-Buffaloes Pump Company.
  - 6. S.A. Armstrong Limited.
  - 7. SPP Pumps.
- B. Pump:
  - 1. Standard: UL 448, for end-suction pumps for fire service.
  - 2. Casing: Radially split case, top centerline discharge, self-venting, 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 or stainless-steel sleeves.
    - a. Shaft Bearings: Grease-lubricated, back-to-back thrust ball bearings and one radial roller bearing.
    - b. Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.
  - 6. Mounting: Back pullout design, allowing complete rotating assembly removal without disturbing the casing piping connections. 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: Refer to plan.

### 3.4 IN-LINE FIRE PUMPS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. A-C Fire Pump; a Xylem brand.
2. CPS Products, Inc.
3. Patterson Pump Company; a Gorman-Rupp company.
4. Peerless Pump Company.
5. Pentair Pump Group.
6. Plad Equipment, Ltd.
7. Reddy-Buffaloes Pump Company.
8. S.A. Armstrong Limited.
9. SPP Pumps.

- B. Pump:

1. Standard: UL 448, for in-line pumps for fire service.
2. Casing: Radially 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 shaft is vertical, with motor above pump and pump on base. Motor and pump rotating assembly shall be removable from top without removing the pump casing from the piping.

- C. Coupling: None or rigid.

- D. Driver:

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

- E. Capacities and Characteristics: Refer to plan.

### 3.5 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, provide products by one of the following:
  - a. BERMAD Control Valves.
  - b. CLA-VAL.
  - c. Kunkle Valve.
  - d. OCV Control Valves.
  - e. WATTS.
  - f. Zurn Industries, LLC.
2. 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.

### 3.6 GROUT

- A. Standard: ASTM C1107, 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, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

## PART 4 - EXECUTION

### 4.1 INSTALLATION

- A. Fire-Pump Installation Standard: Comply with NFPA 20 for installation of fire pumps, relief valves, and related components.
- B. Equipment Mounting:
  1. Install fire pumps on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."
  2. Comply with requirements for vibration isolation devices specified in Section 21 05 48.13 "Vibration Controls for Fire-Suppression Piping and 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 Section 21 12 00 "Fire-Suppression Standpipes." and Section 21 13 13 "Wet-Pipe Sprinkler Systems."
- F. Install pressure gages on fire-pump suction and discharge flange pressure-gage tappings. Comply with requirements for pressure gages specified in Section 21 12 00 "Fire-Suppression Standpipes." and Section 21 13 13 "Wet-Pipe Sprinkler Systems."
- G. Install piping hangers and supports, anchors, valves, gages, and equipment support according to NFPA 20.
- H. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical Installer.
- I. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

#### 4.2 ALIGNMENT

- A. Align end-suction 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.

#### 4.3 CONNECTIONS

- A. Comply with requirements for piping and valves specified in Section 21 12 00 "Fire-Suppression Standpipes." and Section 21 13 13 "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.

#### 4.4 IDENTIFICATION

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

4.5 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 Section 26 23 933 "Controllers for Fire-Pump Drivers."
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
  - 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.
- C. Components, assemblies, and equipment will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. 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.

4.6 STARTUP SERVICE

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

END OF SECTION

## SECTION 21 39 00

### PART 1 -

## CONTROLLERS FOR FIRE-PUMP DRIVERS

### PART 2 - GENERAL

#### 2.1 SUMMARY

##### A. Section Includes:

1. Full-service, full, or reduced-voltage controllers rated 600 V and less.
2. Controllers for pressure-maintenance "Jockey" pumps.

#### 2.2 DEFINITIONS

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

#### 2.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- 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. Detail equipment assemblies and indicate dimensions, weights, loads, method of field assembly, components, and location and size of each field connection.
  2. Schematic and Connection Diagrams: For power, signal, alarm, and control wiring and for pressure-sensing tubing.

#### 2.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Manufacturer's factory test reports of fully assembled and tested equipment.
- C. Source quality-control reports.
- D. Field quality-control reports.

2.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

2.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain fire-pump controllers and all associated equipment from single source or producer.
- 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 standards of authorities having jurisdiction pertaining to materials and installation.
- D. Comply with NFPA 20 and NFPA 70.
- E. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces defined in Section 26 05 48.16 "Seismic Controls for Electrical Systems."

PART 3 - PRODUCTS

3.1 FULL-SERVICE CONTROLLERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Aquarius Fluid Products, Inc.
  2. Eaton.
  3. Hubbell Incorporated.
  4. Hubbell Industrial Controls; Hubbell Incorporated, Commercial and Industrial.
  5. Joslyn Clark Corporation.
  6. Master Control Systems, Inc.
  7. Tornatech.
- 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 or Non-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: Autotransformer 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.
- H. 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.

### 3.2 CONTROLLERS FOR PRESSURE-MAINTENANCE "JOCKEY" PUMPS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Aquarius Fluid Products, Inc.
2. Eaton.
3. Hubbell Incorporated.
4. Hubbell Industrial Controls; Hubbell Incorporated, Commercial, and Industrial.
5. Joslyn Clark Corporation.
6. Master Control Systems, Inc.
7. Tornatech.

- 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.

### 3.3 ENCLOSURES

- A. Fire-Pump Controllers and ATS Panels: NEMA 250, to comply with environmental conditions at installed locations and NFPA 20.

1. Indoor, Dry and Clean Locations: Type 1 (IEC IP10).
2. Indoor Locations Subject to Dripping Noncorrosive Liquids: Type 2 (IEC IP11).
3. Other Wet or Damp, Indoor Locations: Type 4 (IEC IP56) or Type 4X (IEC IP56).
4. 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".
- C. Nameplates: Comply with NFPA 20; complete with capacity, characteristics, approvals, listings, and other pertinent data.
- D. Floor stands, 12 inches high, for floor-mounted controllers.

### 3.4 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 4 - EXECUTION

### 4.1 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 above finished floor, and bottom of enclosure not less than 12 inches 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 Section 26 05 29 "Hangers and Supports for Electrical Systems."
- D. Floor-Mounting Controllers: Install controllers on 4-inch nominal-thickness concrete bases, using floor stands high enough so that the bottom of enclosure cabinet is not less than 12 inches above finished floor. Comply with requirements for concrete bases specified in Section 03 30 00 "Cast-in-Place Concrete." or Section 03 30 53 "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 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.

#### 4.2 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 Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- B. Comply with NECA 1.

#### 4.3 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 Section 26 05 23 "Control-Voltage Electrical Power Cables."
- B. Install wiring between remote alarm panels and controllers. Comply with requirements in NFPA 20, NFPA 70, and Section 26 05 23 "Control-Voltage Electrical Power Cables."
- C. Install wiring between controllers and the building's fire-alarm system. Comply with requirements specified in Section 28 31 11 "Digital, Addressable Fire-Alarm System."
- D. Bundle, train, and support wiring in enclosures.
- E. Connect remote manual and automatic activation devices where applicable.

#### 4.4 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 Section 26 05 53 "Identification for Electrical Systems."

#### 4.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. 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.

C. 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.

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

E. Prepare test and inspection reports.

F. Perform startup service.

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

4.6 ADJUSTING

A. Adjust controllers 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.

4.7 DEMONSTRATION

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

END OF SECTION

## SECTION 22 05 00

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### PART 1 -

### COMMON WORK RESULTS FOR PLUMBING

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### PART 1 - PART 2 - GENERAL

#### 1.12.1 SUMMARY

- A. This Section includes the following:
1. Piping materials and installation instructions common to most piping systems.
  2. Dielectric fittings.
  3. Mechanical sleeve seals.
  4. Sleeves.
  5. Escutcheons.
  6. Grout.
  7. Equipment installation requirements common to equipment sections.
  8. Concrete bases.
  9. Supports and anchorages.

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#### 1.12.2 DEFINITIONS

- A. Finished Spaces: Spaces other than plumbing and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and plumbing equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

#### 1.12.3 SUBMITTALS

- A. Welding certificates.

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**1.42.4 QUALITY ASSURANCE**

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
  - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

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**~~PART 2~~-PART 3 - PRODUCTS**

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**2.43.1 PIPE, TUBE, AND FITTINGS**

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- A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

**2.23.2 JOINING MATERIALS**

- A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
- C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series or BA<sub>g</sub>1, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12.
- G. Solvent Cements for Joining Plastic Piping:
  - 1. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

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**2.33.3 DIELECTRIC FITTINGS**

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
- E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
- F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

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**2.43.4 MECHANICAL SLEEVE SEALS**

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
- B. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

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**2.53.5 SLEEVES**

- A. Galvanized-Steel Sheet: 0.0239-inch-minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
  - 1. Underdeck Clamp: Clamping ring with set screws.
- E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe: ASTM D 1785, Schedule 40.
- G. Molded PE: Reusable, PE, tapered cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

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**2.63.6 ESCUTCHEONS**

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
  - 1. Finish: ~~[Polished chrome-plated]~~ ~~[Rough brass]~~ [Polished chrome-plated and rough brass].
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
  - 1. Finish: ~~[Polished chrome-plated]~~ ~~[Rough brass]~~ [Polished chrome-plated and rough brass].

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**2.73.7 GROUT**

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
  - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
  - 2. Design Mix: 5000-psi, 28-day compressive strength.
  - 3. Packaging: Premixed and factory packaged.

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**PART 3 - PART 4 - EXECUTION**

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**3.14.1 PLUMBING DEMOLITION**

- 1. PIPING SYSTEMS - COMMON REQUIREMENTS
- B. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- C. 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.
- 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.

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- G. Install piping to permit valve servicing.
- H. Install piping at indicated slopes.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Install piping to allow application of insulation.
- L. Select system components with pressure rating equal to or greater than system operating pressure.
- M. Install escutcheons for penetrations of walls, ceilings, and floors.
- N. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
- O. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
  - 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
  - 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
  - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- P. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
  - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- Q. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- R. Verify final equipment locations for roughing-in.
- S. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

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**3-24.2 PIPING JOINT CONSTRUCTION**

- A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.

- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. 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.
  - 2. PVC Nonpressure Piping: Join according to ASTM D 2855.
- J. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.
  - 1. PIPING CONNECTIONS
- K. Make connections according to the following, unless otherwise indicated:
  - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
  - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

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**3.34.3 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS**

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

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- C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
  
- D. Install equipment to allow right of way for piping installed at required slope.
  - 1. ERECTION OF METAL SUPPORTS AND ANCHORAGES
  
- E. Refer to Division 05 Section "Metal Fabrications" for structural steel.
  
- F. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
  
- G. Field Welding: Comply with AWS D1.1.

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## **SECTION 22 05 13**

### PART 1 -

### **COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT**

#### **PART 2 - GENERAL**

##### 2.1 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small, and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

##### 2.2 COORDINATION

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

#### **PART 3 - PRODUCTS**

##### 3.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.

##### 3.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

### 3.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
  - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
  - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Rotor: Random-wound, squirrel cage.
- F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- G. Temperature Rise: Match insulation rating.
- H. Insulation: Class F.
- I. Code Letter Designation:
  - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
  - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

### 3.4 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.

3.5 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: Pre-lubricated, 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 4 - EXECUTION (Not Applicable)**

## **SECTION 22 05 17**

### PART 1 -

### **SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING**

#### **PART 2 - GENERAL**

##### 2.1 SUMMARY

- A. Section Includes:
1. Sleeves.
  2. Sleeve-seal systems.
  3. Grout.

##### 2.2 ACTION SUBMITTALS

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

#### **PART 3 - PRODUCTS**

##### 3.1 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral water stop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

##### 3.2 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Advance Products & Systems, Inc.



2. CALPICO, Inc.
3. GPT; an EnPro Industries company.
4. Metraflex Company (The).
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.

### 3.3 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

## **PART 4 - EXECUTION**

### 4.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
  1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
  1. Cut sleeves to length for mounting flush with both surfaces.
    - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
  2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

- D. Install sleeves for pipes passing through interior partitions.
  - 1. Cut sleeves to length for mounting flush with both surfaces.
  - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
  - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 07 92 00 "Joint Sealants."
  
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 07 84 13 "Penetration Firestopping."

#### 4.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
  
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

#### 4.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
  - 1. Exterior Concrete Walls above Grade:
    - a. Piping Smaller Than NPS 6: Cast-iron wall sleeves, Galvanized-steel wall sleeves or Galvanized-steel-pipe sleeves.
    - b. Piping NPS 6 and Larger: Cast-iron wall sleeves, Galvanized-steel wall sleeves or Galvanized-steel-pipe sleeves.
  
  - 2. Exterior Concrete Walls below Grade:
    - a. Piping Smaller Than NPS 6: 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 annular clear space between piping and sleeve for installing sleeve-seal system.
  
    - b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system, 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 annular clear space between piping and sleeve for installing sleeve-seal system.

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

**END OF SECTION**

**SECTION 22 05 18**

PART 1 -

**ESCUTCHEONS FOR PLUMBING PIPING**

**PART 2 - GENERAL**

2.1 SUMMARY

A. Section Includes:

- 1. Escutcheons.
- 2. Floor plates.

2.2 ACTION SUBMITTALS

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

**PART 3 - PRODUCTS**

3.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Insert manufacturer's name, product name or designation or comparable product by one of the following:

- 1. BrassCraft Manufacturing Co.; a Masco company.
- 2. Dearborn Brass.
- 3. ProFlo; a Ferguson Enterprises, Inc. brand.

~~PART 3~~

~~3.1.2~~ 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.

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3-23.3 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

**PART 4 - EXECUTION**

4.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
  - 1. Escutcheons for New Piping:
    - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
    - b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
    - c. Insulated Piping: One-piece, stamped-steel type.
    - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
    - e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
    - f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
    - g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type.
    - h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished, chrome-plated or rough-brass finish.
    - i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type.
    - j. Bare Piping in Equipment Rooms: One-piece, cast-brass type with polished, chrome-plated or rough-brass finish.
    - k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
  - 1. New Piping: One-piece, floor-plate type.

4.2 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons and floor plates using new materials.

**END OF SECTION**

## **SECTION 22 05 19**

### **PART 1 -**

### **METERS AND GAGEDS FOR PLUMBING PIPING**

### **PART 2 - GENERAL**

#### 2.1 RELATED DOCUMENTS

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

#### 2.2 SUMMARY

- A. Section Includes:
  - 1. Bimetallic-actuated thermometers.
  - 2. Liquid-in-glass thermometers.
  - 3. Gage attachments.

#### 2.3 ACTION SUBMITTALS

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

#### 2.4 INFORMATIONAL SUBMITTALS

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

#### 2.5 CLOSEOUT SUBMITTALS

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

### **PART 3 - PRODUCTS**

#### 3.1 BIMETALLIC-ACTUATED THERMOMETERS

- A. Available Manufacturers: Subject to compliance with requirements, provide one of the following:  
Ashcroft Inc.

Ernst Flow Industries  
Marsh Industries

- B. Standard: ASME B40.200.
- C. Case: Liquid-filled and sealed type(s); stainless steel with 5-innominal diameter.
- D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F.
- E. Connector Type(s): Union joint, adjustable angle with unified-inch screw threads.
- F. Connector Size: 1/2 inch, with ASME B1.1 screw thread.
- G. Stem: 0.25 or 0.375 inch in diameter; stainless steel.
- H. Window: Plain glass
- I. Ring: Stainless steel.
- J. Element: Bimetal coil.
- K. Pointer: Dark-colored metal.
- L. Accuracy: Plus, or minus 1of scale range.

### 3.2 LIQUID-IN-GLASS THERMOMETERS

- A. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:
  - 1. Available Manufacturers: Subject to compliance with requirements, provide one of the following:  
Ernst Flow Industries  
Marsh Industries  
Milioco Corporation
  - 2. Standard: ASME B40.200.
  - 3. Case: Cast aluminum; 6-inch nominal size.
  - 4. Case Form: Back angle or Straight unless otherwise indicated.
  - 5. Tube: Glass with magnifying lens and blue or red organic liquid.
  - 6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
  - 7. Window: Glass 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, with ASME B1.1 screw thread
  - 10. Accuracy: Plus, or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

### 3.3 PRESSURE GAGES

- A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
1. Available Manufacturers: Subject to compliance with requirements, provide one of the following:  
Ernst Flow Industries  
Marsh Industries  
Milioco Corporation
  2. Standard: ASME B40.100.
  3. Case: Liquid-filled type(s); cast aluminum or drawn steel 4-1/2-inch nominal diameter.
  4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
  5. Pressure Connection: Brass, with NPS 1/4, 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 and kPa.
  8. Pointer: Dark-colored metal.
  9. Window: Glass
  10. Ring: Stainless steel.
  11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

### 3.4 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with **NPS 1/4**, ASME B1.20.1 pipe threads and **piston porous-metal**-type surge-dampening device. Include extension for use on insulated piping.
- B. Valves: **Brass or stainless-steel needle**, with **NPS 1/4**, ASME B1.20.1 pipe threads.

## PART 4 - EXECUTION

### 4.1 INSTALLATION

- A. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- B. 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.
- C. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- D. Install thermometers in the following locations:
1. Inlet and outlet of each water heater.



- E. 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.
- F. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.
- G. Adjust faces of meters and gages to proper angle for best visibility.

#### 4.2 THERMOMETER SCHEDULE

- A. Thermometers at inlet and outlet of each domestic water heater shall be:
  - 1. Liquid-filled, bimetallic-actuated type.
- B. Thermometer stems shall be of length to match thermowell insertion length.

#### 4.3 THERMOMETER SCALE-RANGE SCHEDULE

- A. Retain one or more of first three paragraphs below. If retaining more than one scale range, indicate location of each on Drawings. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F.
- B. Scale Range for Domestic Hot-Water Piping: 30 to 240 deg F.

#### 4.4 PRESSURE-GAGE SCHEDULE

- A. Pressure gages at discharge of each water service into building shall be one of the following:
  - 1. Liquid-filled direct-mounted, metal case.
  - 2. Sealed direct-mounted, plastic case.
- B. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be:
  - 1. Liquid-filled direct mounted, metal case.
  - 2. Sealed, direct-mounted, plastic case.
- C. Pressure gages at suction and discharge of each domestic water pump shall:
  - 1. Liquid-filled, direct-mounted, metal case.
  - 2. Sealed direct mounted, plastic case.

#### 4.5 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for Water Service Piping: **0 to 100 psi.**

- B. Scale Range for Domestic Water Piping: **0 to 100 psi.**

END OF SECTION

## SECTION 22 05 23

### PART 1 -

#### GENERAL-DUTY VALVES FOR PLUMBING PIPING

#### PART 2 - GENERAL

##### 2.1 SUMMARY

###### A. Section Includes:

1. ~~B~~Brass ball valves.
2. ~~Bronze ball valves.~~
3. ~~2. B~~Iron, single flange butterfly valves.
4. ~~3. C~~Bronze swing check valves.
4. ~~Iron swing check valves.~~ Gate Valves
5. Globe Valves
6. ~~Iron swing check valves with closure control.~~ Drain Valves
7. ~~Bronze globe valves.~~
8. ~~Iron globe valves.~~

###### B. Related Sections:

1. Section 22 05 53 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
2. Section 22 11 16 "Domestic Water Piping" for valves applicable only to this piping.
3. Section 22 13 19 "Sanitary Waste Piping Specialties" for valves applicable only to this piping.
4. Section 22 14 23 "Storm Drainage Piping Specialties" for valves applicable only to this piping.

##### 2.2 ACTION SUBMITTALS

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

##### 2.3 QUALITY ASSURANCE

- A. ASME Compliance: ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

B. NSF Compliance: NSF 61 for valve materials for potable-water service.

C. Lead Free: Products shall have certification one of the following, regarding lead content outlined above and shall conform to requirements of local authorities having jurisdiction:

1. NSF/ANSI 61 Annex G.
2. NSF 372.
3. An ANSI accredited 3rd party agency.

#### 2.4 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. Components received and stored on the job site shall be stored in dry storage spaces, (e.g. building, trailers, or sheds) whenever possible. Components shall be stored on wooden shipping skids or rails. Under no condition shall the material be stored in such a way that metal components are in direct contact with the ground or floor slabs.
3. Where it is not practical to store items within an enclosure, components may be stored on wooden shipping skids or rails outside.
4. Components shall be covered with 6 mil polyethylene sheet (taped in place) to protect the equipment from damage and the weather.

##### 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.

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### **PART 3 - PRODUCTS**

#### 3.1 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. ~~Gear Actuator: For quarter turn valves NPS 8 and larger.~~
  2. ~~Handwheel: For valves other than quarter turn types.~~
  3. 1. Handlever: For quarter-turn valves NPS 6 and smaller except plug valves.
  4. ~~Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.~~

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. 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. Solder Joint: With sockets according to ASME B16.18.
3. Threaded: With threads according to ASME B1.20.1.

3.2 IRON GATE VALVES

A. Class 125, NRS, Iron Gate Valves:

~~3.2 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-Hammond Valve~~
- b. ~~Milwaukee Valve Company.~~
- c. ~~NIBCO INC.~~
- d. ~~Red White Valve Corporation.~~

2. Description:

- a. Standard: MSS SP-70, Type I.
- b. CWP Rating: 200 psig.
- c. Body Material: ASTM A 126, gray iron.
- d. Bonnet: Bolted
- e. Ends: Flanged.
- f. Trim: Bronze.
- g. Disc: Solid wedge.
- h. Packing and Gasket: Asbestos free.
- i. Handwheel: Malleable Iron

- a. ~~Iron Standard: MSS-SP-110.~~
- b. ~~CWP Rating: 400 psig.~~
- 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.~~

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

~~1. Manufacturers: Subject to compliance with requirements, provide products by one of 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.~~
- ~~m. Red White Valve Corporation.~~
- ~~n. RuB Inc.~~

~~2. Description:~~

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

~~C. Two Piece, Regular Port, Brass Ball Valves with Brass Trim:~~

~~1. Manufacturers: Subject to compliance with requirements, provide products by one of 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.~~
- ~~c. CWP Rating: 600 psig.~~
- ~~d. Body Design: Two piece.~~
- ~~e. Body Material: Forged brass.~~
- ~~f. Ends: Threaded.~~
- ~~g. Seats: PTFE or TFE.~~

- ~~h. Stem: Brass.~~
- ~~i. Ball: Chrome-plated-brass.~~
- ~~j. Port: Regular.~~

3.3 ~~Class 125, RS OS&Y, Iron Gate Valves:~~

~~1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:~~

- ~~a. Hammond Valve.~~
- ~~b. NIBCO~~
- ~~c. Milwaukee Valve Company.~~

~~2. Description:~~

- ~~a. Standard: MSS SP-70, Type I.~~
- ~~b. CWP Rating: 200 psig.~~
- ~~c. Body Material: ASTM A 126, gray iron with bolted bonnet.~~
- ~~d. Bonnet: Bolted~~
- ~~e. Ends: Flanged.~~
- ~~f. Trim: Bronze.~~
- ~~g. Disc: Solid wedge.~~
- ~~h. Packing and Gasket: Asbestos free.~~

~~3.3.4~~ BRONZE BALL VALVES

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

~~1. Manufacturers: Subject to compliance with requirements, provide products by one of 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.~~
- ~~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.A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:~~

~~1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:~~

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

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2. Description:

- a. Standard: MSS SP-110.
- b. SWP Rating: 150 psig.
- c. CWP Rating: 600 psig.
- d. Body Design: Two piece.
- e. Body Material: Bronze.
- f. Ends: Threaded.
- g. Seats: PTFE or TFE.
- h. Stem: Bronze.
- i. Ball: Chrome-plated brass.
- j. Port: Full.
- j.k. Handle: Carbon steel with plastic grip cover.

~~C. Two Piece, Regular Port, Bronze Ball Valves with Bronze Trim:~~

~~1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:~~

- ~~a. American Valve, Inc.~~
- ~~b. Conbraco Industries, Inc.; Apollo Valves.~~
- ~~e. 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.~~
- ~~c. CWP Rating: 600 psig.~~
- ~~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.~~



3-43.5 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

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- a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
- b. Conbraco Industries, Inc.; Apollo Valves.
- ~~c. Cooper Cameron Valves; a division of Cooper Cameron Corporation.~~
- ~~d. Crane Co.; Crane Valve Group; Jenkins Valves.~~
- ~~e. Crane Co.; Crane Valve Group; Stockham Division.~~
- ~~f. DeZurik Water Controls.~~
- ~~g. Flo Fab Inc.~~
- ~~h. Hammond Valve.~~
- ~~i. Kitz Corporation.~~
- ~~j. Legend Valve.~~
- ~~k. Milwaukee Valve Company.~~
- ~~l. NIBCO INC.~~
- ~~m. Norrisal; a Dover Corporation company.~~
- ~~n. Red White Valve Corporation.~~
- ~~o. Spence Strainers International; a division of CIRCOR International, Inc.~~
- p. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

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2. Description:

- a. Standard: MSS SP-67, Type I.
- b. CWP Rating: 200 psig.
- c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
- e. Seat: EPDM.
- f. Stem: One- or two-piece stainless steel.
- g. Disc: Aluminum bronze.
- g-h. Handle: Lever or gear operator

B. 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Aluminum-Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

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- a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
- ~~b. Conbraco Industries, Inc.; Apollo Valves.~~
- ~~c. Cooper Cameron Valves; a division of Cooper Cameron Corporation.~~
- ~~d. Crane Co.; Crane Valve Group; Jenkins Valves.~~
- ~~e. Crane Co.; Crane Valve Group; Stockham Division.~~
- ~~f. DeZurik Water Controls.~~
- ~~g. Flo Fab Inc.~~
- ~~h. Hammond Valve.~~
- ~~i. Kitz Corporation.~~
- ~~j. Legend Valve.~~

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- ~~k-g.~~ Milwaukee Valve Company.
- ~~l-h.~~ NIBCO INC.
- ~~m.~~ Norriseal; a Dover Corporation company.
- ~~n.~~ Red White Valve Corporation.
- ~~o.~~ Spence Strainers International; a division of CIRCOR International, Inc.
- ~~p-i.~~ Watts Regulator Co.; a division of Watts Water Technologies, Inc.

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2. Description:

- a. Standard: MSS SP-67, Type I.
- b. CWP Rating: 200 psig.
- c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
- e. Seat: NBR.
- f. Stem: One- or two-piece stainless steel.
- ~~g.~~ Disc: Aluminum bronze.
- ~~g-h.~~ Handle: Lever or gear operator

~~C.~~ 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Ductile-Iron Disc:

~~1.~~ Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- ~~a.~~ ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
- ~~b.~~ American Valve, Inc.
- ~~c.~~ Conbraco Industries, Inc.; Apollo Valves.
- ~~d.~~ Cooper-Cameron Valves; a division of Cooper-Cameron Corporation.
- ~~e.~~ Crane Co.; Crane Valve Group; Center Line.
- ~~f.~~ Crane Co.; Crane Valve Group; Stockham Division.
- ~~g.~~ DeZurik Water Controls.
- ~~h.~~ Flo-Fab Inc.
- ~~i.~~ Hammond Valve.
- ~~j.~~ Kitz Corporation.
- ~~k.~~ Legend Valve.
- ~~l.~~ Milwaukee Valve Company.
- ~~m.~~ Mueller Steam Specialty; a division of SPX Corporation.
- ~~n.~~ NIBCO INC.
- ~~o.~~ Norriseal; a Dover Corporation company.
- ~~p.~~ Spence Strainers International; a division of CIRCOR International, Inc.
- ~~q.~~ Sure Flow Equipment Inc.
- ~~r.~~ Watts Regulator Co.; a division of Watts Water Technologies, Inc.

~~2.~~ Description:

- ~~a.~~ Standard: MSS SP-67, Type I.
- ~~b.~~ CWP Rating: 200 psig.
- ~~c.~~ Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- ~~d.~~ Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
- ~~e.~~ Seat: EPDM.
- ~~f.~~ Stem: One- or two-piece stainless steel.

~~g. Disc: Nickel plated[ or coated] ductile iron.~~

~~D. 200 CWP, Iron, Single Flange Butterfly Valves with NBR Seat and Ductile Iron Disc:~~

~~1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:~~

- ~~a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.~~
- ~~b. American Valve, Inc.~~
- ~~c. Conbraco Industries, Inc.; Apollo Valves.~~
- ~~d. Cooper Cameron Valves; a division of Cooper Cameron Corporation.~~
- ~~e. Crane Co.; Crane Valve Group; Center Line.~~
- ~~f. Crane Co.; Crane Valve Group; Stockham Division.~~
- ~~g. DeZurik Water Controls.~~
- ~~h. Flo Fab Inc.~~
- ~~i. Hammond Valve.~~
- ~~j. Kitz Corporation.~~
- ~~k. Legend Valve.~~
- ~~l. Milwaukee Valve Company.~~
- ~~m. Mueller Steam Specialty; a division of SPX Corporation.~~
- ~~n. NIBCO INC.~~
- ~~o. Norriseal; a Dover Corporation company.~~
- ~~p. Spence Strainers International; a division of CIRCOR International, Inc.~~
- ~~q. Sure Flow Equipment Inc.~~
- ~~r. Watts Regulator Co.; a division of Watts Water Technologies, Inc.~~

~~2. Description:~~

- ~~a. Standard: MSS SP-67, Type I.~~
- ~~b. CWP Rating: 200 psig.~~
- ~~c. Body Design: Lug type; suitable for bidirectional dead end service at rated pressure without use of downstream flange.~~
- ~~d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.~~
- ~~e. Seat: NBR.~~
- ~~f. Stem: One or two piece stainless steel.~~
- ~~g. Disc: Nickel plated[ or coated] ductile iron.~~

### 3.53.6 BRONZE SWING CHECK VALVES

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

1. ~~Manufacturers: Subject to compliance with requirements, provide products by one of the following:~~

- ~~a. American Valve, Inc.~~
- ~~b. Crane Co.; Crane Valve Group; Crane Valves.~~
- ~~e.a. Crane Co.; Crane Valve Group; Jenkins Valves.~~
- ~~d. Crane Co.; Crane Valve Group; Stockham Division.~~
- ~~e. Hammond Valve.~~
- ~~f.b. Kitz Corporation.~~
- ~~g.c. Milwaukee Valve Company.~~
- ~~h.d. NIBCO INC.~~

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- ~~i.e.~~ Powell Valves.
- ~~j.~~ ~~Red-White Valve Corporation.~~
- ~~k.f.~~ Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- ~~l.~~ ~~Zy-Tech Global Industries, Inc.~~

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2. Description:

- a. Standard: MSS SP-80, Type 3.
- b. CWP Rating: 200 psig.
- c. Body Design: Horizontal flow.
- d. Body Material: ASTM B 62, bronze.
- e. Ends: Threaded.
- f. Disc: Bronze.

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

~~1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:~~

- ~~a. Crane 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. Red-White Valve Corporation.~~
- ~~i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.~~

~~2. Description:~~

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

3-63.7 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Crane Co.; Crane Valve Group; Crane Valves.
- b. Crane Co.; Crane Valve Group; Jenkins Valves.
- ~~c. Crane Co.; Crane Valve Group; Stockham Division.~~
- ~~d.c.~~ Hammond Valve.
- ~~e.~~ Kitz Corporation.
- ~~f.~~ Legend Valve.
- ~~g.d.~~ Milwaukee Valve Company.

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- ~~h.e.~~ NIBCO INC.
- ~~i.~~ ~~Powell Valves.~~
- ~~j.~~ ~~Red White Valve Corporation.~~
- ~~k.~~ ~~Sure Flow Equipment Inc.~~
- ~~l.f.~~ Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- ~~m.~~ ~~Zy-Tech Global Industries, Inc.~~

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2. Description:

- a. Standard: MSS SP-71, Type I.
- b. CWP Rating: 200 psig.
- c. Body Design: Clear or full waterway.
- d. Body Material: ASTM A 126, gray iron with bolted bonnet.
- e. Ends: Flanged.
- f. Trim: Bronze.
- g. Gasket: Asbestos free.

~~B.~~ ~~Class 125, Iron Swing Check Valves with Nonmetallic to Metal Seats:~~

- ~~1. Manufacturers: Subject to compliance with requirements, 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.~~

~~2. Description:~~

- ~~a. Standard: MSS SP 71, Type I.~~
- ~~b. CWP Rating: 200 psig.~~
- ~~c. Body Design: Clear or full waterway.~~
- ~~d. Body Material: ASTM A 126, gray iron with bolted bonnet.~~
- ~~e. Ends: Flanged.~~
- ~~f. Trim: Composition.~~
- ~~g. Seat Ring: Bronze.~~
- ~~h. Disc Holder: Bronze.~~
- ~~i. Disc: PTFE or TFE.~~
- ~~j. Gasket: Asbestos free.~~

C.B. Class 125, Iron Swing Check Valves with Lever- and Weight-Closure Control:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

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- 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.c.~~ Hammond Valve.
- ~~e.d.~~ Milwaukee Valve Company.
- ~~f.e.~~ NIBCO INC.
- ~~g.f.~~ Watts Regulator Co.; a division of Watts Water Technologies, Inc.

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2. Description:

- a. Standard: MSS SP-71, Type I.
- b. CWP Rating: 200 psig.
- c. Body Design: Clear or full waterway.
- d. Body Material: ASTM A 126, gray iron with bolted bonnet.
- e. Ends: Flanged.
- f. Trim: Bronze.
- g. Gasket: Asbestos free.
- h. Closure Control: Factory-installed, exterior lever and weight.

3-73.8 BRONZE GLOBE VALVES

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

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

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2. Description:

- a. Standard: MSS SP-80, Type 2.
- b. CWP Rating: 300 psig.
- c. Body Material: ASTM B 62, bronze with integral seat.
- d. Bonnet: Union.
- e. Ends: Threaded.
- f. Stem: Bronze.
- g. Disc: PTFE or TFE.
- h. Packing: Asbestos free.
- i. Handwheel: Malleable Iron
  
- ~~a. Standard: MSS SP-80, Type 1.~~
- ~~b. CWP Rating: 200 psig.~~
- ~~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.~~

3.9 ~~Handwheel: Malleable iron, bronze, or aluminum.~~ DRAIN VALVES

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A. Angled Bronze Globe Valves with Brass Trim:

1. ~~Manufacturers: Subject to compliance with requirements, provide products by one of the following:~~

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- a. ~~Crane Co.; Crane Valve Group; Crane Valves.~~
- b. ~~Hammond Valve.~~
- c. ~~NIBCO INC.~~
- d. ~~Powell Valves.~~

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2. ~~Description:~~

- a. ~~CWP Rating: 200 psig.~~
- b. ~~Body Design: angled.~~
- c. ~~Body Material: Forged bronze or brass.~~
- d. ~~Inlet: Threaded 3/4 inch.~~
- e. ~~Outlet: 3/4 inch hose thread~~
- f. ~~Handwheel: Aluminum~~
- g. ~~—~~

B. ~~Bronze Ball Valve with cap and chain~~

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1. ~~Manufacturers: Subject to compliance with requirements, provide products by one of the following:~~

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- a. ~~Crane Co.; Crane Valve Group; Crane Valves.~~
- b. ~~Hammond Valve.~~
- c. ~~NIBCO INC.~~
- d. ~~Powell Valves.~~

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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 bronze or brass.~~
- f. ~~Inlet: Threaded.~~
- g. ~~Outlet: 3/ 4-inch hose thread.~~
- h. ~~Seats: PTFE or TFE.~~
- i. ~~Stem: Bronze or brass.~~
- j. ~~Ball: Chrome-plated brass.~~
- k. ~~Port: Full.~~
- l. ~~Handle: Carbon steel with plastic grip cover~~

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

1. ~~Manufacturers: Subject to compliance with requirements, provide products by one of the following:~~

- a. ~~Crane Co.; Crane Valve Group; Crane Valves.~~
- b. ~~Crane Co.; Crane Valve Group; Stockham Division.~~
- c. ~~NIBCO INC.~~
- d. ~~Red White Valve Corporation.~~

2. ~~Description:~~

- ~~a. Standard: MSS SP 80, Type 2.~~
- ~~b. CWP Rating: 200 psig.~~
- ~~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, bronze, or aluminum.~~

### ~~3.8 IRON GLOBE VALVES~~

#### ~~A. Class 125, Iron Globe Valves:~~

- ~~1. Manufacturers: Subject to compliance with requirements, provide products by one of 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. Powell Valves.~~
- ~~i. Red White Valve Corporation.~~
- ~~j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.~~
- ~~k. Zy Tech Global Industries, Inc.~~

- ~~2. Description:~~

- ~~a. Standard: MSS SP 85, Type I.~~
- ~~b. CWP Rating: 200 psig.~~
- ~~c. Body Material: ASTM A 126, gray iron with bolted bonnet.~~
- ~~d. Ends: Flanged.~~
- ~~e. Trim: Bronze.~~
- ~~f. Packing and Gasket: Asbestos free.~~

## **PART 4 - EXECUTION**

### 4.1 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.



1. Install swing check valves for proper direction of flow and in horizontal position with hinge pin level.

#### 4.2 ADJUSTING

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

#### 4.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
  1. Shutoff Service: Ball, butterfly, or gate valves.
  2. Throttling Service: Globe or ball or butterfly, ball, or butterfly valves.
  3. Pump-Discharge Check Valves:
    - a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
    - b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring.
    - c. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.

~~B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.~~

~~C.B.~~ Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

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

- A. Pipe NPS 2 and Smaller:
  1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
  - ~~2. Bronze Angle Valves: Class 125, bronze disc.~~
  - ~~3.2.~~ Ball Valves: one or two-piece, full regular reduced port, brass or bronze with brass bronze trim.
  - ~~4.3.~~ Bronze Swing Check Valves: Class 125 or bronze disc.
  - ~~5.4.~~ Bronze Globe Valves: Class 125, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM or NBR seat, aluminum-bronze or ductile-iron disc.
3. Iron Swing Check Valves: Class 125, metal seats.
4. Iron Swing Check Valves with Closure Control: Class 125, lever and spring or weight.
5. Iron Globe Valves: Class 125.

4.5 SANITARY-WASTE AND STORM-DRAINAGE VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: One or Two piece, full, regular or reduced port, brass or bronze with brass bronze trim.
3. Bronze Swing Check Valves: Class 125, bronze disc.
4. Bronze Gate Valves: Class 125, NRS or RS.
5. Bronze Globe Valves: Class 125, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron Swing Check Valves: Class 125, metal seats.
3. Iron Swing Check Valves with Closure Control: Class 125, lever and spring or weight.
4. Iron Globe Valves: Class 125.

**END OF SECTION**

## **SECTION 22 05 29**

### PART 1 -

### **HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT**

#### **PART 2 - GENERAL**

#### 2.1 SUMMARY

##### A. Section Includes:

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

#### 2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
1. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
  2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

#### 2.3 ACTION SUBMITTALS

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

#### 2.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

## 2.5 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

## **PART 3 - PRODUCTS**

### 3.1 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: Pre-galvanized 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 or stainless steel.

#### B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

#### C. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel or stainless steel.

### 3.2 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.

### 3.3 THERMAL-HANGER SHIELD INSERTS

- A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

- B. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig, ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.
- C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

### 3.4 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 or 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.

### 3.5 PIPE POSITIONING SYSTEMS

- A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

### 3.6 EQUIPMENT SUPPORTS

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

### 3.7 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
  - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
  - 2. Design Mix: 5000-psi, 28-day compressive strength.

## **PART 4 - EXECUTION**

### 4.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
  - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
  - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- D. Fastener System Installation:
  - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
  - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- E. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.
- F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Install lateral bracing with pipe hangers and supports to prevent swaying.
- J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

- K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- M. Insulated Piping:
  - 1. Attach clamps and spacers to piping.
    - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
  - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
    - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
  - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
    - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
  - 4. Shield Dimensions for Pipe: Not less than the following:
    - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    - b. NPS 4: 12 inches long and 0.06 inch thick.
    - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
    - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
  - 5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
  - 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

#### 4.2 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.

#### 4.3 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.

#### 4.4 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.

#### 4.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 09 91 23 "Interior Painting." or Section 09 96 00 "High-Performance Coatings."
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.



#### 4.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.
- J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
  - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
  - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
  - 4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
  - 5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
  - 6. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
  - 7. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
  - 8. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
  - 9. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

- K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
  2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
  2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
- M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
  2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
  3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
  4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
  5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
  6. C-Clamps (MSS Type 23): For structural shapes.
  7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    - a. Light (MSS Type 31): 750 lb.
    - b. Medium (MSS Type 32): 1500 lb.
    - c. Heavy (MSS Type 33): 3000 lb.
  8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
  9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
  2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
  3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
  2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
  3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
- P. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- Q. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

**END OF SECTION**

## SECTION 22 05 33

### PART 1 -

### HEAT TRACING FOR PLUMBING PIPING

#### PART 2 - GENERAL

##### 2.1 SUMMARY

- A. Section includes plumbing piping heat tracing for freeze prevention, domestic hot-water-temperature maintenance, and snow and ice melting on roofs and in gutters and downspouts with the following electric heating cables:

- ~~1. Plastic insulated, series resistance.~~
- 2.1. Self-regulating, parallel resistance.
- ~~3. Section 230533 "Heat Tracing for HVAC Piping."~~

##### 2.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For electric heating cable.

##### 2.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Sample Warranty: For special warranty.

##### 2.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

##### 2.5 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Five years from date of Substantial Completion.

## PART 3 - PRODUCTS

### ~~3.1 PLASTIC INSULATED, SERIES RESISTANCE HEATING CABLES~~

~~A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:~~

- ~~1. Delta Therm Corporation.~~
- ~~2. Easy Heat; a brand of EGS Electrical Group LLC; an division of Emerson Industrial Automation.~~
- ~~3. Nuheat; a brand of nVent.~~
- ~~4. Orbit Manufacturing.~~
- ~~5. Pyrotenax; a brand of nVent.~~
- ~~6. Raychem; a brand of nVent.~~
- ~~7. WarmlyYours Radiant, Inc.~~
- ~~8. Watts Radiant; A WATTS Brand.~~

~~B. Comply with IEEE 515.1.~~

~~C. Heating Element: Single or dual stranded resistor wire. Terminate with waterproof, factory assembled, non-heating leads with connectors at both ends.~~

~~D. Electrical Insulating Jacket: Minimum 4.0 mil Kapton with silicone, Tefzel, or polyolefin.~~

~~E. Cable Cover: Aluminum braid and silicone or Hylar outer jacket.~~

~~F. Maximum Operating Temperature (Power On): 250 deg F.~~

~~G. Maximum Exposure Temperature (Power Off): 185 deg F.~~

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

~~I. Capacities and Characteristics: Refer to MEP plans.~~

### 3.23.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. BriskHeat.
2. Chromalox, Inc.
3. Delta-Therm Corporation.
4. Easy Heat; a brand of EGS Electrical Group LLC; A Division of Emerson Industrial Automation.
5. Nelson Heat Trace.
6. Pyrotenax; a brand of nVent.
7. Raychem; a brand of nVent.
8. Thermon Americas Inc.

9. Trasor Corp.
  - B. Comply with IEEE 515.1.
  - C. Heating Element: Pair of parallel No. 16 or No. 18 AWG, tinned or nickel-coated, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, non-heating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.
  - D. Electrical Insulating Jacket: Flame-retardant polyolefin.
  - E. Cable Cover: Tinned-copper or Stainless-steel braid and polyolefin outer jacket with ultraviolet inhibitor†.
  - F. Maximum Operating Temperature (Power On): 150 deg F.
  - G. Maximum Exposure Temperature (Power Off): 185 deg F.
  - H. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - I. Capacities and Characteristics: Refer to MEP plans.

### 3.33.2 CONTROLS

- A. Pipe-Mounted Thermostats for Freeze Protection:
  1. Remote bulb unit with adjustable temperature range from 30 to 50 deg F.
  2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.
  3. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.
  4. Corrosion-resistant, waterproof control enclosure.
- B. Precipitation and Temperature Sensor for Snow Melting on Roofs and in Gutters:
  1. Microprocessor-based or Automatic control with manual on, automatic, and standby/reset switch.
  2. Precipitation and temperature sensors shall sense the surface conditions of roof and gutters and shall be programmed to energize the cable as follows:
    - a. Temperature Span: 34 to 44 deg F.
    - b. Adjustable Delay-Off Span: 30 to 90 minutes.
    - c. Energize Cables: Following two-minute delay if ambient temperature is below set point and precipitation is detected.
    - d. De-Energize Cables: On detection of a dry surface plus time delay.
  3. Corrosion-proof and waterproof enclosure suitable for outdoor mounting, for controls and precipitation and temperature sensors.

4. Minimum 30-A contactor to energize cable or close other contactors.
5. Precipitation sensor shall be freestanding.
6. Provide relay with contacts to indicate operational status, on or off, for interface with central HVAC control-system workstation.

C. Programmable Timer for Domestic Hot-Water-Temperature Maintenance:

1. Microprocessor based.
2. Minimum of four separate schedules.
3. Minimum 24-hour battery carryover.
4. On-off-auto switch.
5. 365-day calendar with 20 programmable holidays.
6. Relays with contacts to indicate operational status, on or off, and for interface with central HVAC control-system workstation.

### 3.43.3 ACCESSORIES

- A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.
- B. Warning Labels: Refer to Section 22 05 53 "Identification for Plumbing Piping and Equipment."
- C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.
  1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
  2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

## **PART 4 - EXECUTION**

### 4.1 APPLICATIONS

- A. Install the following types of electric heating cable for the applications described:
  1. Temperature Maintenance for Domestic Cold Water and cooling tower condenser water: Self-regulating, parallel-resistance heating cable.

### 4.2 INSTALLATION

- A. Install electric heating cable across expansion, construction, and control joints according to manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.
- B. Electric Heating-Cable Installation for Snow and Ice Melting on Roofs and in Gutters and Downspouts: Install on roof and in gutters and downspouts with clips furnished by manufacturer that are compatible with roof, gutters, and downspouts.

- C. Electric Heating-Cable Installation for Freeze Protection for Piping:
  - 1. Install electric heating cables after piping has been tested and before insulation is installed.
  - 2. Install electric heating cables according to IEEE 515.1.
  - 3. Install insulation over piping with electric cables according to Section 22 07 19 "Plumbing Piping Insulation."
  - 4. Install warning tape on piping insulation where piping is equipped with electric heating cables.
  
- D. Electric Heating-Cable Installation for Temperature Maintenance for Domestic Water:
  - 1. Install electric heating cables after piping has been tested and before insulation is installed.
  - 2. Install insulation over piping with electric heating cables according to Section 22 07 19 "Plumbing Piping Insulation."
  - 3. Install warning tape on piping insulation where piping is equipped with electric heating cables.
  
- E. Set field-adjustable switches and circuit-breaker trip ranges.
  
- F. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
  
- G. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

#### 4.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
  - 2. Test cables for electrical continuity and insulation integrity before energizing.
  - 3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.
  
- B. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.
  
- C. Cables will be considered defective if they do not pass tests and inspections.
  
- D. Prepare test and inspection reports.
  
- E. Remove and replace damaged heat-tracing cables.

**END OF SECTION**



**SECTION 22 05 53**

PART 1 -

**IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT**

**PART 2 - GENERAL**

2.1 SUMMARY

A. Section Includes:

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

2.2 ACTION SUBMITTALS

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

**PART 3 - PRODUCTS**

3.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Brady Corporation.
  - b. Brimar Industries, Inc.
  - c. Champion America.
  - d. Craftmark Pipe Markers.
  - e. emedco.
  - f. Kolbi Pipe Marker Co.
  - g. LEM Products Inc.
  - h. Marking Services, Inc.
  - i. Seton Identification Products; a Brady Corporation company.
- 2. Material and Thickness: Brass, 0.032-inch, stainless steel, 0.025-inch, aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
- 3. Letter Color: Black.

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4. Background Color: White.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

~~B. Plastic Labels for Equipment:~~

- ~~1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - ~~a. Brady Corporation.~~
  - ~~b. Brimar Industries, Inc.~~
  - ~~c. Champion America.~~
  - ~~d. Craftmark Pipe Markers.~~
  - ~~e. emedco.~~
  - ~~f. Kolbi Pipe Marker Co.~~
  - ~~g. LEM Products Inc.~~
  - ~~h. Marking Services, Inc.~~
  - ~~i. Seton Identification Products; a Brady Corporation company.~~~~
- ~~2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.~~
- ~~3. Letter Color: Black.~~
- ~~4. Background Color: White.~~
- ~~5. Maximum Temperature: Able to withstand temperatures up to 160 deg F.~~
- ~~6. Minimum Label Size: Length and width vary for required label content, but not less than 2 1/2 by 3/4 inch.~~
- ~~7. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two thirds to three quarters the size of principal lettering.~~
- ~~8. Fasteners: Stainless steel rivets or self tapping screws.~~
- ~~9. Adhesive: Contact type permanent adhesive, compatible with label and with substrate.~~

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

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3.2 WARNING SIGNS AND LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

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1. Brady Corporation.
2. Brimar Industries, Inc.
3. Carlton Industries, LP.
4. Champion America.
5. Craftmark Pipe Markers.
6. emedco.
7. LEM Products Inc.
8. Marking Sevices Inc.
9. National Marker Company.
10. Seton Identification Products; a Brady Corporation company.
11. Stranco, Inc.

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B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch-thick, and having predrilled holes for attachment hardware.

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C. Letter Color: Black.

D. Background Color: White.

E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

G. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

H. Fasteners: Stainless-steel rivets or self-tapping screws.

I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

J. Label Content: Include caution and warning information plus emergency notification instructions.

3.3 PIPE LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

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1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
2. Brady Corporation.
3. Brimar Industries, Inc.
4. Carlton Industries, LP.
5. Champion America.

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6. Craftmark Pipe Markers.
  7. emedco.
  8. Kolbi Pipe Marker Co.
  9. LEM Products Inc.
  10. Marking Sevices Inc.
  11. Seton Identification Products; a Brady Corporation company.
- B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover or cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
  2. Lettering Size: Size letters according to ASME A13.1 for piping or At least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.

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### 3.4 VALVE TAGS

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- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
1. Tag Material: Brass, 0.032-inch stainless steel, 0.025-inch aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
  2. Fasteners: Brass wire-link chain or beaded chain or S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Valve-tag schedule shall be included in operation and maintenance data.

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### 3.5 WARNING TAGS

- A. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.
1. Size: Approximately 4 by 7 inches

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- 2. Fasteners: Brass grommet and wire
- 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
- 2-4. Color: Safety yellow background with black lettering.

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## **PART 4 - EXECUTION**

### 4.1 EQUIPMENT LABEL INSTALLATION

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

### 4.2 PIPE LABEL INSTALLATION

- A. Piping Color Coding: Painting of piping is specified in Section 09 91 23 "Interior Painting." or Section 09 96 00 "High-Performance Coatings."
- B. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
  - 1. Near each valve and control device.
  - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
  - 3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
  - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
  - 5. Near major equipment items and other points of origination and termination.
  - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
  - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- C. Pipe Label Color Schedule:
  - 1. Natural Gas
    - a. Background: Indicate Temperature Yellow
    - b. Letter Colors: Black
  - 2. Grease Waste
    - a. Background: Green
    - b. Letter Colors: Black
  - 3. Domestic Water Piping

- a. Background: Safety green.
- b. Letter Colors: White.

4. Sanitary Waste and Storm Drainage Piping:

- a. Background Color: Safety white.
- b. Letter Color: Black.

4.3 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
  - 1. Valve-Tag Size and Shape:

- a. Cold Water: 2 inches, round
- b. Hot Water: 2 inches round

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4.4 WARNING-TAG INSTALLATION

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

**END OF SECTION**

## **SECTION 22 05 93**

### PART 1 -

### **TESTING, ADJUSTING, AND BALANCING FOR PLUMBING**

### PART 2 - GENERAL

#### 2.1 SUMMARY

##### A. Section Includes:

1. TAB of domestic water system.
2. TAB of plumbing equipment:
  - a. Domestic water booster pumps.
  - b. Domestic hot-water in-line circulation pumps.
  - c. Sanitary sewage pumps.
  - d. Drainage pumps.
3. Pipe-leakage test verification.
4. Testing, adjusting, and balancing of existing plumbing systems and equipment.

#### 2.2 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An independent entity meeting qualification to perform TAB work.
- F. TDH: Total dynamic head.

#### 2.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within 60 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 60 days of Contractor's Notice to Proceed, submit the Contract Documents review report, as specified in Part 3.
- C. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures, as specified in "Preparation" Article.

- D. System Readiness Checklists: Within 60 days of Contractor's Notice to Proceed, submit system readiness checklists, as specified in "Preparation" Article.
- E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
- F. Certified TAB reports.
- G. Sample report forms.
- H. Instrument calibration reports, to include the following:
  - 1. Instrument type and make.
  - 2. Serial number.
  - 3. Application.
  - 4. Dates of use.
  - 5. Dates of calibration.

## 2.4 QUALITY ASSURANCE

- A. TAB Specialists Qualifications, Certified by AABC:
  - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
  - 2. TAB Technician: Employee of the TAB specialist and certified by AABC.
- B. TAB Specialists Qualifications, Certified by NEBB or TABB:
  - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB or TABB.
  - 2. TAB Technician: Employee of the TAB specialist and certified by NEBB or TABB.
- C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
- D. ASHRAE 111 Compliance: Requirements in ASHRAE 111 applicable to analogous domestic water system and plumbing equipment balancing.
- E. ASHRAE 188 Compliance: Comply with balancing and report requirements, Section 8.3 "Balancing."
- F. Code and Authorities Having Jurisdiction Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

## 2.5 FIELD CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.
- B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.



## PART 4 - EXECUTION

### 4.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, and balancing valves and fittings. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine approved submittals for plumbing systems and equipment.
- D. Examine design data, including plumbing system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about plumbing system and equipment controls.
- E. Examine equipment performance data, including pump curves.
  - 1. Relate performance data to Project conditions and requirements, including pump system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
  - 2. Calculate pump system-effect factors to reduce performance ratings of plumbing equipment when installed under conditions different from the conditions used to rate equipment performance. Compare results with the design data and installed conditions.
- F. Examine system and equipment installations, and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- G. Examine test reports specified in individual system and equipment Sections.
- H. Examine plumbing equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- I. Examine temporary and permanent strainers. Verify that temporary strainer screens used during system cleaning and flushing have been removed and permanent strainers are installed and clean.
- J. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.
- K. Examine system pumps to ensure absence of entrained air in the suction piping.
- L. Examine operating safety interlocks and controls on plumbing equipment.

- M. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

#### 4.2 PREPARATION

- A. Prepare a TAB plan that includes the following:
  - 1. Equipment and systems to be tested.
  - 2. Strategies and step-by-step procedures for balancing the systems.
  - 3. Instrumentation to be used.
  - 4. Sample forms with specific identification for all equipment.
- B. Perform system-readiness checks of plumbing systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
  - 1. Domestic Water System:
    - a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed in accordance with applicable code and authority having jurisdiction.
    - b. Water heaters are installed and functioning.
    - c. Piping is complete and all points of outlet are installed.
    - d. Water treatment is complete.
    - e. Systems are flushed, filled, and air purged.
    - f. Strainers are clean.
    - g. Control valves are functioning in accordance with the sequence of operation.
    - h. Shutoff and balance valves are 100 percent open.
    - i. Booster- and hot-water circulating pumps are operational and proper rotation is verified.
    - j. Pump gauge connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
    - k. Variable-frequency controllers' startup is complete, and safeties are verified.
    - l. Suitable access to balancing devices and equipment is provided.
  - 2. Sanitary Sewage/Drainage System:
    - a. Leakage and pressure tests on sanitary sewage/drainage systems have been completed in accordance with applicable code and authority having jurisdiction requirements.
    - b. Piping is complete.
    - c. Sanitary sewage pumps/drainage pumps are operational.
    - d. Control valves are functioning in accordance with the sequence of operation.
    - e. Shutoff valves are 100 percent open.
    - f. Suitable access to equipment is provided.

#### 4.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system in accordance with the procedures contained in AABC's "National Standards for Total System Balance" or ASHRAE 111 NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.

- B. Cut insulation, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.
  - 1. Where holes for probes are required in piping or equipment, install pressure and temperature test plugs to seal systems.
  - 2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 22 07 16 "Plumbing Equipment Insulation" and Section 22 07 19 "Plumbing Piping Insulation."
- C. Mark equipment and balancing devices, including valve position indicators and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP units).

#### 4.4 GENERAL PROCEDURES FOR PLUMBING EQUIPMENT

- A. Test, adjust, and balance plumbing equipment indicated on Drawings, including, but not limited to, the following:
  - 1. Motors.
  - 2. Domestic water booster pumps.
  - 3. Domestic water in-line pumps.
  - 4. Domestic water heaters.
  - 5. Sanitary sewage pumps.
  - 6. Drainage pumps.

#### 4.5 PROCEDURES FOR DOMESTIC WATER SYSTEMS

- A. Prepare test reports for pumps and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required equipment flow rates with system design flow rates.
- B. Prepare schematic diagrams of systems' Record drawings piping layouts.
- C. In addition to requirements in "Preparation" Article, prepare domestic water systems for testing and balancing as follows:
  - 1. Check expansion tank for proper setting.
  - 2. Check water heater for proper discharge temperature setting.
  - 3. Check remotest point of outlet for adequate pressure.
  - 4. Check flow-control valves for proper position.
  - 5. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
  - 6. Verify that motor controllers are equipped with properly sized thermal protection.
  - 7. Check that air has been purged from the system.
- D. Measure and record upstream and downstream pressure of each piece of equipment.
- E. Measure and record upstream and downstream pressure of pressure-reducing valves.

- F. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.
- G. Check settings and operation of each safety valve. Record settings.

#### 4.6 PROCEDURES FOR DOMESTIC WATER SYSTEM BOOSTER PUMPS

- A. Adjust pumps to deliver total design flow.
  - 1. Measure total water flow.
    - a. Position valves for full flow through coils.
    - b. Measure flow by main flow meter, if installed.
    - c. If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.
  - 2. Measure pump TDH as follows:
    - a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
    - b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
    - c. Convert pressure to head and correct for differences in gauge heights.
    - d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
    - e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.
  - 3. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.
- B. Adjust flow-measuring devices installed in mains and branches to design water flows.
  - 1. Measure flow in main and branch pipes.
  - 2. Adjust main and branch balance valves for design flow.
  - 3. Re-measure each main and branch after all have been adjusted.
- C. Verify final system conditions as follows:
  - 1. Re-measure and confirm that total water flow is within design.
  - 2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
  - 3. Mark final settings.
- D. Verify that memory stops have been set.

#### 4.7 PROCEDURES FOR DOMESTIC HOT-WATER CIRCULATING INLINE PUMP

- A. Balance system with manual or automatic balancing valves by setting at design flow.
  - 1. Measure flow in main and branch pipes.
  - 2. Adjust main and branch balance valves for design flow.
  - 3. Re-measure each main and branch after all have been adjusted.
- B. Adjust pump to deliver total design flow.

1. Measure pump TDH as follows:
  - a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
  - b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
  - c. Convert pressure to head and correct for differences in gauge heights.
  - d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
2. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.
3. Mark final settings and verify that all memory stops have been set.
4. Verify final system conditions as follows:
  - a. Re-measure and confirm that total flow is within design.
  - b. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
  - c. Mark final settings.

#### 4.8 PROCEDURES FOR MOTORS

- A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:
  1. Manufacturer's name, model number, and serial number.
  2. Motor horsepower rating.
  3. Motor rpm.
  4. Phase and hertz.
  5. Nameplate and measured voltage, each phase.
  6. Nameplate and measured amperage, each phase.
  7. Starter size and thermal-protection-element rating.
  8. Service factor and frame size.
- B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

#### 4.9 PROCEDURES FOR WATER HEATERS

- A. Gas ~~and Oil~~-Fired Water Heaters:
  1. Measure and record entering- and leaving-water temperatures.
  2. Measure and record water flow.
  3. Measure and record pressure drop.
  4. Measure and Record relief valve(s) pressure setting.
  5. Capacity: Calculate in Btu/h of heating output.
  6. Fuel Consumption: If fuel supply is equipped with flow meter, measure and record consumption.
  7. Efficiency: Calculate operating efficiency for comparison to submitted equipment.
  8. Fan, motor, and motor controller operating data.

#### 4.10 TOLERANCES

- A. Set plumbing system's flow rates within the following tolerances:
  - 1. Domestic Water Flow Rate: Plus, or minus 5 percent . If design value is less than 10 gpm, within 10 percent.

#### 4.11 PROGRESS REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to plumbing systems and general construction to allow access for performance-measuring and -balancing devices.
- B. Status Reports: Prepare biweekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

#### 4.12 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
  - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
  - 2. Include a list of instruments used for procedures, along with proof of calibration.
  - 3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to certified field-report data, include the following:
  - 1. Pump curves.
  - 2. Manufacturers' test data.
  - 3. Field test reports prepared by system and equipment installers.
  - 4. Other information relative to equipment performance; do not include Shop Drawings and Product Data.
- C. General Report Data: In addition to form titles and entries, include the following data:
  - 1. Title page.
  - 2. Name and address of the TAB specialist.
  - 3. Project name.
  - 4. Project location.
  - 5. Architect's name and address.
  - 6. Engineer's name and address.
  - 7. Contractor's name and address.
  - 8. Report date.
  - 9. Signature of TAB supervisor who certifies the report.

10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
  11. Summary of contents, including the following:
    - a. Indicated versus final performance.
    - b. Notable characteristics of systems.
    - c. Description of system operation sequence if it varies from the Contract Documents.
  12. Nomenclature sheets for each item of equipment.
  13. Notes to explain why certain final data in the body of reports vary from indicated values.
  14. Test conditions for pump performance forms, including the following:
    - a. Variable-frequency controller settings for variable-flow hydronic systems.
    - b. Settings for pressure controller(s).
    - c. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of distribution systems. Present each system with single-line diagram and include the following:
1. Flow rates.
  2. Pipe and valve sizes and locations.
  3. Balancing stations.
  4. Position of balancing devices.
- E. ~~Gas~~ ~~and Oil Fired~~ Water Heaters Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
1. Unit Data:
    - a. System identification.
    - b. Location.
    - c. Make and type.
    - d. Model number and unit size.
    - e. Manufacturer's serial number.
    - f. Fuel type in input data.
    - g. Output capacity in Btu/h.
    - h. Ignition type.
    - i. Burner-control types.
    - j. Motor horsepower and speed.
    - k. Motor volts, phase, and hertz.
    - l. Motor full-load amperage and service factor.
    - m. Sheave make, size in inches, and bore.
    - n. Center-to-center dimensions of sheave and amount of adjustments in inches.
  2. Test Data (Indicated and Actual Values):
    - a. Total airflow rate in cfm.
    - b. Entering-water temperature in deg F.
    - c. Leaving-water temperature in deg F.
    - d. Low-fire fuel input in Btu/h.
    - e. High-fire fuel input in Btu/h.
    - f. High-temperature-limit setting in deg F.
    - g. Operating set point in Btu/h.
    - h. Heating value of fuel in Btu/h.
- F. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves, and include the following:

1. Unit Data:
  - a. Unit identification.
  - b. Location.
  - c. Service.
  - d. Make and size.
  - e. Model number and serial number.
  - f. Water flow rate in gpm.
  - g. Water-pressure differential in feet of head or psig.
  - h. Required net positive suction head in feet of head or psig.
  - i. Pump speed.
  - j. Impeller diameter in inches.
  - k. Motor make and frame size.
  - l. Motor horsepower and rpm.
  - m. Voltage at each connection.
  - n. Amperage for each phase.
  - o. Full-load amperage and service factor.
  - p. Seal type.
2. Test Data (Indicated and Actual Values):
  - a. Static head in feet of head or psig.
  - b. Pump shutoff pressure in feet of head or psig.
  - c. Actual impeller size in inches.
  - d. Full-open flow rate in gpm.
  - e. Full-open pressure in feet of head or psig.
  - f. Final discharge pressure in feet of head or psig.
  - g. Final suction pressure in feet of head or psig.
  - h. Final total pressure in feet of head or psig.
  - i. Final water flow rate in gpm.
  - j. Voltage at each connection.
  - k. Amperage for each phase.

G. Instrument Calibration Reports:

1. Report Data:
  - a. Instrument type and make.
  - b. Serial number.
  - c. Application.
  - d. Dates of use.
  - e. Dates of calibration.

4.13 ADDITIONAL TESTS

- A. Within 180 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

END OF SECTION



## SECTION 22 07 19

### PART 1 -

## PLUMBING PIPING INSULATION

### PART 2 - GENERAL

#### 2.1 SUMMARY

A. Section includes insulating the following plumbing piping services:

1. Domestic cold-water piping.
2. Domestic hot-water piping.
3. Domestic recirculating hot-water piping.
4. Roof drains and rainwater leaders.
5. Supplies and drains for handicap-accessible lavatories and sinks.

~~B. Related Sections:~~

- ~~1. Section 220716 "Plumbing Equipment Insulation" for equipment insulation.~~

#### 2.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content and chemical components.
2. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that product complies 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 attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.

6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.

## 2.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material test reports.
- C. Field quality-control reports.

## 2.4 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 in accordance with ASTM E84 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. Comply with the following applicable standards and other requirements specified for miscellaneous components:
  1. Supply and Drain Protective Shielding Guards: ICC A117.1.

## 2.5 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 22 05 29 "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.

## 2.6 SCHEDULING

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

## PART 3 - PRODUCTS

### 3.1 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 into contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable in accordance with ASTM C795.
- 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. Comply with ASTM C552.
  - 1. Preformed Pipe Insulation: Type II, Class 1, without jacket.
  - 2. Preformed Pipe Insulation: Type II, Class 2, with factory-applied ~~ASJ~~ ~~ASJ~~ ~~SSL~~ jacket.
  - 3. Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.
  - 4. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- G. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534/C534M, Type I for tubular materials.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Aeroflex USA.
    - b. Armacell LLC.
    - c. K-Flex USA.
- H. Mineral-Fiber, Preformed Pipe: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Johns Manville; a Berkshire Hathaway company.
  - b. Knauf Insulation.
  - c. Manson Insulation Inc.
  - d. Owens Corning.
2. Preformed Pipe Insulation: Type I, Grade A, without factory-applied jacket, with factory-applied ASJ or with factory-applied ASJ-SSL.
3. 850 deg F.
4. Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.
5. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

~~I. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C534/C534M or ASTM C1427, Type I, Grade 1, for tubular materials.~~

- ~~1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or "Equal":~~
- ~~a. Armacell LLC.~~
  - ~~b. Nomaco.~~

### 3.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.
  1. Manufacturers: Subject to compliance with requirements, provide products by the following or "Equal":
    - a. Foster Brand; H. B. Fuller Construction Products.
- C. Flexible Elastomeric and Polyolefin Adhesive: Solvent-based adhesive.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Aeroflex USA.
    - b. Armacell LLC.
    - c. Foster Brand; H. B. Fuller Construction Products.
    - d. K-Flex USA.
  2. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less as tested in accordance with ASTM E84.
  3. Wet Flash Point: Below 0 deg F.
  4. Service Temperature Range: 40 to 200 deg F.

- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Foster Brand; H. B. Fuller Construction Products.
    - c. Mon-Eco Industries, Inc.
  
- E. ASJ Adhesive and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A, for bonding insulation jacket lap seams and joints.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Foster Brand; H. B. Fuller Construction Products.
    - c. Mon-Eco Industries, Inc.
  
- F. PVC Jacket Adhesive: Compatible with PVC jacket.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Johns Manville; a Berkshire Hathaway company.
    - b. P.I.C. Plastics, Inc.
    - c. Speedline Corporation.

### 3.3 MASTICS AND COATINGS

- A. Materials shall be compatible with insulation materials, jackets, and substrates.
- B. Vapor-Retarder Mastic Water Based: Suitable for indoor use on below-ambient services.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Foster Brand; H. B. Fuller Construction Products.
    - c. Knauf Insulation.
    - d. Vimasco Corporation.
  - 2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
  - 3. Service Temperature Range: 0 to plus 180 deg F.
  - 4. Comply with MIL-PRF-19565C, Type II, for permeance requirements, with supplier listing on DOD QPD - Qualified Products Database.
  - 5. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Childers Brand; H. B. Fuller Construction Products.
  - b. Foster Brand; H. B. Fuller Construction Products.
  - c. Knauf Insulation.
  - d. Mon-Eco Industries, Inc.
  - e. Vimasco Corporation.
2. Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm at manufacturer's recommended dry film thickness.
3. Service Temperature Range: 0 to plus 180 deg F.
4. Color: White.

### 3.4 SEALANTS

- A. Materials shall be as recommended by the insulation manufacturer and shall be compatible with insulation materials, jackets, and substrates.
- B. Joint Sealants:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Foster Brand; H. B. Fuller Construction Products.
    - c. Mon-Eco Industries, Inc.
  2. Permanently flexible, elastomeric sealant.
  3. Service Temperature Range: Minus 58 to plus 176 deg F.
  4. Color: White or gray.
- C. FSK and Metal Jacket Flashing Sealants:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Foster Brand; H. B. Fuller Construction Products.
    - c. Mon-Eco Industries, Inc.
  2. Fire- and water-resistant, flexible, elastomeric sealant.
  3. Service Temperature Range: Minus 40 to plus 250 deg F.
  4. Color: Aluminum.
- D. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:
  1. Manufacturers: Subject to compliance with requirements, provide products by the following or "Equal":
    - a. Childers Brand; H. B. Fuller Construction Products.

2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.

### 3.5 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
  2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
  3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.

### 3.6 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or "Equal":
    - a. Foster Brand; H. B. Fuller Construction Products.
    - b. Vimasco Corporation.

### 3.7 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C1136, 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 D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Johns Manville; a Berkshire Hathaway company.
    - b. P.I.C. Plastics, Inc.
    - c. Proto Corporation.
    - d. Speedline Corporation.
  2. Adhesive: As recommended by jacket material manufacturer.
  3. Color: Color-code jackets based on system. Color as selected by Architect.
  4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

- a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
- D. Self-Adhesive Outdoor Jacket: 60-mil-thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with white or stucco-embossed aluminum-foil facing.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or "Equal":
    - a. MFM Building Products Corp.
    - b. Polyguard Products, Inc.

### 3.8 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. 3M Industrial Adhesives and Tapes Division.
    - b. Avery Dennison Corporation, Specialty Tapes Division.
    - c. Ideal Tape Co., Inc., an American Biltrite Company.
    - d. Knauf Insulation.
  2. Width: 3 inches.
  3. Thickness: 11.5 mils.
  4. Adhesion: 90 ounces force/inch in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch in width.
  7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. 3M Industrial Adhesives and Tapes Division.
    - b. Avery Dennison Corporation, Specialty Tapes Division.
    - c. Ideal Tape Co., Inc., an American Biltrite Company.
    - d. Knauf Insulation.
  2. Width: 3 inches.
  3. Thickness: 6.5 mils.
  4. Adhesion: 90 ounces force/inch in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch in width.
  7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.



- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or "Equal":
    - a. 3M Industrial Adhesives and Tapes Division.
    - b. Ideal Tape Co., Inc., an American Biltrite Company.
  2. Width: 2 inches.
  3. Thickness: 6 mils.
  4. Adhesion: 64 ounces force/inch in width.
  5. Elongation: 500 percent.
  6. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. 3M Industrial Adhesives and Tapes Division.
    - b. Avery Dennison Corporation, Specialty Tapes Division.
    - c. Ideal Tape Co., Inc., an American Biltrite Company.
    - d. Knauf Insulation.
  2. Width: 2 inches.
  3. Thickness: 3.7 mils.
  4. Adhesion: 100 ounces force/inch in width.
  5. Elongation: 5 percent.
  6. Tensile Strength: 34 lbf/inch in width.

### 3.9 SECUREMENTS

- A. Bands:
1. Stainless Steel: ASTM A240/A240M, Type 304 or Type 316; 0.015 inch thick, 3/4 inch wide with wing seal or closed seal.
  2. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.
- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
- C. Wire: 0.080-inch nickel-copper alloy, 0.062-inch soft-annealed, stainless steel or 0.062-inch soft-annealed, galvanized steel.
1. Manufacturers: Subject to compliance with requirements, provide products by the following or "Equal":
    - a. C & F Wire.

### 3.10 PROTECTIVE SHIELDING GUARDS

#### A. Protective Shielding Pipe Covers,

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Buckaroos, Inc.
  - b. Just Manufacturing.
  - c. McGuire Manufacturing.
  - d. MVG Molded Products.
  - e. Plumberex Specialty Products, Inc.
  - f. Truebro.
  - g. Zurn Industries, LLC.
2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

#### B. Protective Shielding Piping Enclosures:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or "Equal":
  - a. Truebro.
  - b. Zurn Industries, LLC.
2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

## **PART 4 - EXECUTION**

### 4.1 PREPARATION

- A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. 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 thick and an epoxy finish 5 mils thick if operating in a temperature range of between 140 and 300 deg F. 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 of between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

- C. Coordinate insulation installation with the tradesman 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.

#### 4.2 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of 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 storage, application, and finishing. Replace insulation materials that get wet.
- 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 attached to structure with vapor-barrier mastic.
  - 3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
  - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
  
- L. Install insulation with factory-applied jackets as follows:
  - 1. Draw jacket tight and smooth.
  - 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches o.c.
  - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at 4 inches o.c.
    - a. For below-ambient services, apply vapor-barrier mastic over staples.
  - 4. Cover joints and seams with tape, in accordance with 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 25 percent of its nominal thickness.
  
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
  
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches in similar fashion 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.

#### 4.3 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
  - 1. Seal penetrations with flashing sealant.
  - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
  - 4. Seal jacket to roof flashing with flashing sealant.

- B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
  - 1. Seal penetrations with flashing sealant.
  - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
  - 4. Seal jacket to wall flashing with flashing sealant.
  
- C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
  
- D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
  - 1. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
  
- E. Insulation Installation at Floor Penetrations:
  - 1. Pipe: Install insulation continuously through floor penetrations.
  - 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

#### 4.4 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles.
  
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:
  - 1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, 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 that of 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 that 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 that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 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 2 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, mechanical couplings, and unions, using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
  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.
- 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.

#### 4.5 INSTALLATION OF CELLULAR-GLASS INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
  2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
  3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.
  4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
  2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as that of pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as that of straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

#### 4.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as that of pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as that of pipe insulation when available.

2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

#### 4.7 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 o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

##### B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

##### C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as that of 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 that of 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.



#### ~~4.8 — INSTALLATION OF POLYOLEFIN INSULATION~~

##### ~~A. — Insulation Installation on Straight Pipes and Tubes:~~

- ~~1. — Seal split tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.~~

##### ~~B. — Insulation Installation on Pipe Flanges:~~

- ~~1. — Install pipe insulation to outer diameter of pipe flange.~~
- ~~2. — Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.~~
- ~~3. — Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as that of pipe insulation.~~
- ~~4. — Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.~~

##### ~~C. — Insulation Installation on Pipe Fittings and Elbows:~~

- ~~1. — Install mitered sections of polyolefin pipe insulation.~~
- ~~2. — Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.~~

##### ~~D. — Insulation Installation on Valves and Pipe Specialties:~~

- ~~1. — Install cut sections of polyolefin pipe and sheet insulation to valve body.~~
- ~~2. — Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.~~
- ~~3. — Install insulation to flanges as specified for flange insulation application.~~
- ~~4. — Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.~~

#### 4.94.8 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 overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch-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 laps at longitudinal seams and 3-inch-wide joint strips at end joints.
  5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches o.c. and at end joints.

#### 4.104.9 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."
1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
    - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

#### 4.114.10 FIELD QUALITY CONTROL

- A. Tests and Inspections: 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, locations of threaded fittings, locations of welded fittings, locations of threaded strainers, locations of welded strainers, locations of threaded valves, and locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- B. All insulation applications will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

4.124.11 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
  - 1. Drainage piping located in crawl spaces.
  - 2. Underground piping.
  - 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

4.134.12 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Cold Water:
  - 1. NPS 1 and Smaller: Insulation shall be one of the following:
    - a. Flexible Elastomeric: 1 3/4 inch thick.
    - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
    - c. ~~Polyolefin: 3/4 inch thick.~~
  - 2. NPS 1-1/4 and Larger: Insulation shall be one of the following:
    - a. Flexible Elastomeric: 1 inch thick.
    - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
    - c. ~~Polyolefin: 1 inch thick.~~
- B. Domestic Hot and Recirculated Hot Water:
  - 1. NPS 1-1/4 and Smaller: Insulation shall be one of the following:
    - a. Flexible Elastomeric: 1 inch thick.
    - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
    - c. ~~Polyolefin: 1 inch thick.~~
  - 2. NPS 1-1/2 and Larger: Insulation shall be one of the following:
    - a. Flexible Elastomeric: 1 inch thick.
    - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
    - c. ~~Polyolefin: 1 inch thick.~~
- C. Stormwater and Overflow:
  - 1. All Pipe Sizes: Insulation shall be one of the following:
    - a. Flexible Elastomeric: 1 inch thick.
    - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
    - c. ~~Polyolefin: 1 inch thick.~~

- D. Roof Drain and Overflow Drain Bodies:
1. All Pipe Sizes: Insulation shall be one of the following:
    - a. Flexible Elastomeric: 1 inch thick.
    - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
    - c. ~~Polyolefin: 1 inch thick.~~
- E. 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 3/4 inch thick.
    - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
    - c. ~~Polyolefin: 3/4 inch thick.~~
- F. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F:
1. All Pipe Sizes: Insulation shall be one of the following:
    - a. Flexible Elastomeric: 3/4 inch thick.
    - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
    - c. ~~Polyolefin: 3/4 inch thick.~~

#### 4.144.13 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Domestic Water Piping:
1. All Pipe Sizes: Insulation shall be one of the following:
    - a. Cellular Glass: 2 inches thick.
    - b. Flexible Elastomeric: 2 inches thick.
    - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.
    - d. ~~Polyolefin: 2 inches thick.~~

#### 4.154.14 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Exposed:
1. PVC, Color-Coded by System: 30 mils thick.
  2. Aluminum, Smooth, Corrugated or Stucco Embossed: 0.032 inch thick.

4.164.15 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Exposed:
  - 1. PVC: 30 mils thick.
  - 2. Painted Aluminum, Smooth, Corrugated, Stucco Embossed or with Z-Shaped Locking Seam: 0.032 inch thick.

**END OF SECTION**

## SECTION 22 11 16

### PART 1 -

### DOMESTIC WATER PIPING

#### PART 2 - GENERAL

#### 2.1 SUMMARY

- A. Section includes under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.

~~B. Related Requirements:~~

- ~~1. Section 221113 "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.~~
- ~~2. ASTM F 2389-06 Standard Specification for Pressure-rated Polypropylene (PP) Piping Systems~~
- ~~3. CSA B137.11 Polypropylene (PP-R) Pipe and Fittings for Pressure Applications~~
- ~~4. NSF/ANSI 14 Plastic Piping System Components and Related Materials~~
- ~~5. NSF/ANSI 61 Drinking Water Systems Components Health Effects~~

#### 2.2 ACTION SUBMITTALS

- A. Product Data: For transition fittings and dielectric fittings.
- 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."

#### 2.3 INFORMATIONAL SUBMITTALS

- A. System purging and disinfecting activities report.
- B. Field quality-control reports.

## PART 3 - PRODUCTS

### 3.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
- B. Potable-water piping and components shall comply with NSF 14 and NSF 61 Annex G. Plastic piping components shall be marked with "NSF-pw."

### 3.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L and ASTM B 88, Type M water tube, drawn temper.
- B. Soft Copper Tube: ASTM B 88, Type K and ASTM B 88, Type L water tube, annealed temper.
- C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- F. Copper Unions:
  - 1. MSS SP-123.
  - 2. Cast-copper-alloy, hexagonal-stock body.
  - 3. Ball-and-socket, metal-to-metal seating surfaces.
  - 4. Solder-joint or threaded ends.

#### ~~G. Copper Pressure Seal Joint Fittings:~~

- ~~1. Fittings for NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.~~
- ~~2. Fittings for NPS 2 1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.~~

#### ~~H. Copper Push-on Joint Fittings:~~

- ~~1. Cast-copper fitting complying with ASME B16.18 or wrought-copper fitting complying with ASME B 16.22.~~
- ~~2. Stainless-steel teeth and EPDM-rubber, O-ring seal in each end instead of solder-joint ends.~~

### ~~3.3 DUCTILE IRON PIPE AND FITTINGS~~

#### ~~A. Mechanical Joint, Ductile Iron Pipe:~~

- ~~1. AWWA C151/A21.51, with mechanical joint bell and plain spigot end unless grooved or flanged ends are indicated.~~
- ~~2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile or gray iron glands, rubber gaskets, and steel bolts.~~

~~B. Standard Pattern, Mechanical Joint Fittings:~~

- ~~1. AWWA C110/A21.10, ductile or gray iron.~~
- ~~2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile or gray iron glands, rubber gaskets, and steel bolts.~~

~~C. Compact Pattern, Mechanical Joint Fittings:~~

- ~~1. AWWA C153/A21.53, ductile iron.~~
- ~~2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile or gray iron glands, rubber gaskets, and steel bolts.~~

~~3.4 GALVANIZED STEEL PIPE AND FITTINGS~~

~~A. Galvanized Steel Pipe:~~

- ~~1. ASTM A 53/A 53M, Type E, Grade B, Standard Weight.~~
- ~~2. Include ends matching joining method.~~

~~B. Galvanized Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Standard Weight, seamless steel pipe with threaded ends.~~

~~C. Galvanized, Gray Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.~~

~~D. Malleable Iron Unions:~~

- ~~1. ASME B16.39, Class 150.~~
- ~~2. Hexagonal stock body.~~
- ~~3. Ball and socket, metal to metal, bronze seating surface.~~
- ~~4. Threaded ends.~~

~~E. Flanges: ASME B16.1, Class 125, cast iron.~~

~~3.5 CPVC PIPING, if approved by the local authority having jurisdiction (AHJ) and/or Owner. CPVC PIPING SHALL NOT BE USED IN PLENUM SPACES.~~

~~A. CPVC Pipe: ASTM F 441/F 441M, Schedule 40 and Schedule 80.~~

- ~~1. CPVC Socket Fittings: ASTM F 438 for Schedule 40 and ASTM F 439 for Schedule 80.~~
- ~~2. CPVC Threaded Fittings: ASTM F 437, Schedule 80.~~

~~B. CPVC Piping System: ASTM D 2846/D 2846M, SDR 11, pipe and socket fittings.~~

~~C. CPVC Tubing System: ASTM D 2846/D 2846M, SDR 11, tube and socket fittings.~~



~~3.6 PEX TUBE AND FITTINGS, if approved by the local authority having jurisdiction (AHJ) and/or Owner. PEX TUBE SHALL NOT BE USED IN PLENUM SPACES.~~

~~A. PEX Distribution System: ASTM F 877, SDR 9 tubing.~~

~~B. Fittings for PEX Tube: ASTM F 1807, metal insert type with copper or stainless-steel crimp rings and matching PEX tube dimensions.~~

~~C. Manifold: Multiple outlet, plastic or corrosion-resistant metal assembly complying with ASTM F 877; with plastic or corrosion-resistant metal valve for each outlet.~~

~~3.7 PVC PIPE AND FITTINGS, if approved by the local authority having jurisdiction (AHJ) and/or Owner. PVC PIPING SHALL NOT BE USED IN PLENUM SPACES.~~

~~A. PVC Pipe: ASTM D 1785, Schedule 40 and Schedule 80.~~

~~B. PVC Socket Fittings: ASTM D 2466 for Schedule 40 and ASTM D 2467 for Schedule 80.~~

~~C. PVC Schedule 80 Threaded Fittings: ASTM D 2464.~~

### 3.83.3 PIPING JOINING MATERIALS

~~A. Pipe Flange Gasket Materials:~~

~~1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.~~

~~2. Full face or ring type unless otherwise indicated.~~

B.A. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C.B. Solder Filler Metals: ASTM B 32, lead-free alloys.

D.C. Flux: ASTM B 813, water flushable.

E.D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

~~F. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.~~

~~1. CPVC solvent cement shall have a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).~~

~~2. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).~~

~~3. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small Scale Environmental Chambers."~~

~~G. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.~~

- ~~1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).~~
- ~~2. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).~~
- ~~3. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small Scale Environmental Chambers."~~

~~H. Plastic, Pipe Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.~~

### 3.93.4 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

~~C. Plastic to Metal Transition Fittings:~~

~~1. Description:~~

- ~~a. CPVC or PVC one piece fitting with manufacturer's Schedule 80 equivalent dimensions.~~
- ~~b. One end with threaded brass insert and one solvent cement socket or threaded end.~~

~~D. Plastic to Metal Transition Unions:~~

~~1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:~~

- ~~a. Colonial Engineering, Inc.~~
- ~~b. NIBCO INC.~~

~~2. Description:~~

- ~~a. CPVC or PVC four part union.~~
- ~~b. Brass or stainless steel threaded end.~~
- ~~c. Solvent cement joint or threaded plastic end.~~
- ~~d. Rubber O-ring.~~
- ~~e. Union nut.~~

~~3.103.5~~ DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
  
- B. Dielectric Unions:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. A.Y. McDonald Mfg. Co.
    - b. Capitol Manufacturing Company.
    - c. Central Plastics Company.
    - d. HART Industrial Unions, LLC.
    - e. Jomar Valve.
    - f. Matco-Norca.
    - g. WATTS.
    - h. Wilkins.
  - 2. Standard: ASSE 1079.
  - 3. Pressure Rating: 150 psig minimum at 180 deg F.
  - 4. End Connections: Solder-joint copper alloy and threaded ferrous.
  
- C. Dielectric Flanges:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Capitol Manufacturing Company.
    - b. Central Plastics Company.
    - c. Matco-Norca.
    - d. WATTS.
    - e. Wilkins.
  - 2. Standard: ASSE 1079.
  - 3. Factory-fabricated, bolted, companion-flange assembly.
  - 4. Pressure Rating: 150 psig minimum at 180 deg F.
  - 5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
  
- D. Dielectric-Flange Insulating Kits:
  - 1. if approved by the local authority having jurisdiction (AHJ) Nonconducting materials for field assembly of companion flanges.
  - 2. Pressure Rating: 150 psig.
  - 3. Gasket: Neoprene or phenolic.
  - 4. Bolt Sleeves: Phenolic or polyethylene.
  - 5. Washers: Phenolic with steel backing washers.
  
- E. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Elster Perfection Corporation.
  - b. Grinnell G-Fire by Johnson Controls Company.
  - c. Matco-Norca.
  - d. Precision Plumbing Products.
  - e. Sioux Chief Manufacturing Company, Inc.
2. Standard: IAPMO PS 66.
3. Electroplated steel nipple complying with ASTM F 1545.
4. Pressure Rating and Temperature: 300 psig at 225 deg F.
5. End Connections: Male threaded or grooved.
6. Lining: Inert and noncorrosive, propylene.

#### **PART 4 - EXECUTION**

##### 4.1 EARTHWORK

- A. Comply with requirements in Section 31 20 00 "Earth Moving" for excavating, trenching, and backfilling.

##### 4.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
- D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 22 05 19 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 22 11 19 "Domestic Water Piping Specialties."
- E. Install shutoff valve immediately upstream of each dielectric fitting.
- F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 22 11 19 "Domestic Water Piping Specialties."
- G. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.

- H. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- ~~I. — Install seismic restraints on piping. Comply with requirements for seismic restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."~~
- J.I. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- K.J. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- L.K. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- M.L. Install piping to permit valve servicing.
- N.M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- O.N. Install piping free of sags and bends.
- P.O. Install fittings for changes in direction and branch connections.
- ~~Q. — Install PEX piping with loop at each change of direction of more than 90 degrees.~~
- R.P. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- S.Q. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Section 22 05 19 "Meters and Gages for Plumbing Piping."
- ~~T. — Install thermostats in hot water circulation piping. Comply with requirements for thermostats in Section 221123 "Domestic Water Pumps."~~
- U.R. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 22 05 19 "Meters and Gages for Plumbing Piping."
- ~~V. — Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."~~
- ~~W. — Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."~~

- ~~X.S.~~ Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

#### 4.3 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Braze Joints" chapter.
- E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.
- G. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- H. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
  - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
  - 3. PVC Piping: Join according to ASTM D 2855.
- I. ~~Joints for PEX Piping: Join according to ASTM F 1807.~~
- J. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

#### 4.4 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:

1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
2. Fittings for NPS 2 and Larger: Sleeve-type coupling.

- C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

#### 4.5 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings, unions or nipples.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges, flange kits or nipples.
- D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

#### 4.6 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger, support products, and installation in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."
1. Vertical Piping: MSS Type 8 or 42, clamps.
  2. Individual, Straight, Horizontal Piping Runs:
    - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
  3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
  4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
  2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
  3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
  4. NPS 2-1/2: 108 inches with 1/2-inch rod.
  5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.

- F. Install supports for vertical copper tubing every 10 feet.
- G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
  - 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
  - 3. NPS 2: 10 feet with 3/8-inch rod.
  - 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
  - 5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
  - 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
- H. Install supports for vertical steel piping every 15 feet.
- I. Install vinyl-coated hangers for CPVC piping with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 1 and Smaller: 36 inches with 3/8-inch rod.
  - 2. NPS 1-1/4 to NPS 2: 48 inches with 3/8-inch rod.
  - 3. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
  - 4. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
- J. Install supports for vertical CPVC piping every 60 inches for NPS 1 and smaller, and every 72 inches for NPS 1-1/4 and larger.
- ~~K. Install vinyl-coated hangers for PEX piping with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 1 and Smaller: 32 inches with 3/8-inch rod.~~
- ~~L. Install hangers for vertical PEX piping every 48 inches.~~
- M.K. Install vinyl-coated hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 2 and Smaller: 48 inches with 3/8-inch rod.
  - 2. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
  - 3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
- N.L. Install supports for vertical PVC piping every 48 inches.
- O.M. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

#### 4.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.



- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
  - 1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
  - 2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
  - 3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
  - 4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

#### 4.8 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 22 05 53 "Identification for Plumbing Piping and Equipment."
- B. Label pressure piping with system operating pressure.

#### 4.9 FIELD QUALITY CONTROL

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

- a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
  - b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
  - c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
  - d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
  - e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
  - f. Prepare reports for tests and for corrective action required.
- B. Domestic water piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

#### 4.10 ADJUSTING

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

#### 4.11 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:
1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.

2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
  - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
  - b. Fill and isolate system according to either of the following:
    - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
    - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
  - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
  - d. Repeat procedures if biological examination shows contamination.
  - e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

#### 4.12 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Under-building-slab, domestic water, building-service piping, NPS 3 and smaller, shall be one of the following:

1. Soft copper tube, ASTM B 88, Type K, ASTM B 88, Type L; wrought-copper, solder-joint fittings; and brazed or copper pressure-seal fittings; and pressure-sealed joints.

~~2. PVC, Schedule 40 or Schedule 80; socket fittings; and solvent-cemented joints.~~

E. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 and larger, shall be one of the following:

1. Soft copper tube, ASTM B 88, Type K or ASTM B 88, Type L; wrought-copper, solder-joint fittings; and brazed joints.

- ~~2. Plain end, ductile iron pipe; grooved joint, ductile iron pipe appurtenances; and grooved joints.~~
- ~~3. PVC, Schedule 40 or Schedule 80; socket fittings; and solvent cemented joints.~~

~~F. Under building slab, domestic water piping, NPS 2 and smaller, shall be one of the following:~~

- ~~1. Hard or soft copper tube, ASTM B 88, Type L; wrought copper, solder joint fittings; and brazed, copper pressure seal joint fittings; and pressure sealed joints.~~
- ~~2. PVC, Schedule 40 or Schedule 80; socket fittings; and solvent cemented joints.~~

G.F. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:

- ~~1. Galvanized steel pipe and nipples; galvanized, gray iron threaded fittings; and threaded joints.~~
- 2.1. Hard copper tube, ASTM B 88, Type L, ASTM B 88, Type M; cast- or wrought-copper, solder-joint fittings; and brazed or soldered joints.
- ~~3. Hard copper tube, ASTM B 88, Type L or ASTM B 88, Type M; copper pressure seal joint fittings; and pressure sealed joints.~~
- ~~4. Hard copper tube, ASTM B 88, Type L or ASTM B 88, Type M; copper push-on joint fittings; and push-on joints.~~
- ~~5. CPVC, Schedule 40 or Schedule 80; socket fittings; and solvent cemented joints.~~
- ~~6. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.~~
- ~~7. CPVC Tubing System: CPVC tube; CPVC socket fittings; and solvent cemented joints. NPS 1 1/2 and NPS 2 CPVC pipe with CPVC socket fittings may be used instead of tubing.~~
- ~~8. PEX tube, NPS 1 and smaller; fittings for PEX tube; and crimped joints.~~
- ~~9. PVC, Schedule 40 or Schedule 80; socket fittings; and solvent cemented joints.~~

H.G. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L, ASTM B 88, Type M; cast- or wrought-copper, solder-joint fittings; and brazed soldered joints.
- ~~2. Hard copper tube, ASTM B 88, Type L or ASTM B 88, Type M; copper pressure seal joint fittings; and pressure sealed joints.~~
- ~~3. Hard copper tube, ASTM B 88, Type L or ASTM B 88, Type M; grooved joint, copper tube appurtenances; and grooved joints.~~
- ~~4. Galvanized steel pipe and nipples; galvanized, gray iron threaded fittings; and threaded joints.~~
- ~~5. CPVC, Schedule 40 or Schedule 80; socket fittings; and solvent cemented joints.~~
- ~~6. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.~~
- ~~7. PVC, Schedule 40 or Schedule 80; socket fittings; and solvent cemented joints.~~

Bell Auditorium Expansion & Renovations  
Augusta, Georgia  
Issue for Permit / Bid

Perkins&Will  
222028.000  
16 January 2023

**END OF SECTION**

## SECTION 22 11 19

### PART 1 -

### DOMESTIC WATER PIPING SPECIALTIES

#### PART 2 - GENERAL

#### 2.1 SUMMARY

##### A. Section Includes:

1. Vacuum breakers.
2. Backflow preventers.
3. Balancing valves.
4. Temperature-actuated, water mixing valves.
- ~~5. Strainers.~~
- ~~6.5.~~ 6.5. Hose bibbs.
- ~~7.6.~~ 7.6. Wall hydrants.
- ~~8.7.~~ 8.7. Drain valves.
- ~~9.8.~~ 9.8. Water-hammer arresters.
- ~~10.9.~~ 10.9. Trap-seal primer valves.

##### B. Related Requirements:

1. Section 22 11 16 "Domestic Water Piping".
- ~~2. Section 224600 "Security Plumbing Fixtures".~~
- ~~3. Section 224716 "Pressure Water Coolers".~~

#### 2.2 ACTION SUBMITTALS

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

#### 2.3 INFORMATIONAL SUBMITTALS

- ##### A. Field quality-control reports.

#### 2.4 CLOSEOUT SUBMITTALS

- ##### A. Operation and maintenance data.

### **PART 3 - PRODUCTS**

#### 3.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- A. Potable-water piping and components shall comply with NSF 61 Annex G and NSF 14 or Mark "NSF-pw" on plastic piping components.

#### 3.2 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

#### 3.3 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
  - 1. Standard: ASSE 1001.
  - 2. Size: NPS 1/4 to NPS 3, as required to match connected piping.
  - 3. Body: Bronze.
  - 4. Inlet and Outlet Connections: Threaded.
  - 5. Finish: Rough bronze or Chrome plated.
- B. Hose-Connection Vacuum Breakers:
  - 1. Standard: ASSE 1011.
  - 2. Body: Bronze, nonremovable, with manual drain.
  - 3. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
  - 4. Finish: Chrome or nickel plated or Rough bronze.

#### 3.4 BACKFLOW PREVENTERS

- A. Intermediate Atmospheric-Vent Backflow Preventers:
  - 1. Standard: ASSE 1012.
  - 2. Operation: Continuous-pressure applications.
  - 3. Size: NPS 1/2 and NPS 3/4.
  - 4. Body: Bronze.
  - 5. End Connections: Union, solder or Solder joint.
  - 6. Finish: Chrome plated or Rough bronze.
- B. Reduced-Pressure-Principle Backflow Preventers:
  - 1. Standard: ASSE 1013.
  - 2. Operation: Continuous-pressure applications.
  - 3. Pressure Loss: 12 psig maximum, through middle third of flow range.
  - 4. Size: Per plan.
  - 5. Design Flow Rate: 205 gpm.
  - 6. Selected Unit Flow Range Limits: 150-205 gpm.

7. Pressure Loss at Design Flow Rate: 8 psig for sizes NPS 2 and smaller; 12 psig for NPS 2-1/2 and larger.
8. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, steel with interior lining that complies with AWWA C550 or that is FDA approved or stainless steel for NPS 2-1/2 and larger.
9. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
10. Configuration: Designed for horizontal, straight-through flow.
11. Accessories:
  - a. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
  - b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

C. Double-Check, Backflow-Prevention Assemblies:

1. Standard: ASSE 1015.
2. Operation: Continuous-pressure applications unless otherwise indicated.
3. Pressure Loss: 5 psig maximum, through middle third of flow range.
4. Size: 4" NPS.
5. Design Flow Rate: 205 gpm.
6. Selected Unit Flow Range Limits: 150-205 gpm.
7. Pressure Loss at Design Flow Rate: 6 psig for sizes NPS 2 and smaller; 10 psig for NPS 2-1/2 and larger.
8. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, steel with interior lining that complies with AWWA C550 or that is FDA approved or stainless steel for NPS 2-1/2 and larger.
9. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
10. Configuration: Designed for horizontal, straight-through flow.
11. Accessories:
  - a. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.

3.5 BALANCING VALVES

A. Memory-Stop Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
  - b. Crane; a Crane brand.
  - c. Hammond Valve.
  - d. Jenkins Valves; a Crane Co. brand.
  - e. Milwaukee Valve Company.
  - f. NIBCO INC.
  - g. Red-White Valve Corp.
2. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.



3. Pressure Rating: 400-psig minimum CWP.
4. Size: NPS 2 or smaller.
5. Body: Copper alloy.
6. Port: Standard or full port.
7. Ball: Chrome-plated brass.
8. Seats and Seals: Replaceable.
9. End Connections: Solder joint or threaded.
10. Handle: Vinyl-covered steel with memory-setting device.

### 3.6 TEMPERATURE-ACTUATED, WATER MIXING VALVES

#### A. Water-Temperature Limiting Devices:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Acorn Engineering Company; a Division of Morris Group International.
  - b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
  - c. Leonard Valve Company.
  - d. POWERS; A WATTS Brand.
  - e. Symmons Industries, Inc.
  - f. TACO Comfort Solutions, Inc.
  - g. WATTS.
  - h. Bradly.
  - i. HAWS.
  - j. Wilkins.
  - k. Zurn.
2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig.
4. Type: Thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded union inlets and outlet.
7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Valve Finish: Chrome plated or Rough bronze.

#### B. Primary, Thermostatic, Water Mixing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Acorn Engineering Company; a Division of Morris Group International.
  - b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
  - c. Leonard Valve Company.
  - d. POWERS; A WATTS Brand.
  - e. Symmons Industries, Inc.
  - f. WATTS.
2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig minimum unless otherwise indicated.

4. Type: Exposed-mounted or Cabinet-type, thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded union inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Valve Finish: Chrome plated, Polished, chrome plated or Rough bronze.
9. Piping Finish: Chrome plated or Copper.

### ~~3.7 STRAINERS FOR DOMESTIC WATER PIPING~~

#### ~~A. Y Pattern Strainers:~~

- ~~1. Pressure Rating: 125 psig minimum unless otherwise indicated.~~
- ~~2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2 1/2 and larger.~~
- ~~3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2 1/2 and larger.~~
- ~~4. Screen: Stainless steel with round perforations unless otherwise indicated.~~
- ~~5. Perforation Size:
  - ~~a. Strainers NPS 2 and Smaller: 0.033 inch.~~
  - ~~b. Strainers NPS 2 1/2 to NPS 4: 0.045 inch.~~~~
- ~~6. Drain: Pipe plug or Factory installed, hose end drain valve.~~

### 3.83.7 HOSE BIBBS

#### A. Hose Bibbs:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral or field-installation, nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Rough bronze or Chrome or nickel plated.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Wheel handle.
13. Operation for Finished Rooms: Operating key.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

### 3.93.8 WALL HYDRANTS

#### A. Non-Freeze Wall Hydrants:

1. Standard: ASME A112.21.3M for concealed or exposed-outlet, self-draining wall hydrants.
2. Pressure Rating: 125 psig.
3. Operation: Loose key.
4. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
5. Inlet: NPS 3/4 or NPS 1.
6. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
7. Box: Deep, flush mounted with cover.
8. Box and Cover Finish: Polished nickel bronze or Chrome plated.
9. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
10. Nozzle and Wall-Plate Finish: Polished nickel bronze or Rough bronze.
11. Operating Keys(s): Two with each wall hydrant.

#### B. Vacuum Breaker Wall Hydrants:

1. Standard: ASSE 1019, Type A or Type B.
2. Type: Freeze-resistant, automatic draining with integral air-inlet valve.
3. Classification: Type A, for automatic draining with hose removed or Type B, for automatic draining with hose removed or with hose attached and nozzle closed.
4. Pressure Rating: 125 psig.
5. Operation: Loose key.
6. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
7. Inlet: NPS 1/2 or NPS 3/4.
8. Outlet: Exposed with garden-hose thread complying with ASME B1.20.7.

### 3.103.9 DRAIN VALVES

#### A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

3.113.10 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. AMTROL, Inc.
  - b. Jay R. Smith Mfg Co; a division of Morris Group International.
  - c. Josam Company.
  - d. MIFAB, Inc.
  - e. Precision Plumbing Products.
  - f. Sioux Chief Manufacturing Company, Inc.
  - g. WATTS.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Metal bellows or Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

3.123.11 TRAP-SEAL PRIMER DEVICE

A. Supply-Type, Trap-Seal Primer Device:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Jay R. Smith Mfg Co; a division of Morris Group International.
  - b. Josam Company.
  - c. MIFAB, Inc.
  - d. Precision Plumbing Products.
  - e. Sioux Chief Manufacturing Company, Inc.
  - f. WATTS.
2. Standard: ASSE 1018.
3. Pressure Rating: 125 psig minimum.
4. Body: Bronze.
5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

~~B. Drainage-Type, Trap-Seal Primer Device:~~

- ~~1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:~~
  - ~~a. Jay R. Smith Mfg Co; a division of Morris Group International.~~
  - ~~b. MIFAB, Inc.~~
  - ~~c. Precision Plumbing Products.~~

- ~~2. Standard: ASSE 1044, lavatory P-trap with NPS 3/8 minimum, trap makeup connection.~~
- ~~3. Size: NPS 1 1/4 minimum.~~
- ~~4. Material: Chrome-plated, cast brass.~~

## **PART 4 - EXECUTION**

### 4.1 INSTALLATION

- A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
  1. Locate backflow preventers in same room as connected equipment or system.
  2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
  3. Do not install bypass piping around backflow preventers.
- B. Install balancing valves in locations where they can easily be adjusted.
- C. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
  1. Install cabinet-type units recessed in or surface mounted on wall as specified.
- D. Install Y-pattern strainers for water on supply side of each water pressure-reducing valve and pump.
- E. Set non-freeze, nondraining-type post hydrants in concrete or pavement.
- F. Set freeze-resistant yard hydrants with riser pipe in concrete or pavement. Do not encase canister in concrete.
- G. Install water-hammer arresters in water piping according to PDI-WH 201.
- H. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
- I. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

### 4.2 CONNECTIONS

- A. Comply with requirements for ground equipment in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

- B. Fire-retardant-treated-wood blocking is specified in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" for electrical connections.

#### 4.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. Test each pressure vacuum breaker, reduced-pressure-principle backflow preventer, double-check, backflow-prevention assembly and double-check, detector-assembly backflow preventer Insert type according to authorities having jurisdiction and the device's reference standard.
- B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

#### 4.4 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

**END OF SECTION**

**SECTION 23 21 123**

PART 1 -

**FACILITY NATURAL-GAS PIPING**

PART 2 - GENERAL

2.1 SUMMARY

- A. Section Includes:
1. Pipes, tubes, and fittings.
  2. Piping specialties.
  3. Joining materials.
  4. Manual gas shutoff valves.
  5. Earthquake valves.
  6. Pressure regulators.
  7. Dielectric fittings.

2.2 ACTION SUBMITTALS

- A. Product Data:
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 bypass fittings and meter bars meter bars supports.~~
  - 6.5. 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.

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~~2. Detail mounting, supports, and valve arrangements for service meter assembly and pressure regulator assembly.~~

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## 2.3 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. Certificates:
  - 1. Welding certificates.
- C. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.
- D. Field Quality-Control Submittals:
  - 1. Field quality-control reports.

## 2.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data for pressure regulators.

## 2.5 QUALITY ASSURANCE

- A. Qualifications:
  - 1. Steel Support Welding: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."
  - 2. Pipe Welding: Qualify procedures and operators in accordance with the ASME Boiler and Pressure Vessel Code.

## 2.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating and protect from direct sunlight.
- C. Protect stored PE pipes and valves from direct sunlight.

## 2.6.7 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 in accordance with requirements indicated:

1. Notify Construction Manager or Owner 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 or Owner's written permission.

### 2.72.8 COORDINATION

- A. Coordinate requirements for access panels and doors for valves installed and concealed behind finished surfaces. Comply with requirements in Section 083113 "Access Doors and Frames."
- B. Coordinate requirements for piping identification for natural-gas piping. Comply with requirements in Section 220553 "Identification of Plumbing Piping and Equipment."

## PART 3 - PRODUCTS

### 3.1 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 54 and the International Fuel Gas Code.

~~B. Minimum Operating Pressure Ratings:~~

~~— Revise pressure ratings in "Piping and Valves," "Service Regulators," and "Minimum Operating Pressure of Service Meter" subparagraphs below to suit Project. Ratings must be at least one and one-half times the system's operating pressure. Verify requirements with authorities having jurisdiction. Line pressure is usually less than 65 psig (450 kPa).~~

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~~1. Piping and Valves: 100 psig minimum unless otherwise indicated.~~

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~~2. Service Regulators: 100 psig minimum unless otherwise indicated.~~

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~~— Pressure at meter, if downstream from regulator, should be 5 psig (34.5 kPa) or lower for most applications. Pressure for industrial applications may be 100 psig (690 kPa) or higher, but these industrial applications are not addressed in the scope of this Section. If service meters and regulators with more than one pressure rating are required, indicate location of each on Drawings along with their outlet pressure setting.~~

~~3. Minimum Operating Pressure of Service Meter: 5 psig.~~

~~C.B. Natural-Gas System Pressure within Buildings:~~

1. Single Pressure: More than 0.5 psig, but not more than 2 psig or More than 2 psig, but not more than 5 psig.

### 3.2 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A53/A53M, 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 A234/A234M for butt welding and socket welding.
  - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
  - 4. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

#### 4.23.3 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.
  - 6. End Fittings: Zinc-coated steel.
  - 7. Threaded Ends: Comply with ASME B1.20.1.
  - 8. Maximum Length: 72 inches.
- B. Quick-Disconnect Devices: Comply with ANSI Z21.41.
  - 1. Copper-alloy convenience outlet and matching plug connector.
  - 2. Seals: Nitrile.
  - 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 A126, Class B, cast iron with bolted cover and bottom drain connection.~~
- ~~2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2 1/2 and larger.~~
- ~~3. Strainer Screen: 60 mesh startup strainer, and perforated stainless steel basket with 50 percent free area.~~
- ~~4. CWP Rating: 125 psig.~~

#### ~~D.C. Weatherproof Vent Cap:~~

- ~~1. 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.~~

#### 4.33.4 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for natural gas.

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- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

**4.43.5 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 and Smaller: Comply with ASME B16.33.
  - 1. CWP Rating: 125 psig.
  - 2. Threaded Ends: Comply with ASME B1.20.1.
  - 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
  - 4. Tamperproof Feature: Locking feature for valves indicated in "Underground, Manual Gas Shutoff Valve Schedule" and "Aboveground, Manual Gas Shutoff Valve Schedule" articles.
  - 5. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
  - 6. Service Mark: Valves NPS 1-1/4 to NPS 2 having initials "WOG" permanently marked on valve body.
- C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
  - 1. CWP Rating: 125 psig.
  - 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: Initial's "WOG" permanently marked on valve body.

~~D. One Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.~~

~~1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:~~

~~a. A.Y. McDonald Mfg. Co.~~

~~b. Apollo Valves; a part of Aalberts Integrated Piping Systems.~~

~~c. BrassCraft Manufacturing Co.; a Masco company.~~

~~d. Perfection Corporation.~~

~~e. R.W. Lyall; brand of Hubbell Utility Solutions; Hubbell Incorporated.~~

~~2. Body: Bronze, complying with ASTM B584.~~

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- ~~3. Ball: Chrome-plated brass.~~
- ~~4. Stem: Bronze; blowout proof.~~
- ~~5. Seats: Reinforced TFE; blowout proof.~~
- ~~6. Packing: Separate packnut with adjustable stem packing threaded ends.~~
- ~~7. Ends: Threaded, flared, or socket as indicated in "Underground, Manual Gas Shutoff Valve Schedule" and "Aboveground, Manual Gas Shutoff Valve Schedule" articles.~~
- ~~8. CWP Rating: 600 psig.~~
- ~~9. Listing: Valves NPS 1 and smaller are to 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.D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. A.Y. McDonald Mfg. Co.
  - b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
  - c. BrassCraft Manufacturing Co.; a Masco company.
  - d. Perfection Corporation.
  - e. R.W. Lyall; brand of Hubbell Utility Solutions; Hubbell Incorporated.
- 2. Body: Bronze, complying with ASTM B584.
- 3. Ball: Chrome-plated bronze.
- 4. Stem: Bronze; blowout proof.
- 5. Seats: Reinforced TFE; blowout proof.
- 6. Packing: Threaded-body packnut design with adjustable-stem packing.
- 7. Ends: Threaded, flared, or socket as indicated in "Underground, Manual Gas Shutoff Valve Schedule" and "Aboveground, Manual Gas Shutoff Valve Schedule" articles.
- 8. CWP Rating: 600 psig.
- 9. Listing: Valves NPS 1 and smaller are to 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.

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- F. ~~Two Piece, Regular Port Bronze Ball Valves with Bronze Trim: MSS SP 110.~~
- 1. ~~Manufacturers: Subject to compliance with requirements, provide products by one of the following:~~
  - a. ~~A.Y. McDonald Mfg. Co.~~
  - b. ~~Apollo Valves; a part of Aalberts Integrated Piping Systems.~~
  - c. ~~BrassCraft Manufacturing Co.; a Masco company.~~
  - d. ~~Perfection Corporation.~~
  - e. ~~R.W. Lyall; brand of Hubbell Utility Solutions; Hubbell Incorporated.~~
- 2. ~~Body: Bronze, complying with ASTM B584.~~
- 3. ~~Ball: Chrome-plated bronze.~~
- 4. ~~Stem: Bronze; blowout proof.~~
- 5. ~~Seats: Reinforced TFE.~~
- 6. ~~Packing: Threaded body packnut design with adjustable stem packing.~~
- 7. ~~Ends: Threaded, flared, or socket as indicated in "Underground, Manual Gas Shutoff Valve Schedule" and "Aboveground, Manual Gas Shutoff Valve Schedule" articles.~~
- 8. ~~CWP Rating: 600 psig.~~
- 9. ~~Listing: Valves NPS 1 and smaller are to 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.~~

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~~1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:~~

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~~a. A.Y. McDonald Mfg. Co.~~

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~~b. Lee Brass Company.~~

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~~2. Body: Bronze, complying with ASTM B584.~~

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~~3. Plug: Bronze.~~

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~~4. Ends: Threaded, socket, or flanged as indicated in "Underground, Manual Gas Shutoff Valve Schedule" and "Aboveground, Manual Gas Shutoff Valve Schedule" articles.~~

~~5. Operator: Square head or lug type with tamperproof feature where indicated.~~

~~6. Pressure Class: 125 psig.~~

~~7. Listing: Valves NPS 1 and smaller are to 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. Valve Boxes:~~

~~1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:~~

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~~a. Kerotest Manufacturing Corp.~~

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~~b. Perfection Corporation.~~

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~~c. R.W. Lyall, brand of Hubbell Utility Solutions; Hubbell Incorporated.~~

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~~2. Cast iron, two section box.~~

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~~3. Top section with cover with "GAS" lettering.~~

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~~4. Bottom section with base to fit over valve and barrel a minimum of 5 inches in diameter.~~

~~5. Adjustable cast iron extensions of length required for depth of bury.~~

~~6. Include tee handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.~~

#### 4.5 EARTHQUAKE VALVES

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~~A. Earthquake Valves, Maximum Operating Pressure of 5 psig. Comply with ASCE/SEI 25.~~

~~1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:~~

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~~a. Firefighter Gas Safety Products.~~

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~~b. Pacific Seismic Products, Inc.~~

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~~2. Listed and labeled by an NRTL acceptable to authorities having jurisdiction.~~

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~~3. Maximum Operating Pressure: 5 psig.~~

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~~4. Cast aluminum body with nickel-plated chrome steel internal parts.~~

~~5. NBR valve washer.~~

~~6. Sight windows for visual indication of valve position.~~

~~7. Threaded end connections complying with ASME B1.20.1.~~

~~8. Wall mounting bracket with bubble level indicator.~~

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4-63.6 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.



~~B. Line Pressure Regulators: Comply with ANSI Z21.80A.~~

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~~1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:~~

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~~a. Actaris; a brand of ITT Controls.~~

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~~b. Dormont; a WATTS brand.~~

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~~c. Elster American Meter; a Honeywell Company.~~

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~~d. Fischer; Emerson Electric Co., Automation Solutions.~~

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~~e. Itron Gas.~~

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~~f. Maxitrol Company.~~

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~~2. Body and Diaphragm Case: Cast iron or die cast aluminum.~~

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~~3. Springs: Zinc plated steel; interchangeable.~~

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~~4. Diaphragm Plate: Zinc plated steel.~~

~~5. Seat Disc: NBR; resistant to gas impurities, abrasion, and deformation at the valve port.~~

~~6. Orifice: Aluminum; interchangeable.~~

~~7. Seal Plug: UV-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 regulator.~~

~~9. Pressure regulator is to maintain discharge pressure setting downstream and is to not exceed 150 percent of design discharge pressure at shutoff.~~

~~Overpressure protection device is optional feature. See the Evaluations.~~

- ~~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.~~
- ~~C. Appliance Pressure Regulators: Comply with ANSI Z21.18.~~
- ~~1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:~~
  - ~~a. Dormont, a WATTS brand.~~
  - ~~b. Eaton.~~
  - ~~c. Harper Wyman Co.~~
  - ~~d. Maxitrol Company.~~
  - ~~e. SCP, Inc.~~
- ~~2. Body and Diaphragm Case: Die cast aluminum.~~
- ~~3. Springs: Zinc plated steel, interchangeable.~~
- ~~4. Diaphragm Plate: Zinc plated steel.~~
- ~~5. Seat Disc: NBR.~~
- ~~6. Seal Plug: UV 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.~~

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~~9. Maximum Inlet Pressure: 2 psig.~~

#### 4.73.7 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, provide products by one of the following:~~
    - a. ~~Capitol Manufacturing Company.~~
    - b. ~~HART Industrial Unions, LLC.~~
    - c. ~~Jomar Valve.~~
    - d. ~~WATTS.~~
    - e. ~~Wilkins.~~
    - f. ~~Zurn Industries, LLC.~~
  - 2. Description:
    - a. Standard: ASSE 1079.
    - b. Pressure Rating: 125 psig minimum at 180 deg F.
    - c. End Connections: Solder-joint copper alloy and threaded ferrous.

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#### 4.83.8 LABELING AND IDENTIFYING

- A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description and rated pressure of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.
- B. Label and identify gas piping and pressure outside a multitenant building by tenant.

### ~~PART 5~~ PART 4 - EXECUTION

#### 5.14.1 PREPARATION

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural-gas piping in accordance with 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 preventing accidental ignition.

5-24.2 INSTALLATION OF OUTDOOR PIPING

- 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 below finished grade. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.
  - 1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.
- C. Steel Piping with Protective Coating:
  - 1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
- D. Copper Tubing with Protective Coating:
  - 1. Apply joint cover kits over tubing to cover, seal, and protect joints.
- E. Install fittings for changes in direction and branch connections.
- F. Install pressure gauge upstream and downstream from each service regulator. Pressure gauges are specified in Section 230519 "Meters and Gauges for HVAC Piping."

5-24.3 INSTALLATION OF INDOOR PIPING

- 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. Do not install piping in concealed locations unless sleeved with the sleeve open at both ends.
- 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. Where installing piping above accessible ceilings, allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access. Do not locate valves within return air plenums.
- H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

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- 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 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. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- Q. Connect branch piping from top or side of horizontal piping.
- R. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- S. Do not use natural-gas piping as grounding electrode.
- T. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- U. Install pressure gauge upstream and downstream from each line regulator. Pressure gauges are specified in Section 230519 "Meters and Gauges for HVAC Piping."
- V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

#### 5-44.4 INSTALLATION OF VALVES

- 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 earthquake valves aboveground outside buildings according to listing.
- E. Do not install valves in return-air plenums.

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#### 5-54.5 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
  - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
  - 2. Cut threads full and clean using sharp dies.
  - 3. Ream threaded pipe ends to remove burrs and restore full 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 in accordance with 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 in accordance with AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
- F. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, and then use wrench. Do not overtighten.

#### 5-64.6 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.

- B. Install hangers for steel piping and copper tubing, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- C. Install hangers for corrugated stainless-steel tubing, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- D. Support horizontal piping within 12 inches of each fitting.
- E. Support vertical runs of steel piping and copper tubing to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- F. Support vertical runs of corrugated stainless-steel tubing to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

#### 5-74.7 PIPING 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 in accordance with NFPA 70.
- C. Where installing piping adjacent to appliances, allow space for service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

#### 5-84.8 LABELING AND IDENTIFICATION

- A. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for piping and valve identification.
- B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

#### 5-94.9 FIELD QUALITY CONTROL

- A. Tests and Inspections:
  - 1. Test, inspect, and purge natural gas in accordance with NFPA 54 or the International Fuel Gas Code and authorities having jurisdiction.
  - 2. Natural-gas piping will be considered defective if it does not pass tests and inspections.

- B. Prepare test and inspection reports.

5.104.10 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain earthquake valves.

5.114.11 OUTDOOR PIPING SCHEDULE

- A. Underground natural-gas piping is to be one of the following:
  - 1. Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
- B. Aboveground natural-gas piping is to 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.
  - 3. ~~Annealed temper copper tube with wrought copper fittings and brazed joints.~~

5.124.12 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

- A. Aboveground, branch piping NPS 1 and smaller is to be one of the following:
  - ~~Contact authorities having jurisdiction and verify approval before specifying corrugated stainless steel tubing.~~
  - 1. ~~Corrugated stainless steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.~~
  - ~~Tin lined copper tube in first subparagraph below is available in 1/4 to 5/8 inch (6.3 to 15.8 mm) OD and is equivalent to NPS 1/8 to NPS 1/2 (DN 6 to DN 15).~~
  - 2. ~~Annealed temper, tin lined copper tube with flared joints and fittings.~~
  - 3. ~~Annealed temper, copper tube with wrought copper fittings and brazed or flared joints.~~
  - 4.1. Steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground, distribution piping is to 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 is to 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.
  - 3. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
  - 4. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground portion of vent pipe and fittings with protective coating for steel piping.

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5.134.13 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG AND LESS THAN OR EQUAL TO 2 PSIG

- A. Aboveground, branch piping NPS 1 and smaller is to be one of the following:
- ~~1. Corrugated stainless steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.~~
  - ~~2. Annealed temper copper tube with wrought copper fittings and brazed or flared joints.~~
  - ~~3. Aluminum tube with flared fittings and joints.~~
  - 4.1. Steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground, distribution piping is to 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.
  3. Drawn-temper copper tube with wrought-copper fittings and brazed joints.
- C. Underground, below building, piping is to 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.
  3. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat underground pipe and fittings with protective coating for steel piping.
  4. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground portion of vent pipe and fittings with protective coating for steel piping.

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5.144.14 UNDERGROUND, MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.
- B. Underground:
1. NPS 2 and Smaller: Bronze plug valves.

5.154.15 ABOVEGROUND, MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Valves for pipe sizes NPS 2 and smaller at service meter are to be one of the following:
- ~~1. One piece, bronze ball valve with bronze trim.~~
  - 2.1. Two-piece, full or regular-port, bronze ball valves with bronze trim.
- B. Distribution piping valves for pipe sizes NPS 2 and smaller are to be one of the following:
1. ~~One piece, bronze ball valve with bronze trim.~~
  2. Two-piece, full or regular-port, bronze ball valves with bronze trim.
- C. Valves in branch piping for single appliance are to be one of the following:
1. ~~One piece, bronze ball valve with bronze trim.~~
  2. Two-piece, full or regular-port, bronze ball valves with bronze trim.

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~~3- Bronze plug valve.~~

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END OF SECTION

## **SECTION 22 11 23.13**

### **PART 1 -**

### **DOMESTIC-WATER PACKAGED BOOSTER PUMPS**

#### **PART 2 - GENERAL**

##### 2.1 SUMMARY

- A. Section Includes:
  - 1. Multiplex, variable-speed booster pumps.

##### 2.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For booster pumps. Include plans, elevations, sections, details, and attachments to other work.

##### 2.3 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

##### 2.4 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. ASME Compliance: Comply with ASME B31.9 for piping.
- C. UL Compliance for Packaged Pumping Systems:
  - 1. UL 508, "Industrial Control Equipment."
  - 2. UL 508A, "Industrial Control Panels."
  - 3. UL 778, "Motor-Operated Water Pumps."
  - 4. UL 1995, "Heating and Cooling Equipment."
- D. Booster pumps shall be listed and labeled as packaged pumping systems by testing agency acceptable to authorities having jurisdiction.

### **PART 3 - PRODUCTS**

#### 3.1 MULTIPLEX, VARIABLE-SPEED BOOSTER PUMPS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Armstrong Pumps, Inc.
  2. Bell & Gossett; a Xylem brand.
  3. Grundfos Pumps Corporation U.S.A.
  4. Metropolitan Industries, Inc.
  5. PACO Pumps; Grundfos Pumps Corporation, USA.
  6. SyncroFlo, Inc.
  7. Thrush Co. Inc.
  8. TIGERFLOW Systems, Inc.
- B. Description: Factory-assembled and -tested, fluid-handling system for domestic water, with pumps, piping, valves, specialties, and controls, and mounted on base.
- C. Pumps:
1. Type: End suction as defined in HI 1.1-1.2 and HI 1.3 for end-suction, close-coupled, single-stage, overhung-impeller, centrifugal pump.
  2. Casing: Radially split; bronze, cast iron or stainless steel.
  3. Impeller: Closed, ASTM B 584 cast bronze or stainless steel; statically and dynamically balanced and keyed to shaft.
  4. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve and deflector.
  5. Seal: Mechanical.
  6. Orientation: Mounted horizontally.
- D. Pumps:
1. Type: End suction as defined in HI 1.1-1.2 and HI 1.3 for end-suction, frame-mounted, separately coupled, single-stage, overhung-impeller, centrifugal pump. Include back-pullout design.
  2. Casing: Radially split; bronze, cast iron or stainless steel.
  3. Impeller: Closed, ASTM B 584 cast bronze or stainless steel; statically and dynamically balanced and keyed to shaft.
  4. Shaft and Shaft Sleeve: Stainless-steel or steel shaft, with copper-alloy shaft sleeve and deflector.
  5. Seal: Mechanical.
  6. Bearing: Grease-lubricated or pre-greased, permanently shielded ball type.
  7. Coupling: Flexible, with metal guard.
- E. Motors: Variable speed, with grease-lubricated or pre-greased, permanently shielded, ball-type bearings. Select motors that will not overload through full range of pump performance curve.
- F. Piping: Copper tube and copper fittings, Stainless-steel pipe and fittings or Stainless-steel pipe and fitting headers and copper tube and copper fittings between headers and pump.

G. Valves:

1. Shutoff Valves NPS 2 and smaller: two-piece, full-port ball valve, in each pump's suction and discharge piping.
2. Shutoff Valves NPS 2-1/2 and Larger: Gate valve or lug-type butterfly valve, in each pump's suction and discharge piping and in inlet and outlet headers.
3. Check Valves NPS 2 and smaller: Silent or swing type in each pump's discharge piping.
4. Check Valves NPS 2-1/2 and Larger: Silent type in each pump's discharge piping.
5. Control Valves: Adjustable, automatic, pilot-operated or direct-acting, pressure-reducing type in each pump's discharge piping.
6. Control Valves: Combination adjustable, automatic, pilot-operated or direct-acting, pressure-reducing-and-check type in each pump's discharge piping.
7. Thermal-Relief Valve: Temperature-and-pressure relief type in pump's discharge header piping.

H. Dielectric Fittings: With insulating material isolating joined dissimilar metals.

I. Control Panel: Factory installed and connected as an integral part of booster pump; automatic for multiple-pump, constant-speed operation, with load control and protection functions.

1. Control Logic: Electromechanical system with switches, relays or Solid-state system with transducers, programmable microprocessor, and other devices in the controller.
2. Motor Controller: NEMA ICS 2, general-purpose, Class A, full-voltage, combination-magnetic type with undervoltage release feature, motor-circuit-protector-type disconnect, and short-circuit protective device.
  - a. Control Voltage: 120-V ac, with integral control-power transformer.
3. Motor Controller: NEMA ICS 2, solid-state, reduced-voltage type.
  - a. Control Voltage: 24 or 120-V ac, with integral control-power transformer.
4. Enclosure: NEMA 250, Type 1.
5. Motor Overload Protection: Overload relay in each phase.
6. Starting Devices: Hand-off-automatic selector switch for each pump in cover of control panel, plus pilot device for automatic control.
  - a. Duplex, Automatic, Alternating Starter: Switches lead pump to lag main pump and to two-pump operation.
  - b. Triplex, Sequence (Lead-Lag-Lag) Starter: Switches lead pump to one lag main pump and to three-pump operation.
7. Pump Operation and Sequencing: Current- or pressure- sensing method.
  - a. Time Delay: Controls pump on-off operation; adjustable from 90 seconds.
8. Instrumentation: Suction and discharge pressure gages.

9. Lights: Running light for each pump.
10. Alarm Signal Device: Sounds alarm when backup pumps are operating.
  - a. Time Delay: Controls alarm operation; adjustable from 90 seconds, with automatic or manual reset.
11. Thermal-bleed cutoff.
12. Low-suction-pressure or Water-storage-tank, low-level cutout.
13. High-suction-pressure cutout.
14. Low-discharge-pressure cutout.
15. High-discharge-pressure cutout.
16. Building Automation System Interface: Provide auxiliary contacts for interface to BACnet building automation system. Building automation systems are specified in Section 23 09 00 "Instrumentation and Control for HVAC." Include the following:
  - a. On-off status of each pump.
  - b. Alarm status.

J. Base: Structural steel.

K. Capacities and Characteristics: Refer schedule on plumbing plan.

### 3.2 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors.
  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 NFPA 70.

## **PART 4 - EXECUTION**

### 4.1 INSTALLATION

- A. Equipment Mounting:
  1. Install booster pumps on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete." or Section 03 30 53 "Miscellaneous Cast-in-Place Concrete."
  2. Comply with requirements for vibration isolation and seismic control devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment".
  3. Comply with requirements for vibration isolation devices specified in Section 22 05 48.13 "Vibration Controls for Plumbing Piping and Equipment."

- B. Support connected domestic-water piping, so weight of piping is not supported by booster pumps.
- C. Engage a factory-authorized service representative to perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.

#### 4.2 CONNECTIONS

- A. Comply with requirements for piping specified in Section 22 11 16 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect domestic-water piping to booster pumps. Install suction and discharge pipe equal to or greater than size of system suction and discharge headers or piping.
  - 1. Install shutoff valves on piping connections to booster-pump suction and discharge headers or piping. Install ball, butterfly, or gate valves same size as suction and discharge headers or piping. Comply with requirements for general-duty valves specified in Section 22 05 23.
  - 2. Install union, flanged, or grooved-joint connections on suction and discharge headers or piping at connection to domestic-water piping. Comply with requirements for unions and flanges specified in Section 22 11 16 "Domestic Water Piping."
  - 3. Install flexible connectors, same size as piping, on piping connections to booster-pump suction and discharge headers or piping. Comply with requirements for flexible connectors specified in Section 22 11 16 "Domestic Water Piping."
  - 4. Install piping adjacent to booster pumps to allow service and maintenance.

#### 4.3 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

#### 4.4 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. Tests and Inspections:
  - 1. Perform visual and mechanical inspection.
  - 2. Leak Test: After installation, charge booster pump and test for leaks. Repair leaks and retest until no leaks exist.
  - 3. Operational Test: After electrical circuitry has been energized, start booster pumps to confirm proper motor rotation and booster-pump operation.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Pumps and controls will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

#### 4.5 ADJUSTING

A. Adjust booster pumps to function smoothly and lubricate as recommended by manufacturer.

B. Adjust pressure set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting booster pump to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

#### 4.6 DEMONSTRATION

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

**END OF SECTION**



## SECTION 22 13 16

### PART 1 -

### SANITARY WASTE AND VENT PIPING

#### PART 2 - GENERAL

#### 2.1 SUMMARY

##### A. Section Includes:

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

##### ~~B. Related Section:~~

- ~~1. Section 221313 "Facility Sanitary Sewers" for sanitary sewerage piping and structures outside the building.~~

#### 2.2 ACTION SUBMITTALS

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

##### 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."

#### 2.3 INFORMATIONAL SUBMITTALS

##### ~~A. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.~~

- ~~1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.~~
- ~~2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.~~

##### B.A. Field quality-control reports.

## 2.4 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- ~~B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.~~

## PART 3 - PRODUCTS

### 3.1 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.

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

- A. Pipe and Fittings: ASTM A 74, Service class.
- B. Gaskets: ASTM C 564, rubber.

### 3.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. CISPI, Hubless-Piping Couplings:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. ANACO-Husky.
    - b. Charlotte Pipe and Foundry Company.
    - c. Dallas Specialty & Mfg. Co.
    - d. Fernco Inc.
    - e. Ideal Clamp Products, Inc.
    - f. Josam Company.
    - g. Matco-Norca.
    - h. MIFAB, Inc.
  - 2. Standards: ASTM C 1277 and CISPI 310.
  - 3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
- C. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ANACO-Husky.
  - b. Charlotte Pipe and Foundry Company.
  - c. Clamp-All Corp.
  - d. Dallas Specialty & Mfg. Co.
  - e. Ideal Clamp Products, Inc.
  - f. MIFAB, Inc.
  - g. Mission Rubber Company, LLC; a division of MCP Industries.
2. Standards: ASTM C 1277 and ASTM C 1540.
3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

~~3.4 — COPPER TUBE AND FITTINGS FOR PUMP DISCHARGE PIPING~~

~~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. — Copper Flanges: ASME B16.24, Class 150, cast copper with solder joint end.~~

~~1. — Flange Gasket Materials: ASME B16.21, full face, flat, nonmetallic, asbestos-free, 1/8 inch maximum thickness unless thickness or specific material is indicated.~~

~~2. — Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.~~

~~D. — Solder: ASTM B 32, lead free with ASTM B 813, water flushable flux.~~

~~3.5 — ABS PIPE AND FITTINGS — if approved by the local authority having jurisdiction (AHJ) and/or Owner. ABS PIPING SHALL NOT BE USED IN PLENUM SPACES.~~

~~A. — Solid Wall ABS Pipe: ASTM D 2661, Schedule 40.~~

~~B. — Cellular Core ABS Pipe: ASTM F 628, Schedule 40.~~

~~C. — ABS Socket Fittings: ASTM D 2661, made to ASTM D 3311, drain, waste, and vent patterns.~~

~~D. — Solvent Cement: ASTM D 2235.~~

~~1. — ABS solvent cement shall have a VOC content of 325 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).~~

~~2. — Solvent cement shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small Scale Environmental Chambers."~~

~~3.6 STEEL PIPE AND FITTINGS FOR PUMP DISCAHRGE PIPING~~

- ~~A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.~~
- ~~B. Malleable Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in "Piping Applications" Article.~~
- ~~C. Malleable Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Applications" Article.~~
- ~~D. Wrought Cast and Forged Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
  - ~~1. Material Group: 1.1.~~
  - ~~2. End Connections: Butt welding.~~
  - ~~3. Facings: Raised face.~~~~
- ~~E. Grooved Mechanical Joint Fittings and Couplings:
  - ~~1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - ~~a. Anvil International.~~
    - ~~b. Central Sprinkler Company.~~
    - ~~c. Grinnell G Fire by Johnson Controls Company.~~
    - ~~d. National Fittings, Inc.~~
    - ~~e. Nexus Valve, Inc.~~
    - ~~f. S. P. Fittings.~~
    - ~~g. Smith Cooper International.~~
    - ~~h. Star Pipe Products.~~
    - ~~i. Victaulic Company.~~~~
  - ~~2. Joint Fittings: ASTM A 536, Grade 65 45 12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106/A 106M, Grade B steel fittings with grooves or shoulders constructed to accept grooved end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.~~
  - ~~3. Couplings: Ductile or malleable iron housing and EPDM or nitrile gasket of central cavity pressure responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.~~~~

~~3.7 PVC PIPE AND FITTINGS— if approved by the local authority having jurisdiction (AHJ) and/or Owner. PVC PIPING SHALL NOT BE USED IN PLENUM SPACES.~~

- ~~A. Solid Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.~~
- ~~B. Cellular Core PVC Pipe: ASTM F 891, Schedule 40.~~

~~C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.~~

~~D. Adhesive Primer: ASTM F 656.~~

- ~~1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).~~
- ~~2. Adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small Scale Environmental Chambers."~~

~~E. Solvent Cement: ASTM D 2564.~~

- ~~1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).~~
- ~~2. Solvent cement shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small Scale Environmental Chambers."~~

#### 3.83.4 SPECIALTY PIPE FITTINGS

##### A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Unshielded, Non-pressure Transition Couplings:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1) Dallas Specialty & Mfg. Co.
- 2) Fernco Inc.
- 3) Froet Industries LLC.
- 4) Mission Rubber Company, LLC; a division of MCP Industries.

b. Standard: ASTM C 1173.

c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

d. Sleeve Materials:

- 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
- ~~2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.~~
- ~~3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.~~

4. Shielded, Non-pressure Transition Couplings:
  - a. Standard: ASTM C 1460.
  - b. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

## **PART 4 - EXECUTION**

### 4.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 31 20 00 "Earth Moving."

### 4.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping at indicated slopes.
- F. Install piping free of sags and bends.
- G. Install fittings for changes in direction and branch connections.

~~H. Install seismic restraints on piping. Comply with requirements for seismic restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."~~

I.H. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back-to-back or side by side with common drainpipe. 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.

J.I. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

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

1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Sanitary Drainage Piping: 1 percent downward in direction of flow for piping NPS 3 or larger.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

L.K. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

~~M.~~—Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

~~N.~~—Install aboveground ABS piping according to ASTM D 2661.

~~O.~~—Install aboveground PVC piping according to ASTM D 2665.

~~P.~~—Install underground ABS and PVC piping according to ASTM D 2321.

Q.L. Plumbing Specialties:

1. Install backwater valves in sanitary waste gravity-flow piping. Comply with requirements for backwater valves specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Comply with requirements for cleanouts specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
3. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Section 22 13 19 "Sanitary Waste Piping Specialties."

R.M. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

S.N. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

T.O. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

- ~~U.P.~~ Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

#### 4.3 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 less, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hub less-piping coupling joints.

~~C. 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.~~

~~D.C.~~ Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

~~E. Plastic, Non-pressure Piping, Solvent Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:~~

- ~~1. Comply with ASTM F 402 for safe handling practice of cleaners, primers, and solvent cements.~~
- ~~2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.~~
- ~~3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.~~

#### 4.4 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
1. Install transition couplings at joints of piping with small differences in OD's.
  2. In Drainage Piping: Unshielded or Shielded, non-pressure transition couplings.

#### 4.5 VALVE INSTALLATION

- A. Backwater Valves: Install backwater valves in piping subject to backflow.
1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
  2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
  3. Install backwater valves in accessible locations.
  4. Comply with requirements for backwater valve specified in Section 22 13 19 "Sanitary Waste Piping Specialties."



#### 4.6 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger and support devices and installation specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."
  - 1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
  - 2. Install ~~stainless-steel~~ or fiberglass pipe hangers for horizontal piping in corrosive environments.
  - 3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
  - 4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
  - 5. Vertical Piping: MSS Type 8 or Type 42, clamps.
  - 6. Install individual, straight, horizontal piping runs:
    - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
  - 7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
  - 8. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support horizontal piping and tubing within 12 inches of each fitting, 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 minimum rods.
- F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
  - 2. NPS 3: 60 inches with 1/2-inch rod.
  - 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
  - 4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
  - 5. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- G. Install supports for vertical cast-iron soil piping every 15 feet.
- H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 1-1/4: 72 inches with 3/8-inch rod.

2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
3. NPS 2-1/2: 108 inches with 1/2-inch rod.
4. NPS 3 and NPS 5: 10 feet with 1/2-inch rod.
5. NPS 6: 10 feet with 5/8-inch rod.
6. NPS 8: 10 feet with 3/4-inch rod.

I. Install supports for vertical copper tubing every 10 feet.

~~J. Install hangers for ABS and PVC piping with the following maximum horizontal spacing and minimum rod diameters:~~

- ~~1. NPS 1 1/2 and NPS 2: 48 inches with 3/8 inch rod.~~
- ~~2. NPS 3: 48 inches with 1/2 inch rod.~~
- ~~3. NPS 4 and NPS 5: 48 inches with 5/8 inch rod.~~
- ~~4. NPS 6 and NPS 8: 48 inches with 3/4 inch rod.~~

~~K. Install supports for vertical ABS and PVC piping every 48 inches.~~

~~L.J.~~ Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

#### 4.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect drainage and vent piping to the following:
  1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
  2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
  3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
  4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
  5. Install horizontal backwater valves with cleanout cover flush with floor or in pit with pit cover flush with floor.
  6. Comply with requirements for backwater valves, cleanouts and drains specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
  7. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- E. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

#### 4.8 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

#### 4.9 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
  1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
  2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
  1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
  2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
  3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
  4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

#### 4.10 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.
- ~~D. Exposed ABS and PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water based latex paint.~~

#### 4.11 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste piping NPS 4 and smaller shall be any of the following:
  1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
  2. Hubless, cast-iron soil pipe and fittings; CISPI or heavy-duty hubless-piping couplings; and coupled joints.
  - ~~3. Copper DWV tube, copper drainage fittings, and soldered joints.~~
  - ~~4. Solid wall or Cellular core ABS pipe, ABS socket fittings, and solvent-cemented joints.~~
  - ~~5. Solid wall Cellular core PVC pipe, PVC socket fittings, and solvent-cemented joints.~~
  - ~~6. Dissimilar Pipe Material Couplings: Unshielded or Shielded, non-pressure transition couplings.~~
- C. Aboveground, soil and waste piping NPS 5 and larger shall be any of the following:
  1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
  2. Hubless, cast-iron soil pipe and fittings; CISPI or heavy-duty hubless-piping couplings; and coupled joints.
  - ~~3. Solid wall or Cellular core PVC pipe, PVC socket fittings, and solvent-cemented joints.~~
  - ~~4. Dissimilar Pipe Material Couplings: Unshielded or Shielded, non-pressure transition couplings.~~
- D. Aboveground, vent piping NPS 4 and smaller shall be any of the following:
  1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
  2. Hubless, cast-iron soil pipe and fittings; CISPI or heavy-duty hubless-piping couplings; and coupled joints.
  - ~~3. Copper DWV tube, copper drainage fittings, and soldered joints.~~

- ~~4. Solid wall or Cellular core ABS pipe, ABS socket fittings, and solvent-cemented joints.~~
- ~~5. Solid wall Cellular core PVC pipe, PVC socket fittings, and solvent-cemented joints.~~
- ~~6. Dissimilar Pipe Material Couplings: Unshielded or Shielded, non-pressure transition couplings.~~

E. Aboveground, vent piping NPS 5 and larger shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI or heavy-duty hubless-piping couplings; and coupled joints.
- ~~3. Solid wall Cellular core PVC pipe, PVC socket fittings, and solvent-cemented joints.~~
- ~~4. Dissimilar Pipe Material Couplings: Unshielded or Shielded, non-pressure transition couplings.~~

F. Underground, soil, waste, and vent piping NPS 4 and smaller shall be any of the following:

1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI, heavy-duty or cast-iron hubless-piping couplings; and coupled joints.
- ~~3. Solid wall Cellular core ABS pipe, ABS socket fittings, and solvent-cemented joints.~~
- ~~4. Solid wall Cellular core PVC pipe, PVC socket fittings, and solvent-cemented joints.~~
- ~~5. Dissimilar Pipe Material Couplings: Unshielded or Shielded, non-pressure transition couplings.~~

G. Underground, soil and waste piping NPS 5 and larger shall be any of the following:

1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI, heavy-duty or cast-iron hubless-piping couplings; coupled joints.
- ~~3. Solid wall or Cellular core PVC pipe; PVC socket fittings; and solvent-cemented joints.~~
- ~~4. Dissimilar Pipe Material Couplings: Unshielded or Shielded, non-pressure transition couplings.~~

**END OF SECTION**

## **SECTION 22 13 19**

### PART 1 -

## **SANITARY WASTE PIPING SPECIALTIES**

### **PART 2 - GENERAL**

#### 2.1 SUMMARY

##### A. Section Includes:

1. Backwater valves.
2. Cleanouts.
3. Floor drains.
4. Roof flashing assemblies.
5. Miscellaneous sanitary drainage piping specialties.
6. Flashing materials.

#### 2.2 ACTION SUBMITTALS

- ##### A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for grease interceptors.

#### 2.3 QUALITY ASSURANCE

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

### **PART 3 - PRODUCTS**

#### 3.1 BACKWATER VALVES

##### A. Horizontal, Cast-Iron Backwater Valves Insert drawing designation if any:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Jay R. Smith Mfg Co; a division of Morris Group International.
  - b. Josam Company.
  - c. MIFAB, Inc.
  - d. WATTS.
2. Standard: ASME A112.14.1.

3. Size: Same as connected piping.
4. Body: Cast iron.
5. Cover: Cast iron with bolted or threaded access check valve.
6. End Connections: Hub and spigot or hubless.
7. Type Check Valve: Removable, bronze, swing check, factory assembled, or field modified to hang closed or open for airflow unless subject to backflow condition.
8. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

B. Drain-Outlet Backwater Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Jay R. Smith Mfg Co; a division of Morris Group International.
  - b. Josam Company.
  - c. WATTS.
2. Size: Same as floor drain outlet.
3. Body: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.
4. Check Valve: Removable ball float.
5. Inlet: Threaded.
6. Outlet: Threaded or spigot.

3.2 CLEANOUTS

A. Exposed Cast-Iron Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Jay R. Smith Mfg Co; a division of Morris Group International.
  - b. Josam Company.
  - c. MIFAB, Inc.
  - d. Tyler Pipe; a subsidiary of McWane Inc.
  - e. WATTS.
2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
3. Size: Same as connected drainage piping
4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch or Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk, Countersunk or raised-head, Raised-head, brass or cast-iron plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Cast-Iron Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Jay R. Smith Mfg Co; a division of Morris Group International.
  - b. Josam Company.
  - c. Sioux Chief Manufacturing Company, Inc.
  - d. WATTS.
2. Standard: ASME A112.36.2M for adjustable housing, cast-iron soil pipe with cast-iron ferrule, heavy-duty, adjustable housing or threaded, adjustable housing cleanout.
  3. Size: Same as connected branch.
  4. Type: Adjustable housing, Cast-iron soil pipe with cast-iron ferrule, Heavy-duty, adjustable housing or Threaded, adjustable housing.
  5. Body or Ferrule: Cast iron.
  6. Clamping Device: Required.
  7. Outlet Connection: Inside calk, Spigot or Threaded.
  8. Closure: Brass plug with straight threads and gasket, Brass plug with tapered threads or Cast-iron plug.
  9. Adjustable Housing Material: Cast iron with threads, set-screws or other device.
  10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy, Painted cast iron Polished bronze or Rough bronze.
  11. Frame and Cover Shape: Round or Square.
  12. Top Loading Classification: Heavy Duty.
  13. Riser: ASTM A 74, Extra-Heavy Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Jay R. Smith Mfg Co; a division of Morris Group International.
  - b. Josam Company.
  - c. MIFAB, Inc.
  - d. WATTS.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hub-and-spigot, cast-iron soil pipe T-branch or Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, drilled-and-threaded brass or cast-iron plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, deep, chrome-plated bronze or flat, chrome-plated brass or stainless-steel cover plate with screw.
8. Wall Access: Round, Square or nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

3.3 FLOOR DRAINS

A. Cast-Iron Floor Drains:



1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Commercial Enameling Company.
  - b. Jay R. Smith Mfg Co; a division of Morris Group International.
  - c. Josam Company.
  - d. MIFAB, Inc.
  - e. Prier Products, Inc.
  - f. Sioux Chief Manufacturing Company, Inc.
  - g. WATTS.
2. Standard: ASME A112.6.3 with backwater valve.
3. Pattern: Area, Floor, Funnel floor or Sanitary drain.
4. Body Material: Gray iron.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Clamping Device: Required.
8. Outlet: Bottom.
9. Backwater Valve: Not required.
10. Coating on Interior and Exposed Exterior Surfaces: Acid-resistant enamel.
11. Sediment Bucket: required. Refer to schedule
12. Top or Strainer Material: Bronze, Gray iron or Nickel bronze.
13. Top of Body and Strainer Finish: Nickel bronze, Polished bronze or Rough bronze.
14. Top Shape: Round or Square.
15. Funnel: Required. Refer to schedule to plans and schedule.
16. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
17. Trap Material: Bronze or Cast iron.
18. Trap Pattern: Deep-seal P-trap or Standard P-trap.
19. Trap Features: Trap-seal primer valve drain connection.

### 3.4 ROOF FLASHING ASSEMBLIES

#### A. Roof Flashing Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Acorn Engineering Company; a Division of Morris Group International.
  - b. Thaler Metal Industries Ltd.
2. Description: Manufactured assembly made of 6.0-lb/sq. ft., 0.0938-inch-thick, lead flashing collar and skirt extending at least 8 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.
  - a. Open-Top Vent Cap: Without cap.
  - b. Low-Silhouette Vent Cap: With vandal-proof vent cap.
  - c. Extended Vent Cap: With field-installed, vandal-proof vent cap.

### 3.5 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

#### A. Open Drains:

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
2. Size: Same as connected waste piping with increaser fitting of size indicated.

#### B. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.
  - a. NPS 2: 4-inch-minimum water seal.
  - b. NPS 2-1/2 and Larger: 5-inch-minimum water seal.

#### C. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

#### D. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

#### E. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

#### F. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

#### G. Vent Caps:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

### 3.6 FLASHING MATERIALS

- A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:
  1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
  2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
  3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.
- B. Fasteners: Metal compatible with material and substrate being fastened.
- C. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- D. Solder: ASTM B 32, lead-free alloy.
- E. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

## **PART 4 - EXECUTION**

### 4.1 INSTALLATION

- A. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.
- B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
  1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
  2. Locate at each change in direction of piping greater than 45 degrees.
  3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
  4. Locate at base of each vertical soil and waste stack.
- C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.
  2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
    - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
    - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
    - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
  3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
  4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- F. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- G. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
- H. Assemble open drain fittings and install with top of hub 2 inches above floor.
- I. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- J. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
  1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
  2. Size: Same as floor drain inlet.
- K. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- L. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- M. Install vent caps on each vent pipe passing through roof.
- N. Install grease interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.
  1. Above-Floor Installation: Set unit with bottom resting on floor, unless otherwise indicated.
  2. Flush with Floor Installation: Set unit and extension, if required, with cover flush with finished floor.
  3. Recessed Floor Installation: Set unit in receiver housing having bottom or cradle supports, with receiver housing cover flush with finished floor.
  4. Install cleanout immediately downstream from interceptors not having integral cleanout on outlet.

- O. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

#### 4.2 CONNECTIONS

- A. Comply with requirements in Section 22 13 16 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Grease Interceptors: Connect inlet and outlet to unit and connect flow-control fitting and vent to unit inlet piping. Install valve on outlet of automatic draw off-type unit.

#### 4.3 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
  - 1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
  - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
  - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
  - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Section 07 62 00 "Sheet Metal Flashing and Trim."
- F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

#### 4.4 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each grease interceptor.

- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

#### 4.5 PROTECTION

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

**END OF SECTION**

## **SECTION 22 13 323**

### **PART 1 -**

## **SANITARY WASTE INTERCEPTORS**

### **PART 2 - GENERAL**

#### **2.1 SUMMARY**

- A. Section Includes:
  - 1. Grease interceptors.

#### **2.2 ACTION SUBMITTALS**

- A. Product Data: For each type of metal and plastic interceptor.
- B. Shop Drawings: For each type and size of precast-concrete interceptor indicated.
  - 1. Include materials of construction, dimensions, rated capacities, retention capacities, location and size of each pipe connection, furnished specialties, and accessories.

#### **2.3 INFORMATIONAL SUBMITTALS**

- A. Coordination Drawings: Interceptors, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Piping connections. Include size, location, and elevation of each.
  - 2. Interface with underground structures and utility services.

#### **2.4 CLOSEOUT SUBMITTALS**

- A. Operation and maintenance data.

#### **2.5 FIELD CONDITIONS**

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

1. Notify Construction Manager or Owner no fewer than seven days in advance of proposed interruption of service.
2. Do not proceed with interruption of sewer services without Construction Manager's or Owner's written permission.

### **PART 3 - PRODUCTS**

#### 3.1 GREASE INTERCEPTORS

~~A. Precast Concrete Grease Interceptors: Comply with ASTM C913 and local authorities having jurisdiction.~~

- ~~1. Include rubber gasketed joints, vent connections, manholes, compartments or baffles, and piping or openings to retain grease and to permit wastewater flow.~~
  - ~~2. Structural Design Loads:
    - a. Heavy Traffic Load: Comply with ASTM C890, A-16.~~
- ~~3. Resilient Pipe Connectors: ASTM C923, cast or fitted into interceptor walls, for each pipe connection.~~
- ~~4. Steps: Individual FRP steps, FRP ladder, or ASTM A615/A615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D4101, PP or ASTM A615/A615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D4101, PP, wide enough to allow worker to place both feet on one step and 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 interceptor to finished grade is less than 60 inches.~~
- ~~5. Grade Rings: Reinforced concrete rings, 6 to 9-inch total thickness, to match diameter of manhole frame and cover.~~
- ~~6. Manhole Frames and Covers: Ferrous; 24-inch ID by 7 to 9-inch riser with 4-inch minimum width flange and 26-inch diameter cover.
  - a. Ductile Iron: ASTM A536, Grade 60-40-18, unless otherwise indicated.
  - b. Gray Iron: ASTM A48/A48M, Class 35, unless otherwise indicated.
  - c. Include indented top design with lettering cast into cover, using wording equivalent to "GREASE INTERCEPTOR."~~
- ~~7. Capacities and Characteristics: Refer to plan and schedule.~~

B.A. Point-of-Use Plastic Grease Interceptors with Stainless Steel Exterior:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or 'EQUAL':
  - a. Big Dipper.
  - b. Highland Tank.
2. Standard: PDI G101 and ASME A112.14.3, for intercepting and retaining FOG from food-preparation or -processing wastewater.
3. PDI Seal: Required.
4. Body Material: Plastic.
5. Body Dimensions: Refer to schedule on the plan.
6. Body Extension: Not required.



7. Capacities and Characteristics: Refer to schedule on the plan.
  - a. End Connections: Flanged, Hub or Threaded.
  - b. Cleanout: Integral or field installed on outlet.
  - c. Trapped Outlet Required: No.
  - d. Mounting: Above floor.
  - e. Flow-Control Fitting: Required.
  - f. Operation: Automatic recovery - - Fully automatic self-cleaning cycle. Actively removes collected grease & oil from tank without any operator assistance.

## PART 4 - EXECUTION

### ~~4.1 EARTHWORK~~

- ~~A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."~~

### 4.24.1 INSTALLATION

- A. Equipment Mounting:
- ~~1. Install grease interceptors on cast in place concrete equipment base(s).~~
  - ~~2. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast in Place Concrete."~~
- B. Install precast concrete interceptors according to ASTM C891.
- C. Set interceptors level and plumb.
- D. Set tops of grating frames and grates flush with finished surface.
- E. Set metal and plastic interceptors' level and plumb.
- F. Set tops of metal interceptor covers flush with finished surface in pavements.
1. Set tops 3 inches above finish surface elsewhere unless otherwise indicated.
- G. Install grease interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.
1. Above-Floor Installation: Set unit with bottom resting on floor unless otherwise indicated.
  - ~~2. Flush with Floor Installation: Set unit and extension, if required, with cover flush with finished floor.~~
  - 3-2. Install cleanout immediately downstream from interceptors not having integral cleanout on outlet.
- H. Install grease-removal devices on floor. Install trap, vent, and flow-control fitting according to authorities having jurisdiction.

1. Install control panel adjacent to unit unless otherwise indicated.
2. Install trap on interceptors that do not have integral trap and are connected to sanitary drainage and vent systems.

#### 4.34.2 PIPING CONNECTIONS

- A. Piping installation requirements are specified in Section 22 13 16 "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Make piping connections between interceptors and piping systems.

#### 4.44.3 IDENTIFICATION

- A. Identification materials and installation are specified in Section 31 20 00 "Earth Moving."
  1. Arrange for installation of green warning tapes directly over piping and at outside edges of underground interceptors.
  2. Use warning tapes or detectable warning tape over ferrous piping.
  3. Use detectable warning tape over nonferrous piping and over edges of underground structures.
- B. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
  1. Grease interceptors.

#### 4.54.4 PROTECTION

- A. Protect sanitary waste interceptors from damage during construction period.
- B. Repair damage to adjacent materials caused by sanitary waste interceptor installation.

**END OF SECTION**

## **SECTION 22 14 13**

### **PART 1 -**

### **FACILITY STORM DRAINAGE PIPING**

#### **PART 2 - GENERAL**

#### 2.1 SUMMARY

##### A. Section Includes:

1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless, cast-iron soil pipe and fittings.
- ~~3. PVC pipe and fittings.~~
- 4.3. Specialty pipe and fittings.

##### B. Related Requirements:

1. Section 33 44 00 "Stormwater Utility Equipment" for storm drainage piping outside the building.

#### 2.2 ACTION SUBMITTALS

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

##### B. Shop Drawings: For siphonic roof drainage system. Include calculations, plans, and details.

#### 2.3 INFORMATIONAL SUBMITTALS

##### A. Coordination Drawings: Detail storm drainage piping. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, and coordinated with each other, using input from installers of the items involved.

##### B. Field quality-control reports.

#### 2.4 QUALITY ASSURANCE

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

### PART 3 - PRODUCTS

#### 3.1 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
1. Storm Drainage Piping: 10-foot head of water.

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

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AB & I Foundry; a part of the McWane family of companies.
  2. Charlotte Pipe and Foundry Company.
  3. Tyler Pipe; a part of McWane family of companies.
- B. Pipe and Fittings:
1. Marked with CISPI collective trademark and NSF certification mark.
  2. Class: ASTM A 74, Service class.
- C. Gaskets: ASTM C 564, rubber.

#### 3.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AB & I Foundry; a part of the McWane family of companies.
  2. Charlotte Pipe and Foundry Company.
  3. Tyler Pipe; a part of McWane family of companies.
- B. Pipe and Fittings:
1. Marked with CISPI collective trademark and NSF certification mark.
  2. Standard: ASTM A 888 or CISPI 301.

~~C. CISPI, Hubless Piping Couplings:~~

- ~~1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:~~

- ~~a. ANACO Husky.~~
- ~~b. Charlotte Pipe and Foundry Company.~~
- ~~c. Dallas Specialty & Mfg. Co.~~
- ~~d. Feroco Inc.~~
- ~~e. Ideal Clamp Products, Inc.~~
- ~~f. Matco Norca.~~

- ~~g. MIFAB, Inc.~~
- ~~h. Mission Rubber Company, LLC; a division of MCP Industries.~~
- ~~i. NewAge Casting.~~
- ~~j. Tyler Pipe; a subsidiary of McWane Inc.~~
- ~~2. Couplings shall bear CISPI collective trademark and NSF certification mark.~~
- ~~3. Standards: ASTM C 1277 and CISPI 310.~~
- ~~4. Description: Stainless steel corrugated shield with stainless steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.~~

D.C. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ANACO-Husky.
  - b. Charlotte Pipe and Foundry Company.
  - c. Clamp-All Corp.
  - d. Dallas Specialty & Mfg. Co.
  - e. Ideal Clamp Products, Inc.
  - f. MIFAB, Inc.
  - g. Mission Rubber Company, LLC; a division of MCP Industries.
  - h. NewAge Casting.
  - i. Tyler Pipe; a subsidiary of McWane Inc.
2. Standard: ASTM C 1540.
3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

E.D. Cast-Iron, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or 'Equal':
  - a. Charlotte Pipe and Foundry Company.
  - b. MG Piping Products Company.
2. Standard: ASTM C 1277.
3. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

~~3.4 PVC PIPE AND FITTINGS—if approved by the local authority having jurisdiction (AHJ) and/or Owner. PVC PIPING SHALL NOT BE USED IN PLENUM SPACES.~~

~~A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:~~

- ~~1. Charlotte Pipe and Foundry Company.~~
- ~~2. GF Piping Systems.~~
- ~~3. JM Eagle; J-M Manufacturing Co., Inc.~~
- ~~4. Mueller Industries, Inc.~~
- ~~5. National Pipe and Plastic, Inc.~~
- ~~6. North America Pipe Corporation.~~

- ~~7. Rocky Mountain Colby Pipe Company.~~
- ~~8. Silver line Plastics.~~

~~B. NSF Marking: Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF drain" for plastic storm drain and "NSF sewer" for plastic storm sewer piping.~~

~~C. Solid Wall PVC Pipe: ASTM D 2665; drain, waste, and vent.~~

~~D. Cellular Core PVC Pipe: ASTM F 891, Schedule 40.~~

~~E. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.~~

~~F. Adhesive Primer: ASTM F 656.~~

~~G. Solvent Cement: ASTM D 2564.~~

### ~~3.5 SPECIALTY PIPE FITTINGS~~

#### ~~A.E. Transition Couplings:~~

1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.
3. Unshielded, Nonpressure Transition Couplings:
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) Dallas Specialty & Mfg. Co.
    - 2) Fernco Inc.
    - 3) Mission Rubber Company, LLC; a division of MCP Industries.
    - 4) Plastic Oddities.
  - b. Standard: ASTM C 1173.
  - c. Description: Elastomeric sleeve, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
  - d. Sleeve Materials:
    - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
    - ~~2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.~~
    - ~~3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.~~
4. Shielded, Non-pressure Transition Couplings:

- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following or "Equal":
  - 1) Cascade Waterworks Mfg. Co.
  - 2) Mission Rubber Company, LLC; a division of MCP Industries.
- b. Standard: ASTM C 1460.
- c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
- d. End Connections: Same size as and compatible with pipes to be joined.

#### **PART 4 - EXECUTION**

##### 4.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 31 20 00 "Earth Moving."

##### 4.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
  1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
  2. Install piping as indicated unless deviations from 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. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- K. Make changes in direction for piping using appropriate branches, bends, and long-sweep bends.
  - 1. Do not change direction of flow more than 90 degrees.
  - 2. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
    - a. Reducing size of drainage piping in direction of flow is prohibited.
- L. Lay buried building piping beginning at low point of each system.
  - 1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
  - 2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
  - 3. Maintain swab in piping and pull past each joint as completed.
- M. Install piping at the following minimum slopes unless otherwise indicated:
  - 1. Building Storm Drain: ~~{1}~~ Insert number percent downward in direction of flow for piping NPS 3 and smaller; 2 percent downward in direction of flow for piping NPS 4 and larger.
  - 2. Horizontal Storm Drainage Piping: 1 percent downward in direction of flow.
- N. 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."

~~O. — Install aboveground ABS piping according to ASTM D 2661.~~

~~P. — Install aboveground PVC piping according to ASTM D 2665.~~

~~Q. — Install underground PVC piping according to ASTM D 2321.~~

R.O. Plumbing Specialties:

- 1. Install backwater valves in storm drainage gravity-flow piping.
  - a. Comply with requirements for backwater valves specified in Section 22 14 23 "Storm Drainage Piping Specialties."
- 2. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping.
  - a. Comply with requirements for cleanouts specified in Section 22 14 23 "Storm Drainage Piping Specialties."
- 3. Install drains in storm drainage gravity-flow piping.



- a. Comply with requirements for drains specified in Section 22 14 23 "Storm Drainage Piping Specialties."

~~S.P.~~ Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

~~F.Q.~~ Install sleeves for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

~~U.R.~~ Install sleeve seals for piping penetrations of concrete walls and slabs.

1. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

~~V.S.~~ Install escutcheons for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

#### 4.3 JOINT CONSTRUCTION

A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Hubless, Cast-Iron Soil Piping Coupled Joints:

1. Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

~~C. PVC, Nonpressure Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:~~

- ~~1. Comply with ASTM F 402 for safe handling practice of cleaners, primers, and solvent cements.~~
- ~~2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 appendices.~~

~~D.C.~~ Joint Restraints and Sway Bracing:

1. Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:
  - a. Provide axial restraint for pipe and fittings 5 inches and larger, upstream and downstream of all changes in direction, branches, and changes in diameter greater than two pipe sizes.
  - b. Provide rigid sway bracing for pipe and fittings 4 inches and larger, upstream and downstream of all changes in direction 45 degrees and greater.
  - c. Provide rigid sway bracing for pipe and fittings 5 inches and larger, upstream and downstream of all changes in direction and branch openings.

#### 4.4 SPECIALTY PIPE FITTING INSTALLATION

##### A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Drainage Piping: Unshielded or Shielded, non-pressure transition couplings.

#### 4.5 INSTALLATION OF HANGERS AND SUPPORTS

##### A. Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

##### B. Comply with requirements for hangers, supports, and anchor devices specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless-steel or fiberglass pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Install individual, straight, horizontal piping runs:
  - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
  - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
  - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52, spring hangers.

##### C. Install hangers for cast-iron soil piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

~~D. Install hangers for PVC piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.~~

~~E.D.~~ Support horizontal piping and tubing within 12 inches of each fitting and coupling.

~~F.E.~~ Support vertical cast-iron soil piping with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent, but as a minimum at base and at each floor.

~~G. Support vertical PVC piping with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.~~

#### 4.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect storm drainage piping to roof drains and storm drainage specialties.
  - 1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
  - 2. Comply with requirements for cleanouts and drains specified in Section 22 14 23 "Storm Drainage Piping Specialties."
- D. Where installing piping adjacent to equipment, allow space for service and maintenance.
- E. Make connections according to the following unless otherwise indicated:
  - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
  - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

#### 4.7 IDENTIFICATION

- A. Identify exposed storm drainage piping.
- B. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

#### 4.8 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
  - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
  - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Test storm drainage 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.
    - a. 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 storm drainage piping until it has been tested and approved.
    - a. Expose work that was covered or concealed before it was tested.
  3. Test Procedure:
    - a. Test storm drainage piping, except outside leaders, on completion of roughing-in.
    - b. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
  4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
  5. Prepare reports for tests and required corrective action.
- C. Piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

#### 4.9 CLEANING AND PROTECTION

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

#### 4.10 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground storm drainage piping NPS 6 and smaller shall be any of the following:
  1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
  2. Hubless, cast-iron soil pipe and fittings; CISPI, heavy-duty, hubless-piping couplings; and coupled joints.
  - ~~3. Solid wall or Cellular core PVC pipe, PVC socket fittings, and solvent-cemented joints.~~

~~4. Dissimilar Pipe Material Couplings: Unshielded or Shielded, nonpressure transition couplings.~~

C. Aboveground, storm drainage piping NPS 8 and larger shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI, heavy-duty, hubless-piping couplings; and coupled joints.
- ~~3. Solid wall or Cellular core PVC pipe, PVC socket fittings, and solvent cemented joints.~~
- ~~4. Dissimilar Pipe Material Couplings: Unshielded or Shielded, nonpressure transition couplings.~~

D. Underground storm drainage piping NPS 6 and smaller shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI, heavy-duty, cast-iron, hubless-piping couplings; and coupled joints.
- ~~3. Solid wall or Cellular core PVC pipe, PVC socket fittings, and solvent cemented joints.~~
- ~~4. Dissimilar Pipe Material Couplings: Unshielded or Shielded, nonpressure transition couplings.~~

E. Underground, storm drainage piping NPS 8 and larger shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI, heavy-duty, cast-iron, hubless-piping couplings; and coupled joints.
- ~~3. Solid wall or Cellular core PVC pipe, PVC socket fittings, and solvent cemented joints.~~
- ~~4. Cellular core, sewer and drain series, PVC pipe; PVC socket fittings; and solvent cemented joints.~~
- ~~5. Dissimilar Pipe Material Couplings: Unshielded or Shielded, non-pressure transition couplings.~~

**END OF SECTION**

## **SECTION 22 14 23**

### PART 1 -

## **STORM DRAINAGE PIPING SPECIALTIES**

### **PART 2 - GENERAL**

#### 2.1 SUMMARY

##### A. Section Includes:

1. Roof drains.
2. Miscellaneous storm drainage piping specialties.
3. Cleanouts.
4. Backwater valves.
5. Flashing materials.

#### 2.2 ACTION SUBMITTALS

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

#### 2.3 QUALITY ASSURANCE

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

### **PART 3 - PRODUCTS**

#### 3.1 METAL ROOF DRAINS

##### A. Cast-Iron, Large-Sump, General-Purpose Roof Drains:

1. Standard: ASME A112.6.4, for general-purpose roof drains.
2. Body Material: Cast iron.
3. Dimension of Body: Nominal 15-inch diameter.
4. Combination Flashing Ring and Gravel Stop: Required.
5. Flow-Control Weirs: Not required.
6. Outlet: Bottom.
7. Extension Collars: Required for overflow drains.
8. Underdeck Clamp: Required.
9. Expansion Joint: Not required.
10. Sump Receiver Plate: Required.
11. Dome Material: Aluminum or Cast iron.

12. Perforated Gravel Guard: Stainless steel.
13. Vandal-Proof Dome: Not required.
14. Water Dam: 2 inches high.

B. Cast-Iron, Medium-Sump, General-Purpose Roof Drains:

1. Standard: ASME A112.6.4, for general-purpose roof drains.
2. Body Material: Cast iron.
3. Dimension of Body: 8- to 12-inch diameter.
4. Combination Flashing Ring and Gravel Stop: Required.
5. Flow-Control Weirs: Required.
6. Outlet: Bottom.
7. Extension Collars: Required.
8. Underdeck Clamp: Required.
9. Expansion Joint: Not required.
10. Sump Receiver Plate: Not required.
11. Dome Material: Aluminum, Cast iron or Stainless steel.
12. Wire Mesh: Stainless steel or brass over dome.
13. Perforated Gravel Guard: Stainless steel.
14. Vandal-Proof Dome: Not required.
15. Water Dam: 2 inches high.

C. Cast-Iron, Small-Sump, General-Purpose Roof Drains:

1. Standard: ASME A112.6.4, for general-purpose roof drains.
2. Body Material: Cast iron.
3. Dimension of Body: Nominal 3-8-inch diameter.
4. Combination Flashing Ring and Gravel Stop: Not required.
5. Outlet: Bottom.
6. Extension Collars: Required.
7. Underdeck Clamp: Required.
8. Expansion Joint: Not required.
9. Sump Receiver Plate: Required.
10. Dome Material: Cast iron.
11. Wire Mesh: Stainless steel or brass over dome.
12. Vandal-Proof Dome: Not required.

### 3.2 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Conductor Nozzles:

1. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes.
2. Size: Same as connected conductor.

### 3.3 CLEANOUTS

A. Floor Cleanouts:

1. Standard: ASME A112.36.2M, for adjustable housing, cast-iron soil pipe with cast-iron ferrule heavy-duty, adjustable housing or threaded, adjustable housing cleanouts.
2. Size: Same as connected branch.
3. Type: Adjustable housing, Cast-iron soil pipe with cast-iron ferrule or Threaded, adjustable housing.
4. Body or Ferrule Material: Cast iron.
5. Clamping Device: Required.
6. Outlet Connection: Inside calk, Spigot or Threaded.
7. Closure: Brass plug with straight threads and gasket, Brass plug with tapered threads or Cast-iron plug.
8. Adjustable Housing Material: Cast iron with threads set-screws or another device.
9. Frame and Cover Material and Finish: Nickel-bronze, copper alloy, Painted cast iron, Polished bronze or Rough bronze.
10. Frame and Cover Shape: Round.
11. Top-Loading Classification: Medium Duty.
12. Riser: ASTM A 74, Extra-Heavy Service class, cast-iron drainage pipe fitting and riser to cleanout.

B. Test Tees:

1. Standard: ASME A112.36.2M and ASTM A 74, ASTM A 888, or CISPI 301, for cleanout test tees.
2. Size: Same as connected drainage piping.
3. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or hubless, cast-iron soil-pipe test tee as required to match connected piping.
4. Closure Plug: Countersunk or raised head, brass.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

C. Wall Cleanouts:

1. Standard: ASME A112.36.2M, for cleanouts. Include wall access.
2. Size: Same as connected drainage piping.
3. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or Hubless, cast-iron soil-pipe test tee as required to match connected piping.
4. Closure: Countersunk, Countersunk or raised-head, Raised-head, drilled-and-threaded, brass or cast-iron plug.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
6. Wall Access: Round, deep, chrome-plated bronze, flat, chrome-plated brass or stainless-steel cover plate with screw.
7. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

3.4 FLASHING MATERIALS

- A. Copper Sheet: ASTM B 152/B 152M, 12 oz./sq. ft.



- B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.
- C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.
- D. Fasteners: Metal compatible with material and substrate being fastened.
- E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- F. Solder: ASTM B 32, lead-free alloy.

## **PART 4 - EXECUTION**

### 4.1 INSTALLATION

- A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.
  - 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. Install expansion joints, if indicated, in roof drain outlets.
  - 3. 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. Use NPS 4 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 for piping NPS 4 and smaller and 100 feet for larger piping.
  - 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 horizontal backwater valves in floor with cover flush with floor.
- G. Install test tees in vertical conductors and near floor.

- H. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.
- I. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface unless otherwise indicated.
- J. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

#### 4.2 CONNECTIONS

- A. Comply with requirements for piping specified in Section 22 14 13 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

#### 4.3 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. lead sheets, 0.0938-inch thickness or thicker. Solder joints of 4.0-lb/sq. ft. lead sheets, 0.0625-inch 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 and with skirt or flange extending at least 8 inches around pipe.
  - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
  - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

#### 4.4 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**

## **SECTION 22 14 29**

### PART 1 -

#### **SUMP PUMPS**

### **PART 2 - GENERAL**

#### 2.1 SUMMARY

##### A. Section Includes:

1. Submersible sump pumps.
2. Wet-pit-volute sump pumps.
3. Sump-pump basins and basin covers.

#### 2.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Wiring Diagrams: For power, signal, and control wiring.

#### 2.3 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

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

### **PART 3 - PRODUCTS**

#### 3.1 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:
  - a. Barnes; a Crane Pumps & Systems brand.

- b. Bell & Gossett; a Xylem brand.
  - c. Flo Fab Inc.
  - d. Goulds Water Technology; a Xylem brand.
  - e. Grundfos Pumps Corp.
  - f. Liberty Pumps.
  - g. Little Giant; a Franklin Electric brand.
  - h. Weil Pump Company, Inc.
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 or ASTM A 532/A 532M, abrasion-resistant cast iron and ASTM B 584, cast bronze, semi open for clear wastewater handling, and keyed and secured to shaft.
6. Pump and Motor Shaft: Stainless steel or 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: Oil.
9. Controls:
  - a. Enclosure: NEMA 250, Type 1 or Type 4X.
  - b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
  - c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
  - d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
  - e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
10. Controls:
  - a. Enclosure: NEMA 250, Type 1 or Type 4X; wall mounted.
  - b. Switch Type: Mechanical-float or Mercury-float type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
  - c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
  - d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float or mercury-float switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
11. Control-Interface Features:

- a. Remote Alarm Contacts: For remote alarm interface.
- b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

- 1) On-off status of pump.
- 2) Alarm status.

### 3.2 WET-PIT-VOLUTE SUMP PUMPS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Armstrong Pumps, Inc.
  - 2. Chicago Pump Company; Grundfos Pumps Corporation.
  - 3. Federal Pump Corp.
  - 4. PACO Pumps; Grundfos Pumps Corporation, USA.
  - 5. Peerless Pump Company.
  - 6. Weil Pump Company, Inc.
  - 7. Zoeller.
- B. Description: Factory-assembled and -tested sump-pump unit.
- C. Pump Type: Wet-pit-volute, single-stage, separately coupled, overhung-impeller, centrifugal sump pump as defined in HI 1.1-1.2 and HI 1.3.
- D. Pump Casing: Cast iron, with strainer inlet and threaded connection for NPS 2 and smaller and flanged connection for NPS 2-1/2 and larger discharge piping.
- E. 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, semi open design for clear wastewater handling, and keyed and secured to shaft.
- F. Sleeve Bearings: Bronze. Include oil-lubricated, intermediate sleeve bearings at 48-inch maximum intervals if basin depth is more than 48 inches, and grease-lubricated, ball-type thrust bearings.
- G. Pump and Motor Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
- H. Pump Discharge Piping: Factory or field fabricated, galvanized, ASTM A 53/A 53M, Schedule 40, steel pipe with ASME B16.1, Class 125, cast-iron flanges and flanged fittings or ASME B16.4, Class 125, gray iron threaded fittings.
- I. Support Plate: Cast iron or coated steel and strong enough to support pumps, motors, and controls. Refer to Part 2 "Sump-Pump Basins and Basin Covers" Article for requirements.
- J. Shaft Seal: Stuffing box, with graphite-impregnated braided-yarn rings and bronze packing gland.

K. Motor: Single-speed; grease-lubricated ball bearings and mounting on vertical, cast-iron pedestal.

L. Controls:

1. Enclosure: NEMA 250, Type 1 or Type 4X.
2. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
3. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
4. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
5. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

M. Controls:

1. Enclosure: NEMA 250, Type 1 or Type 4X; wall mounted.
2. Switch Type: Mechanical-float or Mercury-float type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
3. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
4. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, or mercury-float switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

N. Control-Interface Features:

1. Remote Alarm Contacts: For remote alarm interface.
2. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
  - a. On-off status of pump.
  - b. Alarm status.

3.3 SUMP PUMP CAPACITIES AND CHARACTERISTICS – Refer to pumps schedule and details.

3.4 SUMP-PUMP BASINS AND BASIN COVERS

A. Basins: Factory-fabricated, watertight, cylindrical, basin sump with top flange and sidewall openings for pipe connections.

1. Material: Fiberglass or Polyethylene.
2. Reinforcement: Mounting plates for pumps, fittings, and accessories.
3. Anchor Flange: Same material as or compatible with basin sump, cast in or attached to sump, in location and of size required to anchor basin in concrete slab.

- B. Basin Covers: Fabricate metal cover with openings having gaskets, seals, and bushings; for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.
  - 1. Reinforcement: Steel or cast iron, capable of supporting foot traffic for basins installed in foot-traffic areas.

3.5 Capacities and Characteristics: Refer to pumps schedule and details.

### 3.6 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 22 05 13 "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.
- B. Motors for submersible pumps shall be hermetically sealed.

## **PART 4 - EXECUTION**

### 4.1 EARTHWORK

- A. Excavation and filling are specified in Section 31 20 00 "Earth Moving."

### 4.2 INSTALLATION

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

## **END OF SECTION**

## **SECTION 22 33 00**

### PART 1 -

## **ELECTRIC, DOMESTIC-WATER HEATERS**

### **PART 2 - GENERAL**

#### 2.1 SUMMARY

##### A. Section Includes:

- ~~1. Commercial, electric, storage, domestic-water heaters.~~
- 2.1. Commercial, light-duty, storage, electric, domestic-water heaters.
- 3.2. Domestic-water heater accessories.

#### 2.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
  - 1. Include diagrams for power, signal, and control wiring.

#### 2.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Equipment room drawing or BIM model, drawn to scale and coordinated with all building trades.
- B. Seismic Qualification Data: Certificates, for commercial domestic-water heaters, accessories, and components, from manufacturer.
- C. Product Certificates: For each type of commercial, electric, domestic-water heater.
- D. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
- E. Source quality-control reports.
- F. Field quality-control reports.
- G. Sample warranty.

#### 2.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.



2.5 COORDINATION

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

2.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.

1. Warranty Periods: From date of Substantial Completion.

~~a. Commercial, Electric, Storage, Domestic Water Heaters:~~

~~1) Storage Tank: Five years.~~

~~2) Controls and Other Components: Five years.~~

b.a. Commercial, Light-Duty, Storage, Electric, Domestic-Water Heaters:

1) Storage Tank: Five years.

2) Controls and Other Components: Three years.

**PART 3 - PRODUCTS**

3.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.
- B. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.
- C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 and NSF 372.

3.2 COMMERCIAL, ELECTRIC, DOMESTIC-WATER HEATERS

~~A. Commercial, Electric, Storage, Domestic Water Heaters:~~

~~1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:~~

~~a. A. O. Smith Corporation.~~

~~b. American Water Heaters.~~

~~c. Bradford White Corporation.~~

~~d. Hubbell Electric Heater Co.~~

- ~~e. Lochinvar, LLC.~~
- ~~f. PVI, A WATTS Brand.~~
- ~~g. Rheem Manufacturing Company.~~
- ~~h. State Industries.~~

~~2. Standard: UL 1453.~~

~~3. Storage Tank Construction: ASME code, steel vertical arrangement.~~

~~a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.~~

~~1) NPS 2 and Smaller: Threaded ends in accordance with ASME B1.20.1.~~

~~2) NPS 2 1/2 and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless steel flanges, and in accordance with ASME B16.24 for copper and copper alloy flanges.~~

~~b. Pressure Rating: 150 psig.~~

~~c. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable water tank linings, including extending lining material into tappings.~~

~~4. Factory Installed, Storage Tank Appurtenances:~~

~~a. Anode Rod: Replaceable magnesium.~~

~~b. Drain Valve: Corrosion resistant metal with hose end connection.~~

~~c. Insulation: Comply with ASHRAE/IES 90.1.~~

~~d. Jacket: Steel with enameled finish or high impact composite material.~~

~~e. Heating Elements: Electric, screw in or bolt on immersion type arranged in multiples of three.~~

~~f. Temperature Control: Adjustable thermostat.~~

~~g. Safety Controls: High temperature limit and low water cutoff devices or systems.~~

~~h. Relief Valves: ASME rated and stamped for combination temperature and pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working pressure rating of domestic water heater. Select one relief valve with sensing element that extends into storage tank.~~

~~5. Special Requirements: NSF 5 construction.~~

B.A. Commercial, Light-Duty, Storage, Electric, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. A. O. Smith Corporation.

~~b. American Water Heaters.~~

~~c. Bradford White Corporation.~~

~~d. Hubbell Electric Heater Co.~~

~~e. Lochinvar, LLC.~~

~~f. Rheem Manufacturing Company.~~

- ~~g-f.~~ Ruud Water Heaters; a Rheem brand.
- ~~h-g.~~ State Industries.
- 2. Standard: UL 174.
- 3. Storage-Tank Construction: Steel, vertical arrangement.
  - a. Tappings: ASME B1.20.1 pipe thread.
  - b. Pressure Rating: 150 psig.
  - c. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining material into tappings.
- 4. Factory-Installed, Storage-Tank Appurtenances:
  - a. Anode Rod: Replaceable magnesium.
  - b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
  - c. Drain Valve: Corrosion-resistant metal with hose-end connection.
  - d. Insulation: Comply with ASHRAE/IES 90.1.
  - e. Jacket: Steel with enameled finish or high-impact composite material.
  - f. Heat-Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
  - g. Heating Elements: Electric, screw-in immersion type.
  - h. Temperature Control: Adjustable thermostat.
  - i. Safety Control: High-temperature-limit cutoff device or system.
  - j. Relief Valve: ASME rated and stamped for combination temperature-and-pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valve with sensing element that extends into storage tank.
- 5. Special Requirements: NSF 5 construction with legs for off-floor installation.

~~C.B.~~ Capacity and Characteristics: Refer to schedule on the plan.

### 3.3 DOMESTIC-WATER HEATER ACCESSORIES

#### A. Domestic-Water Expansion Tanks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. A. O. Smith Corporation.
  - b. AMTROL, Inc.
  - ~~c. Honeywell International Inc.~~
  - ~~d. State Industries.~~
  - ~~e. Taco Comfort Solutions.~~
  - ~~f-c.~~ WESSELS.
  - ~~g-d.~~ ARMSTRONG.
  - ~~h-e.~~ B&G.
2. Description: Steel pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air pre-charge to minimum system-operating pressure at tank.

3. Construction:
    - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
    - b. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
    - c. Air-Charging Valve: Factory installed.
  4. Capacity and Characteristics:
    - a. Working-Pressure Rating: 150 psig.
    - b. Capacity Acceptable: 8 gal. minimum.
    - c. Air Pre-charge Pressure: 40 psi.
  - B. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of domestic water heater and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads.
  - C. Piping-Type Heat Traps: Field-fabricated piping arrangement in accordance with ASHRAE/IES 90.1 or ASHRAE 90.2.
  - D. Heat-Trap Fittings: ASHRAE/IES 90.1 or ASHRAE 90.2.
  - E. Pressure-Reducing Valves: ASSE 1003 for water. Set at 25-psig-maximum outlet pressure unless otherwise indicated.
  - F. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valves with sensing element that extends into storage tank.
  - G. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than working-pressure rating of domestic-water heater.
  - H. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.
  - I. Shock Absorbers: ASSE 1010 or PDI-WH 201, Size A water hammer arrester.
  - J. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Include dimension that will support bottom of domestic-water heater a minimum of 12 inches above the floor.
  - K. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.
- 3.4 SOURCE QUALITY CONTROL
- A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, in accordance with ASME Boiler and Pressure Vessel Code.

- B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.
- C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

## **PART 4 - EXECUTION**

### 4.1 DOMESTIC-WATER HEATER INSTALLATION

- A. Commercial, Electric, Domestic-Water Heater Mounting: Install commercial, electric, domestic-water heaters on concrete base. Comply with requirements for concrete bases specified in Section 03 30 00 "Cast-in-Place Concrete."
  - 1. Exception: Omit concrete bases for commercial, electric, domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
  - 2. Maintain manufacturer's recommended clearances.
  - 3. Arrange units so controls and devices that require servicing are accessible.
  - 4. 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.
  - 5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  - 6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 7. Install anchor bolts to elevations required for proper attachment to supported equipment.
  - 8. Anchor domestic-water heaters to substrate.
- B. Install electric, domestic-water heaters level and plumb, in accordance with layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
  - 1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 22 05 23.
- C. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend domestic-water heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- D. Install combination temperature-and-pressure relief valves in water piping for electric, domestic-water heaters without storage. Extend domestic-water heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

- E. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 22 11 19 "Domestic Water Piping Specialties."
- F. Install thermometers on outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."
- G. Install thermometers on inlet and outlet piping of residential, solar, electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."
- H. Assemble and install inlet and outlet piping manifold kits for multiple electric, domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each electric, domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each electric, domestic-water heater outlet. Comply with requirements for valves specified in Section 22 05 23 and comply with requirements for thermometers specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."
- I. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.
- J. Fill electric, domestic-water heaters with water.
- K. Charge domestic-water expansion tanks with air to required system pressure.
- L. Install dielectric fittings in all locations where piping of dissimilar metals is to be joined. The wetted surface of the dielectric fitting contacted by potable water shall contain less than 0.25 percent of lead by weight.
- M. Identify system components. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

#### 4.2 PIPING CONNECTIONS

- A. Comply with requirements for piping specified in Section 22 11 16 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

#### 4.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections with the assistance of a factory-authorized service representative.
- B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
  3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

#### 4.4 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain commercial, electric, domestic-water heaters. Training shall be a minimum of two hour(s).

**END OF SECTION**

## **SECTION 22 42 13.13**

### PART 1 -

## **COMMERCIAL WATER CLOSETS**

### **PART 2 - GENERAL**

#### 2.1 SUMMARY

A. Section Includes:

1. Water closets.
2. Flushometer valves.
3. Toilet seats.

#### 2.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:

1. Product Data for Prerequisite WE 1 and Credit WE 3, Credit WE 2, and Credit WE 3: Documentation indicating flow and water consumption requirements.
2. Product Data for Prerequisite WE 1: Documentation indicating flow and water consumption requirements.
3. Product Data for Prerequisite WE 1 and Credit WE 2: Documentation indicating flow and water consumption requirements.

C. Shop Drawings: Include diagrams for power, signal, and control wiring.

#### 2.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

### **PART 3 - PRODUCTS**

#### ~~3.1 FLOOR MOUNTED, BOTTOM-OUTLET WATER CLOSETS~~

~~A. Water Closets: Floor mounted, bottom-outlet, top-spud.~~



- ~~1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - ~~a. American Standard.~~
  - ~~b. Kohler Co.~~
  - ~~c. Mansfield Plumbing Products LLC.~~
  - ~~d. Sloan Valve Company.~~
  - ~~e. TOTO USA, INC.~~~~
  
- ~~2. Bowl:
  - ~~a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.~~
  - ~~b. Material: Vitreous china.~~
  - ~~c. Type: Siphon jet.~~
  - ~~d. Style: Flushometer valve.~~
  - ~~e. Height: Standard and Handicapped/elderly, complying with ICC/ANSI A117.1.~~
  - ~~f. Rim Contour: Elongated.~~
  - ~~g. Water Consumption: 1.28 gal. per flush.~~
  - ~~h. Spud Size and Location: NPS 1 1/2; top.~~
  - ~~i. Color: White. Refer to plumbing schedule for confirmation.~~~~
  
- ~~3. Bowl to Drain Connecting Fitting: ASTM A 1045 or ASME A112.4.3.~~
- ~~4. Flushometer Valve.~~
- ~~5. Toilet Seat.~~

### 3.23.1 WALL-MOUNTED WATER CLOSETS

#### A. Water Closets: Wall mounted, top spud, accessible.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. American Standard.
  - ~~b. Kohler Co.~~
  - ~~c. Mansfield Plumbing Products LLC.~~
  - d. Sloan Valve Company.
  - e. TOTO USA, INC.
  
2. Bowl:
  - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
  - b. Material: Vitreous china.
  - c. Type: Siphon jet.
  - d. Style: Flushometer valve.
  - e. Height: Standard.
  - f. Rim Contour: Elongated.
  - g. Water Consumption: 1.28 gal. per flush.
  - h. Spud Size and Location: NPS 1-1/2; top.
  
3. Flushometer Valve.
4. Toilet Seat.

5. Support:

- a. Standard: ASME A112.6.1M.
- b. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.
- c. Water-Closet Mounting Height: Standard and Handicapped/elderly according to ICC/ANSI A117.1.

3.33.2 FLUSHOMETER VALVES

~~A. Lever Handle, Diaphragm Flushometer Valves:~~

- ~~1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:~~

- ~~a. Advanced Modern Technologies Corporation - AMTC.~~
- ~~b. Delany Products.~~
- ~~c. I-Con Systems, Inc.~~
- ~~d. Sloan Valve Company.~~

- ~~2. Standard: ASSE 1037.~~
- ~~3. Minimum Pressure Rating: 125 psig.~~
- ~~4. Features: Include integral check stop and backflow prevention device.~~
- ~~5. Material: Brass body with corrosion-resistant components.~~
- ~~6. Exposed Flushometer Valve Finish: Chrome plated.~~
- ~~7. Panel Finish: Chrome plated or stainless steel.~~
- ~~8. Style: Exposed.~~
- ~~9. Consumption: 1.28 gal. per flush.~~
- ~~10. Minimum Inlet: NPS 1.~~
- ~~11. Minimum Outlet: NPS 1 1/4.~~

B.A. Lever-Handle, Piston Flushometer Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. American Standard.
- b. Delany Products.
- ~~c. I-Con Systems, Inc.~~
- ~~d. Kohler Co.~~
- e.c. Sloan Valve Company.

2. Standard: ASSE 1037.
3. Minimum Pressure Rating: 125 psig.
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Panel Finish: Chrome plated or stainless steel.
8. Style: Exposed.
9. Consumption: 1.28 gal. per flush.

10. Minimum Inlet: NPS 1.
11. Minimum Outlet: NPS 1-1/4.

### 3.43.3 TOILET SEATS

#### A. Toilet Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. American Standard.
  - b. Bemis Manufacturing Company.
  - c. Church Seats; Bemis Manufacturing Company.
  - d. Kohler Co.
  - e. TOTO USA, INC.
2. Standard: IAPMO/ANSI Z124.5.
3. Material: Plastic.
4. Type: Commercial (Standard).
5. Shape: Elongated rim, open front.
6. Hinge: Check, Self-sustaining, Self-sustaining, check or Self-raising.
7. Hinge Material: Noncorroding metal.
8. Seat Cover: Not required.
9. Color: White.

## **PART 4 - EXECUTION**

### 4.1 INSTALLATION

#### A. Water-Closet Installation:

1. Install level and plumb according to roughing-in drawings.
2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.
3. Install accessible, wall-mounted water closets at mounting height for handicapped/elderly, according to ICC/ANSI A117.1.

#### B. Support Installation:

- ~~1. Install supports, affixed to building substrate, for floor-mounted, back-outlet water closets.~~
- 2.1. Use carrier supports with waste-fitting assembly and seal.
- 3.2. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.

#### C. Flushometer-Valve Installation:

1. Install flushometer-valve, water-supply fitting on each supply to each water closet.

2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
3. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
4. Install actuators in locations that are easy for people with disabilities to reach.

D. Install toilet seats on water closets.

E. Wall Flange and Escutcheon Installation:

1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.
3. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

F. Joint Sealing:

1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to water-closet color.
3. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."

#### 4.2 CONNECTIONS

- A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.
- B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."
- D. Where installing piping adjacent to water closets, allow space for service and maintenance.

#### 4.3 ADJUSTING

- A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.
- B. Adjust water pressure at flushometer valves to produce proper flow.

#### 4.4 CLEANING AND PROTECTION

- A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.

- B. Install protective covering for installed water closets and fittings.
- C. Do not allow use of water closets for temporary facilities unless approved in writing by Owner.

**END OF SECTION**

## **SECTION 22 42 13.16**

### PART 1 -

### **COMMERCIAL URINALS**

#### **PART 2 - GENERAL**

##### 2.1 SUMMARY

###### A. Section Includes:

1. Urinals.
2. Flushometer valves.

##### 2.2 ACTION SUBMITTALS

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

###### B. LEED Submittals:

1. Product Data for Prerequisite WE 1 and Credit WE 3, Credit WE 2, and Credit WE 3: Documentation indicating flow and water consumption requirements.
2. Product Data for Prerequisite WE 1: Documentation indicating flow and water consumption requirements.
3. Product Data for Prerequisite WE 1 and Credit WE 2: Documentation indicating flow and water consumption requirements.

###### C. Shop Drawings: Include diagrams for power, signal, and control wiring.

##### 2.3 CLOSEOUT SUBMITTALS

###### A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

#### **PART 3 - PRODUCTS**

##### 3.1 WALL-HUNG URINALS

~~A. Urinals: Wall hung, back-outlet, siphon-jet, accessible.~~

- ~~1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:-~~

- ~~a. American Standard.~~
- ~~b. Briggs Plumbing Products, Inc.~~
- ~~c. Duravit USA, Inc.~~
- ~~d. Gerber Plumbing Fixtures LLC.~~
- ~~e. Kohler Co.~~
- ~~f. Mansfield Plumbing Products LLC.~~
- ~~g. TOTO USA Inc.~~
- ~~h. Zurn.~~

~~2. Fixture:~~

- ~~a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.~~
- ~~b. Material: Vitreous china.~~
- ~~c. Type: Siphon jet with extended shields.~~
- ~~d. Strainer or Trapway: Manufacturer's standard strainer with integral trap.~~
- ~~e. Water Consumption: Water saving.~~
- ~~f. Spud Size and Location: NPS 3/4, top.~~
- ~~g. Outlet Size and Location: NPS 2, back.~~
- ~~h. Color: White.~~

~~3. Flushometer Valve.~~

~~4. Waste Fitting:~~

- ~~a. Standard: ASME A112.18.2/CSA B125.2 for coupling.~~
- ~~b. Size: NPS 2.~~

~~5. Support: ASME A112.6.1M, Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture. Include rectangular, steel uprights.~~

B.A. Urinals: Wall hung, back outlet, washout, accessible.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. American Standard.
- ~~b. Briggs Plumbing Products, Inc.~~
- ~~c. Gerber Plumbing Fixtures LLC.~~
- ~~d.~~ b. Kohler Co.
- ~~e. Mansfield Plumbing Products LLC.~~
- ~~f. Peerless Pottery Sales, Inc.~~
- ~~g.~~ c. TOTO USA, INC.

2. Fixture:

- a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
- b. Material: Vitreous china.
- c. Type: Washout with extended shields.
- d. Strainer or Trapway: Manufacturer's standard strainer with integral trap.
- e. Water Consumption: Water saving.
- f. Spud Size and Location: NPS 3/4, top.

- g. Outlet Size and Location: NPS 2, back.
- h. Color: White.
- 3. Flushometer Valve.
- 4. Waste Fitting:
  - a. Standard: ASME A112.18.2/CSA B125.2 for coupling.
  - b. Size: NPS 2.
- 5. Support: ASME A112.6.1M, Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture. Include rectangular, steel uprights.

### 3.2 URINAL FLUSHOMETER VALVES

#### A. Lever-Handle, ~~Diaphragm-Piston~~ Flushometer Valves:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. American Standard.
  - ~~b. Delany Products.~~
  - ~~c. Gerber Plumbing Fixtures LLC.~~
  - ~~d. I-Con Systems, Inc.~~
  - ~~e. Sloan Valve Company.~~
  - ~~f. Kohler.~~
  - ~~g. Zurn.~~
- 2. Standard: ASSE 1037.
- 3. Minimum Pressure Rating: 125 psig.
- 4. Features: Include integral check stop and backflow-prevention device.
- 5. Material: Brass body with corrosion-resistant components.
- 6. Exposed Flushometer-Valve Finish: Chrome plated.
- 7. Style: Exposed.
- 8. Consumption: 0.5 gal. per flush.
- 9. Minimum Inlet: NPS 3/4.
- 10. Minimum Outlet: NPS 1-1/4.

#### ~~B. Solenoid Actuator, Diaphragm Flushometer Valves:~~

- ~~1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - ~~a. Delany Products.~~
  - ~~b. I-Con Systems, Inc.~~
  - ~~c. Sloan Valve Company.~~
  - ~~d. Stern Engineering Ltd.~~~~
- ~~2. Standard: ASSE 1037.~~
- ~~3. Minimum Pressure Rating: 125 psig.~~
- ~~4. Features: Include integral check stop and backflow-prevention device.~~
- ~~5. Material: Brass body with corrosion-resistant components.~~



- ~~6. Exposed Flushometer Valve Finish: Chrome plated.~~
- ~~7. Style: Exposed.~~
- ~~8. Actuator: Solenoid complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.~~
- ~~9. Trip Mechanism: Hard wired, electronic sensor complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.~~
- ~~10. Consumption: 0.5 gal. per flush.~~
- ~~11. Minimum Inlet: NPS 3/4.~~
- ~~12. Minimum Outlet: NPS 1 1/4.~~

~~C. Electric Powered, Solenoid Actuator, Piston Flushometer Valves:~~

- ~~1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:~~
  - ~~a. American Standard.~~
  - ~~b. Delany Products.~~
  - ~~c. Hydrotek International, Inc.~~
  - ~~d. Kohler Co.~~
  - ~~e. Sloan Valve Company.~~
  - ~~f. TOTO USA, INC.~~
- ~~2. Standard: ASSE 1037.~~
- ~~3. Minimum Pressure Rating: 125 psig.~~
- ~~4. Features: Include integral check stop and backflow prevention device.~~
- ~~5. Material: Brass body with corrosion resistant components.~~
- ~~6. Exposed Flushometer Valve Finish: Chrome plated.~~
- ~~7. Style: Exposed.~~
- ~~8. Actuator: Solenoid complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.~~
- ~~9. Trip Mechanism: Battery powered electronic sensor complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.~~
- ~~10. Consumption: 0.5 gal. per flush.~~
- ~~11. Minimum Inlet: NPS 3/4.~~
- ~~12. Minimum Outlet: NPS 1 1/4.~~

## **PART 4 - EXECUTION**

### **4.1 EXAMINATION**

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before urinal installation.
- B. Examine walls and floors for suitable conditions where urinals will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 4.2 INSTALLATION

##### A. Urinal Installation:

1. Install urinals level and plumb according to roughing-in drawings.
2. Install wall-hung, back-outlet urinals onto waste fitting seals and attached to supports.
- ~~3. Install wall hung, bottom outlet urinals with tubular waste piping attached to supports.~~
- 4.3. Install accessible, wall-mounted urinals at mounting height for the handicapped/elderly, according to ICC/ANSI A117.1.
- ~~5. Install trap seal liquid in waterless urinals.~~

##### B. Support Installation:

1. Install supports, affixed to building substrate, for wall-hung urinals.
2. Use off-floor carriers with waste fitting and seal for back-outlet urinals.
3. Use carriers without waste fitting for urinals with tubular waste piping.
4. Use chair-type carrier supports with rectangular steel uprights for accessible urinals.

##### C. Flushometer-Valve Installation:

1. Install flushometer-valve water-supply fitting on each supply to each urinal.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
3. Install lever-handle flushometer valves for accessible urinals with handle mounted on open side of compartment.
- ~~4. Install fresh batteries in battery powered, electronic sensor mechanisms.~~

##### D. Wall Flange and Escutcheon Installation:

1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.
3. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

##### E. Joint Sealing:

1. Seal joints between urinals and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to urinal color.
3. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."

#### 4.3 CONNECTIONS

- ##### A.
1. Connect urinals with water supplies and soil, waste, and vent piping. Use size fittings required to match urinals.

- B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."
- D. Where installing piping adjacent to urinals, allow space for service and maintenance.

#### 4.4 ADJUSTING

- A. Operate and adjust urinals and controls. Replace damaged and malfunctioning urinals, fittings, and controls.
- B. Adjust water pressure at flushometer valves to produce proper flow.

~~C. Install fresh batteries in battery powered, electronic sensor mechanisms.~~

#### 4.5 CLEANING AND PROTECTION

- A. Clean urinals and fittings with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed urinals and fittings.
- C. Do not allow use of urinals for temporary facilities unless approved in writing by Owner.

**END OF SECTION**

## **SECTION 22 42 16.13**

### PART 1 -

## **COMMERCIAL LAVATORIES**

### **PART 2 - GENERAL**

#### 2.1 SUMMARY

A. Section Includes:

1. Lavatories.
2. Faucets.

#### 2.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:

1. Product Data for Prerequisite WE 1 and Credit WE 3, Credit WE 2, and Credit WE 3: Documentation indicating flow and water consumption requirements.
2. Product Data for Prerequisite WE 1: Documentation indicating flow and water consumption requirements.
3. Product Data for Prerequisite WE 1 and Credit WE 2: Documentation indicating flow and water consumption requirements.

C. Shop Drawings: Include diagrams for power, signal, and control wiring of automatic faucets.

#### 2.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.

#### 2.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lavatories and faucets to include in operation and maintenance manuals.

1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:
  - a. Servicing and adjustments of automatic faucets.

### PART 3 - PRODUCTS

#### 3.1 VITREOUS-CHINA, COUNTER-MOUNTED LAVATORIES

- A. Lavatory: Oval or Round, self rimming, vitreous china, counter mounted.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Standard.
    - ~~b. Briggs Plumbing Products, Inc.~~
    - ~~e.b. Crane Plumbing, L.L.C.~~
    - ~~d. FNW; Ferguson Enterprises, Inc.~~
    - ~~e. Gerber Plumbing Fixtures LLC.~~
    - ~~f. Kohler Co.~~
    - ~~g. Mansfield Plumbing Products LLC.~~
    - ~~h.c. Sloan Valve Company.~~
    - ~~i.d. TOTO USA, INC.~~
  2. Fixture: Refer to plumbing schedule for more information.
  3. Faucet: Refer to plumbing schedule for more information.
- B. Lavatory: Oval, vitreous china, undercounter mounted.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Standard.
    - ~~b. Gerber Plumbing Fixtures LLC.~~
    - ~~c. Kohler Co.~~
    - ~~d. Mansfield Plumbing Products LLC.~~
    - ~~e.b. Sloan Valve Company.~~
    - ~~f.c. TOTO USA, INC.~~
  2. Fixture: Refer to plumbing schedule for more information.
  3. Faucet: Refer to plumbing schedule for more information.

#### 3.2 VITREOUS-CHINA, WALL-MOUNTED LAVATORIES

- A. Lavatory: Vitreous china, wall mounted, with back.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Standard.
    - ~~b. Briggs Plumbing Products, Inc.~~
    - ~~e.b. Gerber Plumbing Fixtures LLC.~~
    - ~~d. Kohler Co.~~
    - ~~e. Mansfield Plumbing Products LLC.~~

f.c. Sloan Valve Company.

2. Fixture: Refer to plumbing schedule for more information.
  - a. Standard: ASME A112.19.2/CSA B45.1.
  - b. Type: For wall hanging.
  - c. Faucet-Hole Location: Top.
  - d. Color: White.
  - e. Mounting Material: Chair carrier.
3. Faucet: Refer to plumbing schedule for more information.
4. Support: ASME A112.6.1M, Type II, concealed-arm lavatory carrier with escutcheons.

B. Lavatory: Wheelchair, vitreous china, wall mounted.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. American Standard.
  - b. Gerber Plumbing Fixtures LLC.
  - ~~c. Kohler Co.~~
  - ~~d. Mansfield Plumbing Products LLC.~~
  - e.c. Sloan Valve Company.
2. Fixture: Refer to plumbing schedule for more information.
  - a. Standard: ASME A112.19.2/CSA B45.1.
  - b. Type: Slab or wheelchair.
  - c. Faucet-Hole Location: Top.
  - d. Color: White.
  - e. Mounting: For concealed-arm carrier.
3. Faucet: Refer to plumbing schedule for more information.
4. Support: ASME A112.6.1M, Type II, concealed-arm lavatory carrier with rectangular, steel uprights.

3.3 SOLID-BRASS, MANUALLY OPERATED FAUCETS

- A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for faucet materials that will be in contact with potable water.

B. Lavatory Faucets: Battery Operated, commercial, solid-brass valve.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. American Standard.
  - b. Chicago Faucets; Geberit Company.
  - c. Sloan

2. Standard: ASME A112.18.1/CSA B125.1.
3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punching; coordinate outlet with spout and fixture receptor.
4. Body Type: Center set, Widespread or Single hole.
5. Body Material: Commercial, solid brass.
6. Finish: Polished chrome plate.
7. Maximum Flow Rate: 0.5 gpm.
8. Maximum Flow: 0.25 gal. per metering cycle.
9. Mounting Type: Deck, concealed.
10. Valve Handle(s): Single lever.
11. Spout: Rigid
12. Spout Outlet: Aerator.
13. Operation: Compression, manual or Non-compression, manual.
14. Drain: Not part of faucet.

B.C. Lavatory Faucets: Manual-type, commercial, solid-brass valve.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. American Standard.
  - b. Chicago Faucets; Geberit Company.
  - c. Delta Faucet Company.
  - d. Elkay.
  - e. Gerber Plumbing Fixtures LLC.
  - f. Just Manufacturing.
  - g. Kohler Co.
  - h. Moen Incorporated.
  - i. Speakman Company.
  - j. T&S Brass and Bronze Works, Inc.
2. Standard: ASME A112.18.1/CSA B125.1.
3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punching; coordinate outlet with spout and fixture receptor.
4. Body Type: Center set, Widespread or Single hole.
5. Body Material: Commercial, solid brass.
6. Finish: Polished chrome plate.
7. Maximum Flow Rate: 0.5 gpm.
8. Maximum Flow: 0.25 gal. per metering cycle.
9. Mounting Type: Deck, concealed.
10. Valve Handle(s): Single lever.
11. Spout: Rigid ~~or Rigid, gooseneck type.~~
12. Spout Outlet: Aerator.
13. Operation: Compression, manual or Non-compression, manual.
14. Drain: Not part of faucet.

### 3.4 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.
- B. Standard: ASME A112.18.1/CSA B125.1.
- C. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless-steel wall flange.
- D. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
- E. Operation: Wheel handle.
- F. Risers:
  - 1. NPS 3/8 or NPS 1/2.
  - 2. Chrome-plated, soft-copper flexible tube ASME A112.18.6, braided- or corrugated-stainless-steel, flexible hose riser.

### 3.5 WASTE FITTINGS

- A. Standard: ASME A112.18.2/CSA B125.2.
- B. Drain: Grid type with NPS 1-1/4 offset and straight tailpiece.
- C. Trap:
  - 1. Size: NPS 1-1/2 by NPS 1-1/4 or NPS 1-1/4.
  - 2. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch-thick brass tube to wall, two-piece, cast-brass trap and ground-joint swivel elbow with 0.032-inch-thick brass tube to wall or one-piece, cast-brass trap with swivel 0.029-inch-thick tubular brass wall bend; and chrome-plated, brass or steel wall flange.
  - 3. Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch-thick stainless-steel tube to wall; and stainless-steel wall flange.

## **PART 4 - EXECUTION**

### 4.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before lavatory installation.
- B. Examine counters and walls for suitable conditions where lavatories will be installed.



- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 4.2 INSTALLATION

- A. Install lavatories level and plumb according to roughing-in drawings.
- B. Install supports, affixed to building substrate, for wall-mounted lavatories.
- C. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1.
- D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."
- E. Seal joints between lavatories and counters and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."
- F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 22 07 19 "Plumbing Piping Insulation."

#### 4.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

#### 4.4 ADJUSTING

- A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.
- C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

#### 4.5 CLEANING AND PROTECTION

- A. After completing installation of lavatories, inspect and repair damaged finishes.

- B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed lavatories and fittings.
- D. Do not allow use of lavatories for temporary facilities unless approved in writing by Owner.

**END OF SECTION**

## **SECTION 22 42 23**

### PART 1 -

## **COMMERCIAL SHOWERS**

### **PART 2 - GENERAL**

#### 2.1 SUMMARY

- A. Section Includes:
  - 1. Shower heads and shower valves.
  - 2. Grout.

#### 2.2 ACTION SUBMITTALS

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

#### 2.3 CLOSEOUT SUBMITTALS

- A. Maintenance data.

### PART 3 - PRODUCTS

#### 3.1 PERFORMANCE REQUIREMENTS

- A. Shower valves intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

#### 3.2 SHOWER HEADS AND SHOWER VALVES

- A. Shower Head with Single-Handle, Pressure-Balanced Mixing Valve:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Standard.
    - b. Kohler Co.
    - c. Leonard Valve Company.
    - d. Moen Incorporated.

- e. POWERS; A WATTS Brand.
  - f. Speakman Company.
  - g. Symmons Industries, Inc.
  - h. Zurn Industries, LLC.
2. Description: Single-handle, accessible, pressure-balance mixing valve with hot- and cold-water indicators; diverting valve check stops; and shower head.
  3. Shower Valve:
    - a. Standards: ASME A112.18.1/CSA B125.1 and ASSE 1016/ASME A112.1016/CSA B125.16.
    - b. Body Material: Solid brass.
    - c. Finish: Polished chrome plate.
    - d. Mounting: Concealed.
    - e. Operation: Single-handle, push-pull or twist or rotate or metering control.
    - f. Antiscald Device: Integral with mixing valve.
    - g. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
  4. Supply Connections: NPS 1/2.
  5. Shower Head:
    - a. Standard: ASME A112.18.1/CSA B125.1.
    - b. Type: Ball joint and head integral with mounting flange.
    - c. EPA WaterSense: Required.
    - d. Shower Head Maximum Flow Rate: 2.0 gpm.
    - e. Shower Head Material: Metallic with chrome-plated finish.
    - f. Spray Pattern: Adjustable.
    - g. Integral Volume Control: Required.
    - h. Temperature Indicator: Integral with valve.
- B. Shower Head with Single-Handle Thermostatic Mixing Valve:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Acorn Engineering Company; a Division of Morris Group International.
    - b. Kohler Co.
    - c. Leonard Valve Company.
    - d. Matco-Norca.
    - e. POWERS; A WATTS Brand.
    - f. Symmons Industries, Inc.
  2. Description: Single-handle, accessible, thermostatic mixing valve with hot- and cold-water indicators; diverting valve check stops; and shower head.
  3. Shower Valve:
    - a. Standards: ASME A112.18.1/CSA B125.1 and ASSE 1016/ASME A112.1016/CSA B125.16.
    - b. Body Material: Solid brass.
    - c. Finish: Polished chrome plate.
    - d. Mounting: Concealed.

- e. Operation: Single-handle, push-pull or twist or rotate control.
    - f. Antiscald Device: Integral with mixing valve.
    - g. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
  4. Supply Connections: NPS 1/2.
  5. Shower Head:
    - a. Standard: ASME A112.18.1/CSA B125.1.
    - b. Type: Ball joint and head integral with mounting flange.
    - c. EPA WaterSense: Required.
    - d. Shower Head Maximum Flow Rate: 2.0 gpm.
    - e. Shower Head Material: Metallic with chrome-plated finish.
    - f. Spray Pattern: Adjustable.
    - g. Integral Volume Control: Required.
    - h. Temperature Indicator: Integral with valve.
- C. Shower Head with Single-Handle, Thermostatic/Pressure-Balancing Mixing Valve:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Chicago Faucets; Geberit Company.
    - b. Lawler Manufacturing Company, Inc.
    - c. POWERS; A WATTS Brand.
  2. Description: Single-handle, accessible, thermostatic/pressure-balancing mixing valve with hot- and cold-water indicators; diverting valve check stops; and hose with handheld shower head, hose with handheld shower head on sliding rod shower head.
  3. Shower Valve:
    - a. Standards: ASME A112.18.1/CSA B125.1 and ASSE 1016/ASME A112.1016/CSA B125.16.
    - b. Body Material: Solid brass.
    - c. Finish: Polished chrome plate.
    - d. Mounting: Concealed.
    - e. Operation: Single-handle, push-pull or twist or rotate control.
    - f. Antiscald Device: Integral with mixing valve.
    - g. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
  4. Supply Connections: NPS 1/2.
  5. Shower Head:
    - a. Standard: ASME A112.18.1/CSA B125.1.
    - b. Type: Ball joint and head integral with mounting flange.
    - c. EPA WaterSense: Required.
    - d. Shower Head Maximum Flow Rate: 2.0 gpm.
    - e. Shower Head Material: Metallic with chrome-plated finish.
    - f. Spray Pattern: Adjustable.
    - g. Integral Volume Control: Required.
    - h. Temperature Indicator: Integral with valve.

### 3.3 GROUT

- A. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000 psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

## **PART 4 - EXECUTION**

### 4.1 INSTALLATION

- A. Assemble shower components according to manufacturers' written instructions.
- B. Install showers level and plumb.
- C. Install ball valves in water-supply piping to the shower if supply stops are specified with the shower valve. Comply with valve requirements specified in Section 22 05 23. Install valves in locations that are accessible for ease of operation.
- D. Install shower flow-control fittings with specified maximum flow rates in shower arms.
- E. Set shower receptors in leveling bed of cement grout.
- F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheons requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."
- G. Seal joints between showers and floors and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."

### 4.2 PIPING CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."
- C. Comply with traps and soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

4.3 ADJUSTING

- A. Operate and adjust showers and controls. Replace damaged and malfunctioning showers, fittings, and controls.
- B. Adjust water pressure at shower valves to produce proper flow.

4.4 CLEANING AND PROTECTION

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

**END OF SECTION**

**SECTION 22 47 136**

PART 1 -

**PRESSURE WATER COOLERS DRINKING FOUNTAINS**

**PART 2 - GENERAL**

2.1 SUMMARY

- A. Section includes pressure water coolers and related components.

2.2 ACTION SUBMITTALS

- A. Product Data: For each type of pressure water cooler.
- B. LEED Submittals:
  - 1. Product Data for Prerequisite WE 1 and Credit WE 3, Credit WE 2, and Credit WE 3: Documentation indicating flow and water consumption requirements.
- C. Shop Drawings: Include diagrams for power, signal, and control wiring.

2.3 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For pressure water coolers to include in maintenance manuals.

2.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Filter Cartridges: Equal to 20% percent of quantity installed for each type and size indicated, but no fewer than 2 of each.

**PART 3 - PRODUCTS**

3.1 **PRESSURE WATER COOLERS DRINKING FOUNTAINS**

- ~~A. Pressure Water Coolers: Freestanding or Flush to wall.~~

- ~~1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved "EQUAL":~~



- a. ~~Elkay.~~
- b. ~~Halsey Taylor.~~

2. ~~Standards:~~

- a. ~~Comply with NSF 61 Annex G.~~
- b. ~~Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant unless otherwise indicated.~~

3. ~~Cabinet: Steel with powder coat finish or Vinyl covered steel with stainless steel top.~~

4. ~~Bubbler: One, with adjustable stream regulator, located on deck.~~

5. ~~Control: Push button.~~

6. ~~Drain: Grid with NPS 1-1/4 tailpiece.~~

7. ~~Supply: NPS 3/8 with shutoff valve.~~

8. ~~Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 brass P trap.~~

9. ~~Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.~~

10. ~~Cooling System: Electric, with pre-cooler, hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant metal storage tank, and adjustable thermostat.~~

- 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.~~

11. ~~Capacities and Characteristics:~~

- a. ~~Cooled Water: 8 gph.~~
- b. ~~Ambient Air Temperature: 90 deg F.~~
- c. ~~Inlet Water Temperature: 80 deg F.~~
- d. ~~Cooled Water Temperature: 50 deg F.~~
- e. ~~Cooled Water Storage: MFG standard.~~
- f. ~~Electrical Characteristics: Per MFG cutsheet~~

B.A. Pressure Water Coolers: Wall mounted; wheelchair accessible. Drinking Fountains

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Elkay.
- b. Halsey Taylor.
- c. Haws Corporation.
- d. Larco Inc.

2. ~~Cabinet: Bi-level, wall mounted, stainless steel with two attached cabinets and with a bi-level skirt kit.~~

3. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.

4. Control: Push button or Push bar.

5. Drain: Grid with NPS 1-1/4 tailpiece.

6. Supply: NPS 3/8 with shutoff valve.
  7. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 brass P-trap.
  8. ~~Support: Mounting frame or brackets for attaching to wood blocking or substrate.~~
  9. ~~Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.~~
  9. ~~Cooling System: Electric, with hermetically sealed compressor, cooling coil, air cooled condensing unit, corrosion resistant tubing, refrigerant, corrosion resistant metal storage tank, and adjustable thermostat.~~
    - 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.~~
  10. ~~Capacities and Characteristics:~~
    - a. ~~Cooled Water: 5 gph or 8 gph Insert value.~~
    - b. ~~Ambient Air Temperature: 90 deg F.~~
    - c. ~~Inlet Water Temperature: 80 deg F.~~
    - d. ~~Cooled Water Temperature: 50 deg F.~~
    - e. ~~Electrical Characteristics: Per MFG's cutsheet.~~
- ~~11-9.~~ Support: ASME A112.6.1M, Type I water-cooler carrier.

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#### PART 4 - EXECUTION

##### 4.1 EXAMINATION

- A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.
- B. Examine walls and floors for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

##### 4.2 INSTALLATION

- A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.
- ~~B. Set freestanding pressure water coolers on floor.~~
- ~~C.~~ B. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.
- ~~D.~~ C. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball or gate valve. Install valves in locations where they can be easily reached for operation. ~~Valves are~~

~~specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."~~

- E.D. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- F.E. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."
- G.F. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."

#### 4.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."
- C. Install ball or gate shutoff valve on water supply to each fixture. Install valve upstream from filter for water cooler. ~~Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."~~
- D. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

#### 4.4 ADJUSTING

- A. Adjust fixture flow regulators for proper flow and stream height.
- B. Adjust pressure water-cooler temperature settings.

#### 4.5 CLEANING

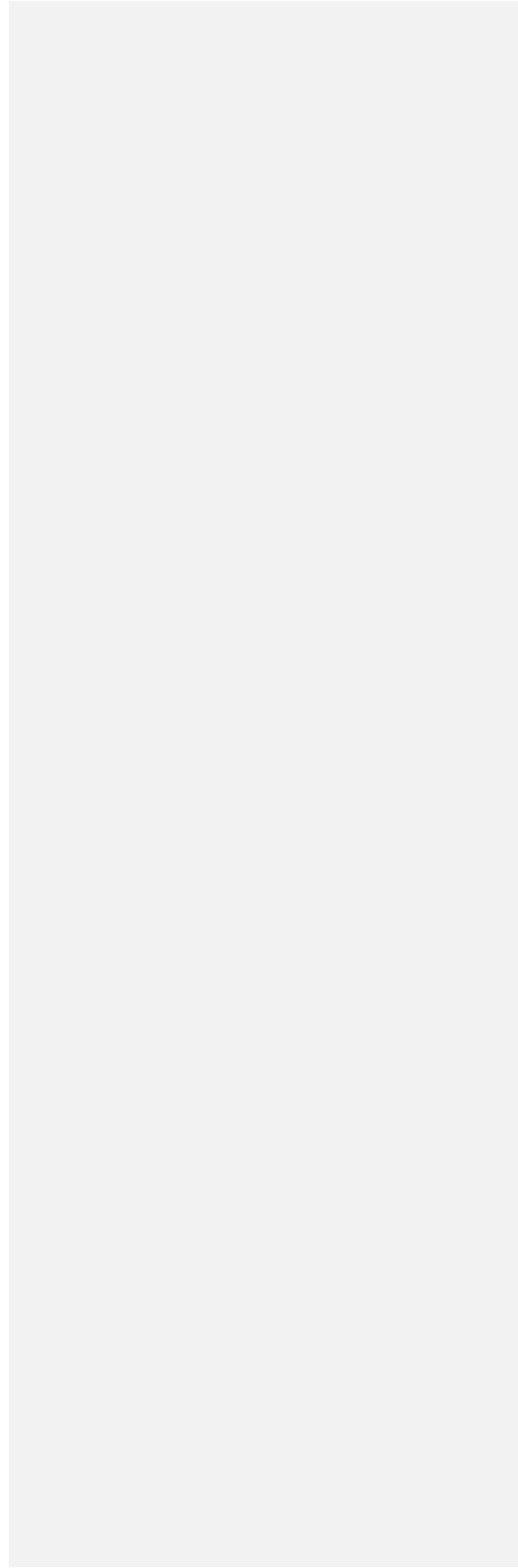
- A. After installing fixture, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.
- C. Provide protective covering for installed fixtures.
- D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

Bell Auditorium Expansion & Renovations  
Augusta, Georgia  
Issue for Permit / Bid

Perkins&Will  
222028.000  
16 January 2023

**END OF SECTION**

PRESSURE WATER COOLERS  
22 47 16 - 5



## **SECTION 22 47 16**

### PART 1 -

#### **PRESSURE WATER COOLERS**

#### **PART 2 - GENERAL**

##### 2.1 SUMMARY

- A. Section includes pressure water coolers and related components.

##### 2.2 ACTION SUBMITTALS

- A. Product Data: For each type of pressure water cooler.
- B. LEED Submittals:
  - 1. Product Data for Prerequisite WE 1 and Credit WE 3, Credit WE 2, and Credit WE 3: Documentation indicating flow and water consumption requirements.
- C. Shop Drawings: Include diagrams for power, signal, and control wiring.

##### 2.3 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For pressure water coolers to include in maintenance manuals.

##### 2.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Filter Cartridges: Equal to 20% percent of quantity installed for each type and size indicated, but no fewer than 2 of each.

#### **PART 3 - PRODUCTS**

##### 3.1 PRESSURE WATER COOLERS

~~A. Pressure Water Coolers: Freestanding or Flush to wall.~~

- ~~1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved "EQUAL":~~

- ~~a. Elkay.~~
- ~~b. Halsey Taylor.~~

~~2. Standards:~~

- ~~a. Comply with NSF 61 Annex G.~~
- ~~b. Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant unless otherwise indicated.~~

~~3. Cabinet: Steel with powder coat finish or Vinyl covered steel with stainless-steel top.~~

~~4. Bubbler: One, with adjustable stream regulator, located on deck.~~

~~5. Control: Push button.~~

~~6. Drain: Grid with NPS 1 1/4 tailpiece.~~

~~7. Supply: NPS 3/8 with shutoff valve.~~

~~8. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1 1/4 brass P-trap.~~

~~9. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.~~

~~10. Cooling System: Electric, with precooler, hermetically sealed compressor, cooling coil, air cooled condensing unit, corrosion resistant tubing, refrigerant, corrosion resistant metal storage tank, and adjustable thermostat.~~

- ~~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.~~

~~11. Capacities and Characteristics:~~

- ~~a. Cooled Water: 8 gph.~~
- ~~b. Ambient Air Temperature: 90 deg F.~~
- ~~c. Inlet Water Temperature: 80 deg F.~~
- ~~d. Cooled Water Temperature: 50 deg F.~~
- ~~e. Cooled Water Storage: MFG standard.~~
- ~~f. Electrical Characteristics: Per MFG cutsheet~~

B.A. Pressure Water Coolers: Wall mounted; wheelchair accessible.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Elkay.
- b. Halsey Taylor.
- c. Haws Corporation.
- d. Larco Inc.

2. Cabinet: Bi-level with two attached cabinets and with a bi-level skirt kit.

3. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.

3-4. Bottle Filling Station

4-5. Control: Push button or Push bar.

5-6. Drain: Grid with NPS 1-1/4 tailpiece.

~~6-7.~~ Supply: NPS 3/8 with shutoff valve.

~~7-8.~~ Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 brass P-trap.

~~8-9.~~ Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.

~~9-10.~~ Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.

- 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.

~~10-11.~~ Capacities and Characteristics:

- a. Cooled Water: 5 gph or 8 gph Insert value.
- b. Ambient-Air Temperature: 90 deg F.
- c. Inlet-Water Temperature: 80 deg F.
- d. Cooled-Water Temperature: 50 deg F.
- e. Electrical Characteristics: Per MFG's cutsheet.

~~11-12.~~ Support: ASME A112.6.1M, Type I water-cooler carrier.

## **PART 4 - EXECUTION**

### 4.1 EXAMINATION

- A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.
- B. Examine walls and floors for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 4.2 INSTALLATION

- A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.
- B. Set freestanding pressure water coolers on floor.
- C. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.
- D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball or gate valve. Install valves in locations where they can be easily reached for operation. ~~Valves are specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."~~

- E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."
- G. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."

#### 4.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."
- C. Install ball or gate shutoff valve on water supply to each fixture. Install valve upstream from filter for water cooler. ~~Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."~~
- D. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

#### 4.4 ADJUSTING

- A. Adjust fixture flow regulators for proper flow and stream height.
- B. Adjust pressure water-cooler temperature settings.

#### 4.5 CLEANING

- A. After installing fixture, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.
- C. Provide protective covering for installed fixtures.
- D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

**END OF SECTION**



**SECTION 230500**  
**COMMON WORK RESULTS FOR HVAC**

**PART 1 - GENERAL**

1.1 SUMMARY

A. This Section includes the following:

1. Grout.
2. Equipment installation requirements common to equipment sections.
3. Concrete bases.
4. Supports and anchorages.

1.2 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces 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.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. Connect: Complete hook-up of item with required services.
- G. Furnish: Supply and deliver complete.

1.3 SUBMITTALS

- A. Welding certificates.
- B. Within 20 calendar days after award of contract and in ample time to avoid delay of work, prepare a complete list and submittal of all materials including shop drawings, catalog information and other descriptive data for all items and submit to the Owner for review and comment.

- C. Submit shop drawings, catalog information, etc., neatly organized in binders, all at one time, for equipment furnished under this section. Five copies of all initial submittals are required for materials offered as specified, as well as for any proposed substitutions.
- D. Submittals shall clearly indicate on every copy:
  - 1. Tag, mark, or number by which item is identified in contract documents.
  - 2. Complete dimensional data.
  - 3. Elevation views for complete representation.
  - 4. Construction details.
  - 5. Arrangement of devices and appurtenances.
  - 6. Nameplate legends.
  - 7. Locations and sizes of connections.
  - 8. Finish materials and colors.
  - 9. Complete descriptive information.

#### 1.4 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
  - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.
- D. The design, manufacture and testing of mechanical equipment and materials shall conform to or exceed the latest applicable NEMA, ASME and ANSI standards.
- E. All materials must be new and bear a U.L. label. Materials that are not covered by U.L. testing standards shall be tested and listed by an independent testing laboratory of a governmental agency, which laboratory shall be acceptable to the Architect, Owner and code enforcing authority.
- F. These drawings and specifications define the minimum quality of product equipment by designating a manufacturer's trade name and catalog model number. The design has been based on this equipment selection and where more than one name is given, the first is the basis of the design. Other named equipment will require a request for substitution and be submitted as indicated herein.

#### 1.5 MATERIALS AND SUBSTITUTIONS

- A. Materials shall be new and of specified quality. Deliver materials to and store them at the project in unbroken factory containers, indication manufacturer's brand, and name of materials, which shall be used throughout the work.
- B. Clearly and permanently mark or stamp all materials with manufacturer's standard nameplate showing the model number and performance data. All materials shall be new and unused and provided with nameplates to indicate what function it serves.
- C. Brands or trade names are mentioned to set standards of quality; use no substitute materials unless acceptable in writing by the Architect. Acceptance of substitute materials does not relieve the Contractor of responsibility for providing a workable and functioning system as designed.
- D. Proof of equality is the sole responsibility of the Contractor. Descriptive data must be adequate to show the Architect why the materials or equipment meets the job requirements.
- E. Material submission is a requirement of these specifications. No payment for any work will be approved until this is done. Partial compliance or partial submittals will not be considered to show intent or ability to perform the work properly.
- F. Mark any submittal "As Specified", or accompanied by a letter from the supplier explaining in detail what the difference if any, exists between the submitted item and the specified item. Failure to point out differences will be considered cause for non-acceptance. The Architect and the Engineer will not assume any responsibility for any delays, damage, or expenses incurred by others due to such action.
- G. Revisions or additional work required, due to the use of substitute materials, shall be fully indicated on detailed drawings submitted with the shop drawings. Substitutions proposed because of insufficient time for delivery of previously approved item shall be accompanied by the original purchase order with date and "received" stamp by the vendor.

#### 1.6 OPERATING AND MAINTENANCE MANUALS

- A. Deliver to the Architect, for the Owner's use, three (3) complete operating and maintenance manuals covering all equipment and systems installed under this Division.
- B. Include spare parts, lists, wiring diagrams and operating instructions for all operating instructions for all operating equipment, as well as approved submittals. All information shall be in a three ring binder with hard cover and tab indexes. Provide index in front cover indicating parts name, date and local vendors for furnishing parts and information on equipment.

#### 1.7 EQUIPMENT HANDLING

- A. New equipment received at site prior to installation shall be stored indoors; when outdoors shall be mounted a minimum of 6" above grade with at least (1) layer of

heavy polyethylene plastic sheet weather proof covering anchored to prevent damage by high winds.

- B. Care shall be exercised during construction to avoid damage of any kind to mechanical equipment. Equipment shall be protected from dust and moisture during construction. Failure of the Contractor to protect the equipment as outlined herein shall be grounds for rejection of the equipment.
- C. Where equipment is specified to be installed in accordance with manufacturers recommendations, a copy of these recommendations shall be kept on the job site at all times and shall be made available to the Owners upon request.
- D. The general arrangement and location of piping, ductwork and equipment is shown on the Drawings, and shall be installed in accordance therewith, except for minor changes required by conflicts with other trades.

## 1.8 JOB CONDITIONS

- A. Visit to site is required of all bidders prior to submission of bid. All bidders will be held to have familiarized themselves with all discernible conditions and no extra payment will be allowed for work required because of these conditions, whether specifically mentioned or not.

## 1.9 DRAWINGS AND SPECIFICATIONS

- A. All drawings and all divisions of these specifications shall be considered as a whole. This contractor shall inform and report any apparent discrepancies before submitting bid.
- B. Every effort to make these drawings as accurate as available information allows has been made; however, the final location of piping, ductwork and equipment shall be verified and coordinated prior to installation.

## **PART 2 - PRODUCTS**

### 2.1 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
  - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
  - 2. Design Mix: 5000-psi, 28-day compressive strength.
  - 3. Packaging: Premixed and factory packaged.

### **PART 3 - EXECUTION**

#### 3.1 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

#### 3.2 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
  - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
  - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
  - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
  - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
  - 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
  - 7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

#### 3.3 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.4 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor HVAC materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.5 GROUTING

- A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

**END OF SECTION 230500**

## **SECTION 230513**

### **COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT**

#### **PART 1 - GENERAL**

##### 1.1 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

##### 1.2 COORDINATION

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

#### **PART 2 - PRODUCTS**

##### 2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.

##### 2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

##### 2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.

- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
  - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
  - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Rotor: Random-wound, squirrel cage.
- F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- G. Temperature Rise: Match insulation rating.
- H. Insulation: Class F.
- I. Code Letter Designation:
  - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
  - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

#### 2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
  - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
  - 2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
  - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
  - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

#### 2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
  - 1. Permanent-split capacitor.
  - 2. Split phase.
  - 3. Capacitor start, inductor run.
  - 4. Capacitor start, capacitor run.



- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

**PART 3 - EXECUTION (Not Applicable)**

**END OF SECTION 230513**

## **SECTION 230529**

### **HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT**

#### **PART 1 - GENERAL**

##### 1.1 SUMMARY

- A. This Section includes the following:
  - 1. Equipment supports.
- B. See Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
- C. See Division 21 Section "Fire-Suppression Systems" for pipe hangers for fire-protection piping.
- D. See Division 23 Section(s) "Metal Ducts" for duct hangers and supports.

##### 1.2 DEFINITIONS

- A. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

##### 1.3 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

##### 1.4 SUBMITTALS

- A. Product Data: For the following:
  - 1. Steel pipe hangers and supports.
  - 2. Thermal-hanger shield inserts.
  - 3. Powder-actuated fastener systems.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
  - 1. Trapeze pipe hangers. Include Product Data for components.
  - 2. Metal framing systems. Include Product Data for components.
  - 3. Equipment supports.

- C. Welding certificates.

## 1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

## **PART 2 - PRODUCTS**

### 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

### 2.2 EQUIPMENT SUPPORTS

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

### 2.3 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, 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 APPLICATIONS

- A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
  
  - E. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
    - 1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
    - 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction to attach to top flange of structural shape.
    - 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
    - 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
    - 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
    - 6. C-Clamps (MSS Type 23): For structural shapes.
    - 7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
      - a. Light (MSS Type 31): 750 lb (340 kg).
      - b. Medium (MSS Type 32): 1500 lb (680 kg).
      - c. Heavy (MSS Type 33): 3000 lb (1360 kg).
    - 8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
    - 9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
  
  - F. 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.
  
  - G. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
  
  - H. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
  
  - I. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- 3.2 HANGER AND SUPPORT INSTALLATION

- A. Ductwork 6 square feet or more in area shall be suspended by hangers not more than 12 inches in length; In-line components with an operating weight of more than 75lbs shall be supported and laterally braced independently of the duct; Items

mounted more than 4 feet from the floor and weighing more than 400 lbs shall be laterally braced. Laterally brace S5 and S6.

- B. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps and attachments as required to properly support piping from building structure.
- C. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
  - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
  - 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- E. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- F. Fastener System Installation:
  - 1. Install powder-actuated fasteners 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.
- G. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- I. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- J. Install lateral bracing with pipe hangers and supports to prevent swaying.
- K. 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.
- L. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

### 3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports: In-line components with an operating weight of more than 75 lbs shall be supported and laterally braced independently of the duct; Items mounted more than 4 feet from the floor and weighing more than 400 lbs shall be laterally braced. Laterally braced S5 and S6.

### 3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

### 3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

### 3.6 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

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16 January 2023

**END OF SECTION 230529**

## **SECTION 230548**

### **VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT**

#### **PART 1 - GENERAL**

##### 1.1 SUMMARY

A. This Section includes the following:

1. Isolation pads.
2. Freestanding spring isolators.
3. Restraining braces and cables.

B. Definitions:

1. IBC international Building Code
2. ICC-ES: Evaluation Service
3. OSHPD: Office of Statewide Health Planning and Development for the State of California

##### 1.2 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:

1. See Structural Drawings for Criteria

##### 1.3 SUBMITTALS

A. Product Data: For each product indicated.

B. Coordination Drawings: Show coordination of seismic bracings for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

C. Welding certificates.

D. Qualification Data: For professional engineer.

E. Field quality-control test reports.

##### 1.4 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.



- B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

## **PART 2 - PRODUCTS**

### 2.1 VIBRATION ISOLATORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
  - 1. Amber/Booth Company, Inc.
  - 2. California Dynamics Corporation.
  - 3. Kinetics Noise Control.
  - 4. Mason Industries.
  - 5. Vibration Eliminator Co., Inc.
- B. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
  - 1. Resilient Material: Oil- and water-resistant neoprene.
- C. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
  - 1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  - 2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  - 3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  - 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  - 5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch-thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
  - 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

### 2.2 SEISMIC-RESTRAINT DEVICES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:

1. Mason Industries, Inc.
  2. Amber/Booth Company, Inc.
  3. California Dynamics Corporation.
  4. Cooper B-Line, Inc.; a division of Cooper Industries.
  5. Hilti, Inc.
  6. Unistrut; Tyco International, Ltd.
- B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- C. Restraint Cables: ASTM A 603 galvanized-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cables service ; and with a minimum of two clamping bolts for cable engagement. Cables shall have a minimum safety factor of two and arranged to provide all-directional restraint. Cables must be prestretched to achieve a certified minimum modulus of elasticity. Cables must not be allowed to bend across sharp edges.
- D. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or Reinforcing steel angle clamped to hanger rod.
- E. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

### **PART 3 - EXECUTION**

#### 3.1 APPLICATIONS

- A. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

#### 3.2 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- B. Refer to Mason Industries "Seismic Restraint Guidelines For Suspended Piping, Ductwork, Electrical Systems and Floor Mounted Equipment" 8<sup>th</sup> Edition, June 2009 and Federal Emergency Management Agency FEMA 414/January 2004 "Installing Seismic Restraints For Duct And Pipe."
- C. Equipment Restraints:

1. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

D. Seismic Restraint of Piping

1. Seismically restrain all piping listed as a, b or c below. Use restraint cables.
  - a. Fuel oil piping, gas piping, medical gas piping, and compressed air piping that is 1" (25mm) I.D. or larger.
  - b. Piping located in boiler rooms, mechanical equipment rooms, and refrigeration equipment rooms that is 1 1/4" (32mm) I.D. and larger.
  - c. All other piping 2 1/2" (64mm) diameter and larger.
2. Transverse piping restraints shall be at 40' (12m) maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
3. Longitudinal restraints shall be at 80' (24m) maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
4. Where thermal expansion is a consideration, guides and anchors may be used as transverse and longitudinal restraints provided they have a capacity equal to or greater than the restraint loads in addition to the loads induced by expansion or contraction.
5. For fuel oil and all gas piping transverse restraints must be at 20' (6m) maximum and longitudinal restraints at 40' (12m) maximum spacing.
6. Transverse restraint for one pipe section may also act as a longitudinal restraint for a pipe section of the same size connected perpendicular to it if the restraint is installed within 24" (600mm) of the elbow or TEE or combined stresses are within allowable limits at longer distances.
7. Hold down clamps must be used to attach pipe to all trapeze members before applying restraints in a manner similar to clevis supports.
8. Branch lines may not be used to restrain main lines.
9. Cast iron pipe of all types, glass pipe and any other pipes joined with a four band shield and clamp assembly in areas with  $S_s$  of 0.35 or greater shall be braced as in sections 3.2.C.2 and 3. For areas with  $S_s$  less than 0.35, 2 band clamps may be used with a reduced spacing of 1/2 of those listed in sections 3.2.C.2 and 3.
10. Connection to the structure must be made with a non-friction connection.

E. Pipe Exclusions

1. Gas piping less than 1" (25mm) inside diameter.
2. Piping in boiler and mechanical rooms less than 1 1/4" (32mm) inside diameter.
3. All other piping less than 2 1/2" (64mm) inside diameter.

4. All piping suspended by clevis hangers where the distance from the top of the pipe to the suspension point is 12" or less.
5. All trapezed piping where the distance from the suspension point to the trapeze member is 12" or less.
6. If any suspension location in the run exceeds the above, the entire run must be braced.

F. Seismic Restraint of Ductwork

1. Seismically restrain all ductwork with cable restraints as listed below:
  - a. Restrain rectangular ducts with cross sectional area of 6 sq.ft. (.5 m<sup>2</sup>) or larger.
  - b. Restrain round ducts with diameters of 28" (700mm) or larger.
  - c. Restrain flat oval ducts the same as rectangular ducts of the same nominal size.
2. Transverse restraints shall occur at 30' (9m) intervals or at both ends of the duct run if less than the specified interval. Transverse restraints shall be installed at each duct turn and at each end of a duct run.
3. Longitudinal restraints shall occur at 60' (18m) intervals with at least one restraint per duct run. Transverse restraints for one duct section may also act as a longitudinal restraint for a duct section connected perpendicular to it if the restraints are installed within 4' (1.2m) of the intersection of the ducts and if the restraints are sized for the larger duct. Duct joints shall conform to SMACNA duct construction standards.
4. The ductwork must be reinforced at the restraint locations. Reinforcement shall consist of an additional angle on top of the ductwork that is attached to the support hanger rods. Ductwork is to be attached to both upper angle and lower trapeze.
5. A group of ducts may be combined in a larger frame so that the combined weights and dimensions of the ducts are less than or equal to the maximum weight and dimensions of the duct for which bracing details are selected.
6. Walls, including gypsum board non bearing partitions, which have ducts running through them may replace a typical transverse brace. Provide channel framing around ducts and solid blocking between the duct and frame.
7. Connection to the structure must be made with a non-friction connection.

G. Ductwork Exclusions

1. Rectangular and square and ducts that are less than 6 square feet in cross sectional area.
2. Oval ducts that are less than 6 square feet (.5m<sup>2</sup>) in cross sectional area based on nominal size.
3. Round duct less than 28" (.5m<sup>2</sup>) in diameter.
4. All trapezed ductwork where the distance from the suspension point to the trapeze member is 12" or less.

5. Ductwork hung with straps where the top of the duct is 12" or less from the suspension point and the strap has 2 #10 sheet metal screws within 2" of the top of the duct.
6. If any suspension location in the run exceeds the above, the entire run must be braced.

H. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.3 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 23 Section "Hydronic Piping" for piping flexible connections.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
  1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
  2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days' advance notice.
  3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
  4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
  5. Test to 90 percent of rated proof load of device.
  6. Measure isolator restraint clearance.
  7. Measure isolator deflection.

8. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports.

### 3.5 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust active height of spring isolators.
- D. Adjust restraints to permit free movement of equipment within normal mode of operation.

**END OF SECTION 230548**

## **SECTION 230553**

### **IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT**

#### **PART 1 - GENERAL**

##### 1.1 SUMMARY

- A. Section Includes:
  - 1. Equipment labels.
  - 2. Pipe labels.
  - 3. Duct labels.

##### 1.2 SUBMITTAL

- A. Product Data: For each type of product indicated.
- B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content of each label.

##### 1.3 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

#### **PART 2 - PRODUCTS**

##### 2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
  - 1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
  - 2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
  - 3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

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

## 2.2 DUCT LABELS

- A. Material and Thickness: Self-sticking, plastic film designed for permanent installation, 4 mil minimum thickness.
- B. General Requirements for Manufactured Duct Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- C. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- D. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- E. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.
  1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
  2. Lettering Size: At least 1-1/2 inches high.

## **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.



DUCT LABEL INSTALLATION

- C. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:
  - 1. Blue: For cold-air supply ducts.
  - 2. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
  - 3. ASME A13.1 Colors and Designs: For hazardous material exhaust.
  
- D. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

**END OF SECTION 230553**

## **SECTION 230593**

### **TESTING, ADJUSTING, AND BALANCING FOR HVAC**

#### **PART 1 - GENERAL**

##### 1.1 SUMMARY

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

##### 1.2 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
- F. TDH: Total dynamic head.

##### 1.3 INFORMATIONAL SUBMITTALS

- A. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- B. Certified TAB reports.

##### 1.4 QUALITY ASSURANCE

- A. TAB Specialists Qualifications: Certified by AABC, NEBB or TABB.
  - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC NEBB or TABB.
  - 2. TAB Technician: Employee of the TAB specialist and certified by AABC, NEBB or TABB as a TAB technician.

- B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

## PART 2 - PRODUCTS (Not Applicable)

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for 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 applicable for intended purpose and 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 used for supply, return, or relief air to verify that they 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 verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- K. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.
- L. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N. Examine operating safety interlocks and controls on HVAC equipment.
- O. 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 for balancing the systems.
- B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
  - 1. Airside:
    - a. Duct systems are complete with terminals installed.
    - b. Volume, smoke, and fire dampers are open and functional.
    - c. Clean filters are installed.
    - d. Fans are operating, free of vibration, and rotating in correct direction.
    - e. Variable-frequency controllers' startup is complete and safeties are verified.
    - f. Automatic temperature-control systems are operational.
    - g. Ceilings are installed.
    - h. Windows and doors are installed.
    - i. Suitable access to balancing devices and equipment is provided.

### 3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance", ASHRAE 111 NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of

Environmental Systems" or SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.

- 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 Section 233300 "Air Duct Accessories."
  - 3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

#### 3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.
- L. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

### 3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
  - 1. Measure total airflow.
    - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
    - b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
    - c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
    - d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
  - 2. Measure fan static pressures as follows:
    - a. Measure static pressure directly at the fan outlet or through the flexible connection.
    - b. Measure static pressure directly at the fan inlet or through the flexible connection.
    - c. Measure static pressure across each component that makes up the air-handling system.
    - d. Report artificial loading of filters at the time static pressures are measured.
  - 3. 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.
  - 4. Obtain approval from Owner or Construction Manager for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
  - 5. 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 occurs. 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.
  - 1. Measure airflow of submain and branch ducts.
  - 2. Adjust submain and branch duct volume dampers for specified airflow.
  - 3. Re-measure each submain and branch duct after all have been adjusted.
- C. Adjust air inlets and outlets for each space to indicated airflows.
  - 1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
  - 2. Measure inlets and outlets airflow.

3. Adjust each inlet and outlet for specified airflow.
4. Re-measure each inlet and outlet after they have been adjusted.

### 3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

#### A. Adjust the variable-air-volume systems as follows:

1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
2. Verify that the system is under static pressure control.
3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point 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.
4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
  - a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
  - b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
  - c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
  - d. Adjust controls so that terminal is calling for minimum airflow.
  - e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
  - f. When in full cooling or full heating, ensure that there is no mixing of hot-deck and cold-deck airstreams unless so designed.
  - g. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.
5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.
  - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
  - b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow so that connected total matches fan selection and simulates actual load in the building.
  - c. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
  - d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
  - e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

6. Measure fan static pressures as follows:
  - a. Measure static pressure directly at the fan outlet or through the flexible connection.
  - b. Measure static pressure directly at the fan inlet or through the flexible connection.
  - c. Measure static pressure across each component that makes up the air-handling system.
  - d. Report any artificial loading of filters at the time static pressures are measured.
7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
  - a. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
  - b. Verify that terminal units are meeting design airflow under system maximum flow.
8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls contractor.
9. Verify final system conditions as follows:
  - a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
  - b. Re-measure and confirm that total airflow is within design.
  - c. Re-measure final fan operating data, rpms, volts, amps, and static profile.
  - d. Mark final settings.
  - e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
  - f. Verify tracking between supply and return fans.

### 3.7 TOLERANCES

- A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
  1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
  2. Air Outlets and Inlets: Plus or minus 10 percent.
- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

### 3.8 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.



1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
  2. Include a list of instruments used for procedures, along with proof of calibration.
  3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to certified field-report data, include the following:
1. 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 specialist.
  3. Project name.
  4. Project location.
  5. Architect's name and address.
  6. Engineer's name and address.
  7. Contractor's name and address.
  8. Report date.
  9. Signature of TAB supervisor who certifies the report.
  10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
  11. Summary of contents including the following:
    - a. Indicated versus final performance.
    - b. Notable characteristics of systems.
    - c. Description of system operation sequence if it varies from the Contract Documents.
  12. Nomenclature sheets for each item of equipment.
  13. Data for terminal units, including manufacturer's name, type, size, and fittings.
  14. Notes to explain why certain final data in the body of reports vary from indicated values.
  15. Test conditions for fans and pump performance forms including the following:
    - a. Settings for outdoor-, return-, and exhaust-air dampers.
    - b. Conditions of filters.
    - c. Cooling coil, wet- and dry-bulb conditions.
    - d. Face and bypass damper settings at coils.
    - e. Fan drive settings including settings and percentage of maximum pitch diameter.
    - f. Inlet vane settings for variable-air-volume systems.
    - g. Settings for supply-air, static-pressure controller.
    - h. Other system operating conditions that affect performance.

- D. System Diagrams: Include schematic layouts of air distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
  2. Duct, outlet, and inlet sizes.
  3. Pipe and valve sizes and locations.
  4. Terminal units.
  5. Balancing stations.
  6. Position of balancing devices.
- E. Roof Top Units Test Reports: For air-handling units with coils, include the following:
1. Unit Data:
    - a. Unit identification.
    - b. Location.
    - c. Make and type.
    - d. Model number and unit size.
    - e. Manufacturer's serial number.
    - f. Unit arrangement and class.
    - g. Discharge arrangement.
    - h. Sheave make, size in inches, and bore.
    - i. Center-to-center dimensions of sheave and amount of adjustments in inches.
    - j. Number, make, and size of belts.
    - k. Number, type, and size of filters.
  2. Motor Data:
    - a. Motor make, and frame type and size.
    - b. Horsepower and rpm.
    - c. Volts, phase, and hertz.
    - d. Full-load amperage and service factor.
    - e. Sheave make, size in inches, and bore.
    - f. Center-to-center dimensions of sheave and amount of adjustments in inches.
  3. Test Data (Indicated and Actual Values):
    - a. Total airflow rate in cfm.
    - b. Total system static pressure in inches wg.
    - c. Fan rpm.
    - d. Discharge static pressure in inches wg.
    - e. Filter static-pressure differential in inches wg.
    - f. Preheat-coil static-pressure differential in inches wg.
    - g. Cooling-coil static-pressure differential in inches wg.
    - h. Heating-coil static-pressure differential in inches wg.
    - i. Outdoor airflow in cfm.
    - j. Return airflow in cfm.
    - k. Outdoor-air damper position.
    - l. Return-air damper position.
    - m. Vortex damper position.

- F. Gas 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.
    - 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, and bore.
    - n. Center-to-center dimensions of sheave and amount of adjustments in inches.
  2. Test Data (Indicated and Actual Values):
    - a. Total airflow rate in cfm.
    - b. Entering-air temperature in deg F.
    - c. Leaving-air temperature in deg F.
    - d. Air temperature differential in deg F.
    - e. Entering-air static pressure in inches wg.
    - f. Leaving-air static pressure in inches wg.
    - g. Air static-pressure differential in inches wg.
    - h. Low-fire fuel input in Btu/h.
    - i. High-fire fuel input in Btu/h.
    - j. Manifold pressure in psig.
    - k. High-temperature-limit setting in deg F.
    - l. Operating set point in Btu/h.
    - m. Motor voltage at each connection.
    - n. Motor amperage for each phase.
    - o. Heating value of fuel in Btu/h.
- G. Fan Test Reports: For supply, return, and exhaust fans, include the following:
1. Fan Data:
    - a. System identification.
    - b. Location.
    - c. Make and type.
    - d. Model number and size.
    - e. Manufacturer's serial number.
    - f. Arrangement and class.
    - g. Sheave make, size in inches, and bore.
    - h. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Motor Data:
    - a. Motor make, and frame type and size.
    - b. Horsepower and rpm.
    - c. Volts, phase, and hertz.
    - d. Full-load amperage and service factor.
    - e. Sheave make, size in inches, and bore.
    - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
    - g. Number, make, and size of belts.
  3. Test Data (Indicated and Actual Values):
    - a. Total airflow rate in cfm.
    - b. Total system static pressure in inches wg.
    - c. Fan rpm.
    - d. Discharge static pressure in inches wg.
    - e. Suction static pressure in inches wg.
- H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
1. Report Data:
    - a. System and air-handling-unit number.
    - b. Location and zone.
    - c. Traverse air temperature in deg F.
    - d. Duct static pressure in inches wg.
    - e. Duct size in inches.
    - f. Duct area in sq. ft.
    - g. Indicated airflow rate in cfm.
    - h. Indicated velocity in fpm.
    - i. Actual airflow rate in cfm.
    - j. Actual average velocity in fpm.
    - k. Barometric pressure in psig.
- I. 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.
  2. Test Data (Indicated and Actual Values):
    - a. Airflow rate in cfm.

- b. Air velocity in fpm.
- c. Preliminary airflow rate as needed in cfm.
- d. Preliminary velocity as needed in fpm.
- e. Final airflow rate in cfm.
- f. Final velocity in fpm.
- g. Space temperature in deg F.

J. System-Coil Reports: For reheat coils of terminal units, include the following:

1. Unit Data:

- a. System and air-handling-unit identification.
- b. Location and zone.
- c. Room or riser served.
- d. Coil make and size.

2. Test Data (Indicated and Actual Values):

- a. Airflow rate in cfm.
- b. Entering-air temperature in deg F.
- c. Leaving-air temperature in deg F.

K. Instrument Calibration Reports:

1. Report Data:

- a. Instrument type and make.
- b. Serial number.
- c. Application.
- d. Dates of use.
- e. Dates of calibration.

### 3.9 VERIFICATION OF TAB REPORT

- A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Owner or Construction Manager.
- B. Architect, Owner or Construction Manager 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.
- C. 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."
- D. 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.
- E. If TAB work fails, proceed as follows:

1. TAB specialists shall 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 specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.
3. If the second verification also fails, Owner or design professional may contact AABC Headquarters regarding the AABC National Performance Guaranty.

F. Prepare test and inspection reports.

### 3.10 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 230593

## **SECTION 230713**

### **DUCT INSULATION**

#### **PART 1 - GENERAL**

##### 1.1 SUMMARY

- A. Section includes insulating the following duct services:
  - 1. Indoor, concealed supply and outdoor air.
  - 2. Indoor, exposed supply and outdoor air.
  - 3. Indoor, concealed return located in unconditioned space.
  - 4. Indoor, exposed return located in unconditioned space.
  
- B. Related Sections:
  - 1. Section 233113 "Metal Ducts" for duct liners.

##### 1.2 ACTION SUBMITTALS

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

##### 1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

##### 1.4 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
  - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
  - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less. PRODUCTS

##### 1.5 INSULATION MATERIALS

- A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.
  
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I, Type II with factory-applied vinyl jacket, Type III with factory-applied FSK jacket or Type III with factory-applied FSP jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. CertainTeed Corporation.
    - b. Johns Manville; a Berkshire Hathaway company.
    - c. Knauf Insulation.
    - d. Manson Insulation Inc.
- 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, with factory-applied ASJ or with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. CertainTeed Corporation.
    - b. Johns Manville; a Berkshire Hathaway company.
    - c. Knauf Insulation.
    - d. Manson Insulation Inc.

## 1.6 FIRE-RATED INSULATION SYSTEMS

- A. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. 3M.
    - b. CertainTeed Corporation.
    - c. Johns Manville; a Berkshire Hathaway company.
    - d. Nelson Firestop; a brand of Emerson Industrial Automation.
    - e. Thermal Ceramics.



## 1.7 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Eagle Bridges - Marathon Industries.
    - c. Foster Brand; H. B. Fuller Construction Products.
  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).
- 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Eagle Bridges - Marathon Industries.
    - c. Foster Brand; H. B. Fuller Construction Products.
  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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Dow Corning Corporation.
    - b. Johns Manville; a Berkshire Hathaway company.
    - c. P.I.C. Plastics, Inc.
  2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## 1.8 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
  1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Foster Brand; H. B. Fuller Construction Products.
  2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
  3. Service Temperature Range: Minus 20 to plus 180 deg F.
  4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
  5. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Eagle Bridges - Marathon Industries.
    - c. Foster Brand; H. B. Fuller Construction Products.
    - d. Knauf Insulation.
    - e. Mon-Eco Industries, Inc.
  2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
  3. Service Temperature Range: Minus 20 to plus 180 deg F.
  4. Solids Content: 60 percent by volume and 66 percent by weight.
  5. Color: White.

## 1.9 SEALANTS

- A. FSK and Metal Jacket Flashing Sealants:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Eagle Bridges - Marathon Industries.
    - c. Foster Brand; H. B. Fuller Construction Products.
  2. Materials shall be compatible with insulation materials, jackets, and substrates.

3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

#### 1.10 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
  2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
  3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
  4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
  5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

#### 1.11 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for ducts.
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. Foster Brand; H. B. Fuller Construction Products.

#### 1.12 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Johns Manville; a Berkshire Hathaway company.
  - b. P.I.C. Plastics, Inc.
  - c. Proto Corporation.
2. Adhesive: As recommended by jacket material manufacturer.
  3. Color: Color-code jackets based on system. Color as selected by Architect.
- D. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. ITW Insulation Systems; Illinois Tool Works, Inc.
  2. Sheet and roll stock ready for shop or field sizing or Factory cut and rolled to size.
  3. Finish and thickness are indicated in field-applied jacket schedules.
  4. Moisture Barrier for Indoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper or 2.5-mil-thick polysurlyn.

#### 1.13 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Avery Dennison Corporation, Specialty Tapes Division.
    - b. Compac Corporation.
    - c. Ideal Tape Co., Inc., an American Biltrite Company.
    - d. Knauf Insulation.
  2. Width: 3 inches.
  3. Thickness: 11.5 mils.
  4. Adhesion: 90 ounces force/inch in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch in width.
  7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Avery Dennison Corporation, Specialty Tapes Division.
    - b. Compac Corporation.

- c. Ideal Tape Co., Inc., an American Biltrite Company.
      - d. Knauf Insulation.
    - 2. Width: 3 inches.
    - 3. Thickness: 6.5 mils.
    - 4. Adhesion: 90 ounces force/inch in width.
    - 5. Elongation: 2 percent.
    - 6. Tensile Strength: 40 lbf/inch in width.
    - 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
  - C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
    - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - a. Compac Corporation.
      - b. Ideal Tape Co., Inc., an American Biltrite Company.
    - 2. Width: 2 inches.
    - 3. Thickness: 6 mils.
    - 4. Adhesion: 64 ounces force/inch in width.
    - 5. Elongation: 500 percent.
    - 6. Tensile Strength: 18 lbf/inch in width.
  - D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
    - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - a. Avery Dennison Corporation, Specialty Tapes Division.
      - b. Compac Corporation.
      - c. Ideal Tape Co., Inc., an American Biltrite Company.
      - d. Knauf Insulation.
    - 2. Width: 2 inches.
    - 3. Thickness: 3.7 mils.
    - 4. Adhesion: 100 ounces force/inch in width.
    - 5. Elongation: 5 percent.
    - 6. Tensile Strength: 34 lbf/inch in width.
- 1.14 SECUREMENTS
- A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.
    - 1. 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. ITW Insulation Systems; Illinois Tool Works, Inc.

B. Insulation Pins and Hangers:

1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) AGM Industries, Inc.
    - 2) Gemco.
  - b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
  - c. Spindle: Copper- or zinc-coated, low-carbon steel, Aluminum or Stainless steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
  - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
2. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
  - a. 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.
  - b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
  - c. Spindle: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
  - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
3. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) AGM Industries, Inc.
    - 2) Gemco.
    - 3) Hardcast, Inc.
  - b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
  - c. Spindle: Copper- or zinc-coated, low-carbon steel, Aluminum or Stainless steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
  - d. Adhesive-backed base with a peel-off protective cover.
4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel, aluminum or stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) AGM Industries, Inc.
    - 2) Gemco.
    - 3) Hardcast, Inc.
    - 4) Midwest Fasteners, Inc.
  - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
5. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- 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.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
- D. Wire: 0.080-inch nickel-copper alloy, 0.062-inch soft-annealed, stainless steel or 0.062-inch soft-annealed, galvanized steel.
- 1.15 CORNER ANGLES
- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

- B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

## **PART 2 - EXECUTION**

### 2.1 PREPARATION

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

### 2.2 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:



1. Draw jacket tight and smooth.
  2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
  3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
    - a. For below ambient services, apply vapor-barrier mastic over staples.
  4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
  5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

## 2.3 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
  2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
  4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
  2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
  4. Seal jacket to wall flashing with flashing sealant.

- C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
  - 1. Comply with requirements in Section 078413 "Penetration Firestopping" for 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.
  - 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

#### 2.4 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
  - 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
  - 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
  - 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    - d. Do not overcompress insulation during installation.
    - e. Impale insulation over pins and attach speed washers.
    - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
  - 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with

- 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
- a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
  - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
  6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
  7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
- B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
  2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
  3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    - d. Do not overcompress insulation during installation.
    - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
  4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with

1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

- a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
  - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
  6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

## 2.5 FIELD-APPLIED JACKET INSTALLATION

- A. Where FSK jackets are indicated, install as follows:
  1. Draw jacket material smooth and tight.
  2. Install lap or joint strips with same material as jacket.
  3. Secure jacket to insulation with manufacturer's recommended adhesive.
  4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
  5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
  1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

## 2.6 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

- B. Insulate duct access panels and doors to achieve same fire rating as duct.
- C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Section 078413 "Penetration Firestopping."

## 2.7 FINISHES

- A. Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
  - 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
    - a. Finish Coat Material: Interior, flat, latex-emulsion size.
  - B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
  - C. Do not field paint aluminum or stainless-steel jackets.

## 2.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
  - 1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

## 2.9 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
  - 1. Indoor, concealed supply and outdoor air.
  - 2. Indoor, exposed supply and outdoor air.
  - 3. Indoor, concealed return located in unconditioned space.
  - 4. Indoor, exposed return located in unconditioned space.
  - 5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
  - 6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
- 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.

## 2.10 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Concealed, Supply-Air Duct and Plenum Insulation: Mineral-fiber blanket or board, 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
- B. Concealed, Return-Air Duct and Plenum Insulation: Mineral-fiber blanket or board, 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
- C. Concealed, Outdoor-Air Duct and Plenum Insulation: Mineral-fiber blanket or board, 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
- D. Concealed, Exhaust-Air Duct and Plenum Insulation: Mineral-fiber blanket or board, 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
- E. Exposed, Supply-Air Duct and Plenum Insulation: Mineral-fiber blanket or board, 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
- F. Exposed, Return-Air Duct and Plenum Insulation: Mineral-fiber blanket or board, 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
- G. Exposed, Outdoor-Air Duct and Plenum Insulation: Mineral-fiber blanket or board, 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
- H. Exposed, Exhaust-Air Duct and Plenum Insulation: Mineral-fiber blanket or board, 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

## 2.11 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Ducts and Plenums, Concealed:
  1. None.
  2. PVC, Color-Coded by System: 30 mils thick.
  3. Aluminum, Smooth, Corrugated or Stucco Embossed: 0.024 inch thick.

**END OF SECTION 230713**

Bell Auditorium Expansion & Renovations  
Augusta, Georgia  
Issue for Permit / Bid

Perkins&Will  
222028.000  
16 January 2023

## **SECTION 230800**

### **COMMISSIONING OF HVAC**

#### **PART 1 - GENERAL**

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- A. Section includes commissioning process requirements for the following HVAC&R systems, assemblies, and equipment:

1. Energy supply systems, including gas supply.
2. Cooling generation systems, including direct-expansion systems.
3. Distribution systems, including air distribution (heating and cooling) systems, exhaust systems air-handling units and outside air distribution systems.
4. Terminal and packaged units, including unit ventilators, fan-coil units electric heating and packaged units.
5. Vibration and sound systems, including sound attenuation, vibration isolation devices and seismic/wind restraints.
6. Controls and instrumentation, including BAS and energy monitoring and control system.
7. Systems testing and balancing verification, including heating-water piping systems, chilled-water piping systems, domestic hot-water circulating systems, supply-air systems, return-air systems, exhaust-air systems and outside air systems.
8. Insert HVAC systems.

- B. Related Requirements:

1. Section 019113 "General Commissioning Requirements" for general commissioning process requirements and Commissioning Coordinator responsibilities.

##### 1.3 DEFINITIONS

- A. BAS: Building automation system.
- B. DDC: Direct digital controls.
- C. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.



- D. "Systems," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.
- E. TAB: Testing, adjusting, and balancing.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For BAS and HVAC&R Testing Technician.
- B. Construction Checklists: For the following:
  - 1. Vibration and seismic/wind controls for HVAC&R piping and equipment.
  - 2. Instrumentation and control for HVAC&R.
  - 3. Refrigerant piping.
  - 4. Metal ducts and accessories.
  - 5. Fans.
  - 6. Particulate air filtration.
  - 7. Air-handling units.

#### 1.5 QUALITY ASSURANCE

- A. BAS Testing Technician Qualifications: Technicians to perform BAS construction checklist verification tests, construction checklist verification test demonstrations, commissioning tests, and commissioning test demonstrations shall have the following minimum qualifications:
  - 1. Journey-level or equivalent skill level with knowledge of BAS, HVAC&R, electrical concepts, and building operations.
  - 2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.
  - 3. International Society of Automation (ISA) Certified Control Systems Technician (CCST) Level I.
- B. HVAC&R Testing Technician Qualifications: Technicians to perform HVAC&R construction checklist verification tests, construction checklist verification test demonstrations, commissioning tests, and commissioning test demonstrations shall have the following minimum qualifications:
  - 1. Journey-level or equivalent skill level. Vocational School four-year program graduate or an Associate's degree in mechanical systems, air conditioning, or similar field. Degree may be offset by three years' experience in servicing mechanical systems in the HVAC industry. Generally, required knowledge includes HVAC&R systems, electrical concepts, building operations, and application and use of tools and instrumentation to measure performance of HVAC&R equipment, assemblies, and systems.
  - 2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.
  - 3. One of the following:

- a. National Environmental Balancing Bureau (NEBB) Certified Testing, Adjusting, and Balancing Technician.
  - b. Associated Air Balance Council (AABC) Certified Test and Balance Technician.
  - c. Owner retains the right to waive NEBB or AABC Certification.
- C. Testing Equipment and Instrumentation Quality and Calibration: For test equipment and instrumentation required to perform HVAC&R commissioning work, perform the following:
1. Submit test equipment and instrumentation list. For each equipment or instrument, identify the following:
    - a. Equipment/instrument identification number.
    - b. Planned commissioning application or use.
    - c. Manufacturer, make, model, and serial number.
    - d. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.
  2. Test equipment and instrumentation shall meet the following criteria:
    - a. Capable of testing and measuring performance within the specified acceptance criteria.
    - b. Be calibrated at the manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
    - c. Be maintained in good repair and operating condition throughout the duration of use on this Project.
    - d. Be recalibrated/repared if dropped or damaged in any way since last calibrated.
- D. Proprietary Test Instrumentation and Tools:
1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the commissioning process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, perform the following:
    - a. Submit proprietary instrumentation and tools list. For each instrument or tool, identify the following:
      - 1) Instrument or tool identification number.
      - 2) Equipment schedule designation of equipment for which the instrument or tool is required.
      - 3) Manufacturer, make, model, and serial number.
      - 4) Calibration history, including certificates from agencies that calibrate the instrument or tool, where appropriate.
    - b. Include a separate list of proprietary test instrumentation and tools in the operation and maintenance manuals.
    - c. HVAC&R proprietary test instrumentation and tools become the property of Owner at the time of Substantial Completion.

## **PART 2 - PRODUCTS (Not Used)**

### **PART 3 - EXECUTION**

#### 3.1 GENERAL TESTING REQUIREMENTS

- A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents and approved Shop Drawings and submittals.
- B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents and approved Shop Drawings and submittals, and that pretest set points have been recorded.
- C. Certify that TAB procedures have been completed and that TAB reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Set systems, subsystems, and equipment into operating mode to be tested according to approved test procedures (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. Construction Checklists: Prepare and submit detailed construction checklists for HVAC&R systems, subsystems, equipment, and components.
  - 1. Contributors to the development of construction checklists shall include, but are not limited to, the following:
    - a. HVAC&R systems and equipment installers.
    - b. TAB technicians.
    - c. HVAC&R instrumentation and controls installers.
- F. Perform tests using design conditions, whenever possible.
  - 1. Simulated conditions may, with approval of commissioning agent, be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by Commissioning Coordinator and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.
  - 2. Commissioning test procedures may direct that set points be altered when simulating conditions is impractical.
  - 3. Commissioning test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.
- G. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to Owner. After deficiencies are resolved, reschedule tests.

- H. If seasonal testing is specified, complete appropriate initial performance tests and documentation and schedule seasonal tests.
- I. Coordinate schedule with, and perform the following activities at the direction of, Commissioning Coordinator.
- J. Comply with construction checklist requirements, including material verification, installation checks, start-up, and performance tests requirements specified in Sections specifying HVAC systems and equipment.
- K. Provide technicians, instrumentation, tools, and equipment to complete and document the following:
  - 1. Performance tests.
  - 2. Demonstration of a sample of performance tests.
  - 3. Commissioning tests.
  - 4. Commissioning test demonstrations.

### 3.2 TAB COMMISSIONING TESTS

#### A. TAB Verification:

- 1. Conditions of the Test:
  - a. Commissioning Test Demonstration Sampling Rate: As specified in "Inspections" Article in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
  - b. Systems operating in full heating mode with minimum outside-air volume.
  - c. Systems operating in full cooling mode with minimum outside-air volume.
  - d. For measurements at air-handling units with economizer controls; systems operating in economizer mode with 100 percent outside air.
- 2. Acceptance Criteria:
  - a. Under all conditions, rechecked measurements comply with "Inspections" Article in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
  - b. Additionally, no rechecked measurement shall differ from measurements documented in the final report by more than two times the tolerances allowed.
  - c. Under all conditions, where the Contract Documents indicate a differential in airflow between supply and exhaust and/or return in a space, the differential relationship shall be maintained.

### 3.3 AIR-HANDLING SYSTEM COMMISSIONING TESTS

#### A. Supply Fan(s) Variable-Volume Control:

- 1. Prerequisites: Installation verification of the following:

- a. Volume Control Input Device: Static-pressure transmitter or Differential-pressure switch sensing supply-duct static pressure referenced to conditioned-space static pressure.
  - b. Volume Control Output Device: Receiver controller or DDC system analog output to modulating damper actuator. Set inlet guide vanes to minimum or closed position when fan is stopped.
  - c. Volume Control Input Device: Static-pressure transmitter or Differential-pressure switch sensing supply-duct static pressure referenced to conditioned-space static pressure.
  - d. Volume Control Output Device: Receiver controller or DDC system analog output to motor speed controller. Set variable-speed drive to minimum speed when fan is stopped.
  - e. High-Pressure Input Device: Static-pressure transmitter sensing supply-duct static pressure referenced to static pressure outside the duct.
  - f. High-Pressure Output Device: Receiver controller or DDC system binary output to alarm panel or motor starter.
  - g. Display the following at the operator's workstation:
    - 1) Supply-fan-discharge static-pressure indication.
    - 2) Supply-fan-discharge static-pressure set point.
    - 3) Supply-fan airflow rate.
    - 4) Supply-fan speed.
2. Conditions of the Test:
- a. Minimum supply-air flow.
  - b. Midrange Supply-Air Flow: 50 to 60 percent of maximum.
  - c. Maximum supply-air flow.
  - d. Excess supply-air discharge static pressure.
3. Acceptance Criteria:
- a. At all supply-air flow rates, and during changes in supply-air flow, discharge air static pressure is at set point plus or minus 2 percent.
  - b. Fan stops and an alarm is initiated at the operator's workstation when supply-air discharge static pressure is at the excess static pressure plus or minus 2 percent.
- B. Air-Handler Mixed-Air Control:
1. Prerequisites: Installation verification of the following:
    - a. Minimum Position Input Device: Time clock or DDC system time schedule.
    - b. Output Device: Receiver controller or DDC system analog output to modulating damper actuator(s).
    - c. Heating Reset Input Device: Room thermostat or DDC system software.
    - d. Supply Mixed-Air Temperature Input Device: Duct-mounted thermostat Electronic temperature sensor.
    - e. Cooling Reset Input Device: Outdoor- and return-air, duct-mounted thermostats or electronic temperature sensors.
    - f. Display the following at the operator's workstation:

- 1) Mixed-air-temperature indication.
- 2) Mixed-air-temperature set point.
- 3) Mixed-air damper position.

2. Conditions of the Test:

- a. Occupied Time Control: Start in unoccupied schedule. Advance to occupied schedule time.
- b. Minimum Damper Position Control: Command system to mode in which minimum damper position is required.
- c. Heating Reset Control: Create a call for heating.
- d. Supply or Mixed-Air Temperature Control: Override supply or mixed-air temperature set point to a value 2.0 deg F above current supply or mixed-air temperature.
- e. Cooling Reset Control: Override outdoor-air temperature to a value that exceeds return-air temperature or enthalpy to a value that exceeds return-air enthalpy.
- f. Unoccupied Time Control: Advance to unoccupied schedule time.
- g. Control Data Trend Log: Set up a data trend log of the following input device values and output device commands. Record data at hourly intervals. Submit trend data for 24-hour periods in which natural conditions require heating reset control, supply and mixed-air temperature control, and cooling reset control.
  - 1) Minimum position input device.
  - 2) Heating reset input device.
  - 3) Supply and Mixed-air temperature input device.
  - 4) Cooling reset input device.

3. Acceptance Criteria:

- a. Occupied Time Control: Mixed-air control is active in occupied mode.
- b. Minimum Damper Position Control: Controller opens minimum outdoor-air dampers or positions outdoor-air dampers to minimum position.
- c. Heating Reset Control: Controller closes minimum outdoor-air dampers or sets outdoor-air dampers to minimum position.
- d. Supply Mixed-Air Temperature Control: Controller modulates outdoor-, return-, and relief-air dampers to maintain temporary supply mixed-air temperature set point plus or minus 1.0 deg F Inset temperature.
- e. Cooling Reset Control: Controller sets outdoor-air dampers to minimum position when outdoor-air temperature exceeds return-air temperature or enthalpy exceeds return-air enthalpy.
- f. Unoccupied Time Control: Controller positions outdoor- and relief-air dampers closed and return-air dampers open.
- g. Control Data Trend Log: Data verifies control according to sequence of control.

**END OF SECTION 230800**

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## **SECTION 230993**

### **SEQUENCE OF OPERATIONS FOR HVAC CONTROLS**

#### **PART 1 - GENERAL**

##### 1.1 SUMMARY

- A. This Section includes control sequences for HVAC systems, subsystems, and equipment.
- B. See Section 230900 "Instrumentation and Control for HVAC" for control equipment and devices and for submittal requirements.

##### 1.2 AIR-HANDLING-UNIT/PACKAGED UNIT CONTROL SEQUENCES

###### A. Start and Stop Supply Fan(s):

###### 1. Enable: Smoke Control:

- a. Input Device: Duct-mounted smoke detector, located in supply air.
- b. Output Device: Hard wired through motor starter; analog alarm panel or DDC system alarm.
- c. Action: Allow start if duct is free of products of combustion.

###### 2. Initiate: Occupied Time Schedule:

- a. Input Device: Time clock or DDC system time schedule.
- b. Output Device: Time clock or Binary output to motor starter.
- c. Action: Energize fan(s).

###### 3. Display: Supply-fan on-off indication.

###### B. Supply Fan(s) Variable-Volume Control:

###### 1. Occupied Time Schedule:

- a. Input Device: Time clock or DDC system time schedule.
- b. Output Device: Time clock or Binary output.
- c. Action: Enable control.

###### 2. Volume Control:

- a. Input Device: Static-pressure transmitter or Differential-pressure switch sensing supply-duct static pressure referenced to conditioned-space static pressure.
- b. Output Device: Receiver controller or DDC system analog output to modulating damper actuator. Set inlet guide vanes to minimum closed position when fan is stopped.



- c. Action: Maintain constant supply-duct static pressure.
  3. Volume Control:
    - a. Input Device: Static-pressure transmitter or Differential-pressure switch sensing supply-duct static pressure referenced to conditioned-space static pressure.
    - b. Output Device: Receiver controller or DDC system analog output to motor speed controller. Set variable-speed drive to minimum speed when fan is stopped.
    - c. Action: Maintain constant supply-duct static pressure.
  4. High Pressure:
    - a. Input Device: Static-pressure transmitter sensing supply-duct static pressure referenced to static pressure outside the duct.
    - b. Output Device: Receiver controller or DDC system binary output to alarm panel or motor starter.
    - c. Action: Stop fan and signal alarm when static pressure rises above excessive-static-pressure set point.
  5. Display:
    - a. Supply-fan-discharge static-pressure indication.
    - b. Supply-fan-discharge static-pressure set point.
    - c. Supply-fan airflow rate.
    - d. Supply-fan speed.
- C. Filters: During occupied periods, when fan is running, differential air-pressure transmitters exist.
  1. Differential Pressure:
    - a. Input Device: Differential-pressure switches or Pressure transmitter.
    - b. Output Device: Analog alarm panel or DDC system alarm.
    - c. Action: Signal alarm on low- and high-pressure conditions.
  2. Display:
    - a. Filter air-pressure-drop indication.
    - b. Filter low-air-pressure set point.
    - c. Filter high-air-pressure set point.
- D. Gas Heating:
  1. Occupied Time Schedule:
    - a. Input Device: Time clock or DDC system time schedule.
    - b. Output Device: Time clock or Binary output.
    - c. Action: Enable control.
  2. Supply or Discharge-Air Temperature:

- a. Input Device: Room mounted thermostat.
  - b. Output Device: Normally open control valve.
  - c. Action: Maintain supply-air temperature set point of 55 deg F.
3. Temperature Reset:
    - a. Input Device: Duct-mounted thermostat or Electronic temperature sensor in return air.
    - b. Output Device: Direct to receiver controller or DDC system in straight-line relationship for the following conditions:
      - 1) 65 deg F when return-air temperature is 70 deg F.
      - 2) 55 deg F when return-air temperature is 75 deg F.
    - c. Action: Reset supply-air temperature set point of 55 deg F.
  4. Display:
    - a. Fan-discharge air-temperature indication.
    - b. Fan-discharge air-temperature set point.
- E. DX Cooling Coil:
1. Occupied Time Schedule:
    - a. Input Device: Time clock or DDC system time schedule.
    - b. Output Device: Time clock or Binary output.
    - c. Action: Enable control.
  2. Supply or Discharge-Air Temperature:
    - a. Input Device: Room mounted thermostat or Electronic temperature sensor.
    - b. Output Device: energizes compressor(s).
    - c. Action: Maintain supply-air temperature set point of 55 deg F.
  3. Temperature Reset:
    - a. Input Device: Duct-mounted thermostat or Electronic temperature sensor in return air.
    - b. Output Device: Direct to receiver controller or DDC system in straight-line relationship for the following conditions:
      - 1) 65 deg F when return-air temperature is 70 deg F.
      - 2) 55 deg F when return-air temperature is 75 deg F.
    - c. Action: Reset supply-air temperature set point of 55 deg F.
  4. Display:
    - a. Fan-discharge air-temperature indication.
    - b. Fan-discharge air-temperature set point.

- F. Coordination of Air-Handling Unit Sequences: Ensure that heating, and cooling-coil controls have common inputs and do not overlap in function.
  
- G. Operator Station Display: Indicate the following on operator workstation display terminal:
  - 1. DDC system graphic.
  - 2. DDC system on-off indication.
  - 3. DDC system occupied/unoccupied mode.
  - 4. Outdoor-air-temperature indication.
  - 5. Supply-fan on-off indication.
  - 6. Supply-fan speed.
  - 7. Building static-pressure indication.
  - 8. Building static-pressure set point.
  - 9. Relative humidity indication.
  - 10. Relative humidity set point.
  - 11. Fan-discharge air-temperature indication.
  - 12. Fan-discharge air-temperature set point.
  - 13. Room temperature indication.
  - 14. Room temperature set point.

### 1.3 VENTILATION SEQUENCES

- A. Outside-Air, Makeup Unit Control, gas: Unit interlocks with kitchen hood and grease fan when gas range is used.
  
- B. Relief Roof Ventilator: interlock with exhaust fan to open dampers.
  
- C. Exhaust Fan: manual switch, Interlock with light switch and Room thermostat cycle fans.

### **PART 2 - PRODUCTS (Not Applicable)**

### **PART 3 - EXECUTION (Not Applicable)**

### **END OF SECTION 230993**

**SECTION 232300**  
**REFRIGERANT PIPING**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
  - 1. Refrigerant pipes and fittings.
  - 2. Refrigerant piping valves and specialties.
  - 3. Refrigerants.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of valve and refrigerant piping specialty.
- B. Shop Drawings:
  - 1. Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
  - 2. Show interface and spatial relationships between piping and equipment.
  - 3. Shop Drawing Scale: 1/4-inch equals 1 foot.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

- B. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

## **PART 2 - PRODUCTS**

### 2.1 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-134a:
  - 1. Suction Lines for Air-Conditioning Applications: 115 psig.
  - 2. Suction Lines for Heat-Pump Applications: 225 psig.
  - 3. Hot-Gas and Liquid Lines: 225 psig.
- B. Line Test Pressure for Refrigerant R-407C:
  - 1. Suction Lines for Air-Conditioning Applications: 230 psig.
  - 2. Suction Lines for Heat-Pump Applications: 380 psig.
  - 3. Hot-Gas and Liquid Lines: 380 psig.
- C. Line Test Pressure for Refrigerant R-410A:
  - 1. Suction Lines for Air-Conditioning Applications: 300 psig.
  - 2. Suction Lines for Heat-Pump Applications: 535 psig.
  - 3. Hot-Gas and Liquid Lines: 535 psig.

### 2.2 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B 88, Type K or L or ASTM B 280, Type ACR.
- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.
- D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
- E. Brazing Filler Metals: AWS A5.8/A5.8M.
- F. Flexible Connectors:
  - 1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
  - 2. End Connections: Socket ends.
  - 3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch long assembly.
  - 4. Working Pressure Rating: Factory test at minimum 500 psig.
  - 5. Maximum Operating Temperature: 250 deg F.

2.3 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Danfoss Inc.
  - b. Heldon Products; Henry Technologies.
  - c. Parker Hannifin Corp.
2. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
3. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
4. Operator: Rising stem and hand wheel.
5. Seat: Nylon.
6. End Connections: Socket, union, or flanged.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275 deg F.

B. Packed-Angle Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Danfoss Inc.
  - b. Heldon Products; Henry Technologies.
  - c. Parker Hannifin Corp.
2. Body and Bonnet: Forged brass or cast bronze.
3. Packing: Molded stem, back seating, and replaceable under pressure.
4. Operator: Rising stem.
5. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
6. Seal Cap: Forged-brass or valox hex cap.
7. End Connections: Socket, union, threaded, or flanged.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 275 deg F.

C. Check Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Danfoss Inc.
  - b. Emerson Climate Technologies.
  - c. Heldon Products; Henry Technologies.
  - d. Parker Hannifin Corp.
2. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
3. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
4. Piston: Removable polytetrafluoroethylene seat.
5. Closing Spring: Stainless steel.
6. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.

7. End Connections: Socket, union, threaded, or flanged.
8. Maximum Opening Pressure: 0.50 psig.
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 275 deg F.

D. Service Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Danfoss Inc.
  - b. Emerson Climate Technologies.
  - c. Heldon Products; Henry Technologies.
  - d. Parker Hannifin Corp.
  - e. Paul Mueller Company.
2. Body: Forged brass with brass cap including key end to remove core.
3. Core: Removable ball-type check valve with stainless-steel spring.
4. Seat: Polytetrafluoroethylene.
5. End Connections: Copper spring.
6. Working Pressure Rating: 500 psig.

E. Solenoid Valves: Comply with AHRI 760 and UL 429; listed and labeled by a National Recognized Testing Laboratory (NRTL).

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Danfoss Inc.
  - b. Emerson Climate Technologies.
  - c. Heldon Products; Henry Technologies.
  - d. Parker Hannifin Corp.
2. Body and Bonnet: Plated steel.
3. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
4. Seat: Polytetrafluoroethylene.
5. End Connections: Threaded.
6. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24V ac coil.
7. Working Pressure Rating: 400 psig.
8. Maximum Operating Temperature: 240 deg F.

F. Safety Relief Valves: Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Danfoss Inc.
  - b. Heldon Products; Henry Technologies.
  - c. Parker Hannifin Corp.
2. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.

3. Piston, Closing Spring, and Seat Insert: Stainless steel.
  4. Seat: Polytetrafluoroethylene.
  5. End Connections: Threaded.
  6. Working Pressure Rating: 400 psig.
  7. Maximum Operating Temperature: 240 deg F.
- G. Thermostatic Expansion Valves: Comply with AHRI 750.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Danfoss Inc.
    - b. Emerson Climate Technologies.
    - c. Heldon Products; Henry Technologies.
  2. Body, Bonnet, and Seal Cap: Forged brass or steel.
  3. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
  4. Packing and Gaskets: Non-asbestos.
  5. Capillary and Bulb: Copper tubing filled with refrigerant charge.
  6. Suction Temperature: 40 deg F.
  7. Superheat: Adjustable or Nonadjustable.
  8. Reverse-flow option (for heat-pump applications).
  9. End Connections: Socket, flare, or threaded union.
  10. Working Pressure Rating: 700 psig.
- H. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Danfoss Inc.
    - b. Heldon Products; Henry Technologies.
  2. Body, Bonnet, and Seal Cap: Ductile iron or steel.
  3. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
  4. Packing and Gaskets: Non-asbestos.
  5. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
  6. Seat: Polytetrafluoroethylene.
  7. Equalizer: Internal or External.
  8. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter and 24-V ac coil.
  9. End Connections: Socket.
  10. Set Pressure: 500 psig.
  11. Throttling Range: Maximum 5 psig.
  12. Working Pressure Rating: 500 psig.
  13. Maximum Operating Temperature: 240 deg F.
- I. Straight-Type Strainers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Danfoss Inc.



- b. Heldon Products; Henry Technologies.
  2. Body: Welded steel with corrosion-resistant coating.
  3. Screen: 100-mesh stainless steel.
  4. End Connections: Socket or flare.
  5. Working Pressure Rating: 500 psig.
  6. Maximum Operating Temperature: 275 deg F.
  
- J. Angle-Type Strainers:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Danfoss Inc.
    - b. Heldon Products; Henry Technologies.
  2. Body: Forged brass or cast bronze.
  3. Drain Plug: Brass hex plug.
  4. Screen: 100-mesh monel.
  5. End Connections: Socket or flare.
  6. Working Pressure Rating: 500 psig.
  7. Maximum Operating Temperature: 275 deg F.
  
- K. Moisture/Liquid Indicators:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Danfoss Inc.
    - b. Emerson Climate Technologies.
    - c. Heldon Products; Henry Technologies.
  2. Body: Forged brass.
  3. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
  4. Indicator: Color coded to show moisture content in parts per million (ppm).
  5. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
  6. End Connections: Socket or flare.
  7. Working Pressure Rating: 500 psig.
  8. Maximum Operating Temperature: 240 deg F.
  
- L. Permanent Filter Dryers: Comply with AHRI 730.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Danfoss Inc.
    - b. Emerson Climate Technologies.
    - c. Heldon Products; Henry Technologies.
  2. Body and Cover: Painted-steel shell.
  3. Filter Media: 10 microns, pleated with integral end rings; stainless-steel support.

4. Desiccant Media: Activated alumina or charcoal.
5. Designed for reverse flow (for heat-pump applications).
6. End Connections: Socket.
7. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
8. Maximum Pressure Loss: 2 psig.
9. Rated Flow: 4 tons.
10. Working Pressure Rating: 500 psig.
11. Maximum Operating Temperature: 240 deg F.

## 2.4 REFRIGERANTS

### A. ASHRAE 34, R-134a: Tetrafluoroethane.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Arkema Inc.
  - b. DuPont Fluorochemicals Div.
  - c. Genetron Refrigerants; Honeywell International Inc.

### B. ASHRAE 34, R-407C: Difluoromethane/Pentafluoroethane/1,1,1,2-Tetrafluoroethane.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Arkema Inc.
  - b. DuPont Fluorochemicals Div.
  - c. Genetron Refrigerants; Honeywell International Inc.

### C. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Arkema Inc.
  - b. DuPont Fluorochemicals Div.
  - c. Genetron Refrigerants; Honeywell International Inc.

## **PART 3 - EXECUTION**

### 3.1 PIPING APPLICATIONS FOR REFRIGERANT R-134a

- A. Suction Lines: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.
- B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.

- C. Safety-Relief-Valve Discharge Piping: Copper, Type ACR, Type ) or Type L drawn-temper tubing and wrought-copper fittings with soldered joints.

### 3.2 PIPING APPLICATIONS FOR REFRIGERANT R-407C

- A. Suction Lines: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with [**brazed**] [**or**] [**soldered**] joints.
- B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.
- C. Safety-Relief-Valve Discharge Piping: Copper, Type ACR, Type K or Type L, drawn-temper tubing and wrought-copper fittings with soldered joints.

### 3.3 PIPING APPLICATIONS FOR REFRIGERANT R-410A

- A. Suction Lines: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.
- B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR or Type L, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
- C. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type K , annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
- D. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, Type K or Type L, drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.
- E. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, Type K or Type L, drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.
- F. Safety-Relief-Valve Discharge Piping: Copper, Type ACR or Type L, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
- G. Safety-Relief-Valve Discharge Piping: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
- H. Safety-Relief-Valve Discharge Piping: Copper, Type ACR, Type K or Type L, drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.
- I. Safety-Relief-Valve Discharge Piping: Copper, Type ACR, Type K or Type L, drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.

### 3.4 VALVE AND SPECIALTY APPLICATIONS

- A. Install diaphragm packless or packed-angle valves in suction and discharge lines of compressor.
- B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
- C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
- D. Except as otherwise indicated, install diaphragm packless or packed-angle valves on inlet and outlet side of filter dryers.
- E. Install a full-size, three-valve bypass around filter dryers.
- F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.
- G. Install thermostatic expansion valves as close as possible to distributors on evaporators.
  - 1. Install valve so diaphragm case is warmer than bulb.
  - 2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
  - 3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
- H. Install safety relief valves where required by 2010 ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.
- I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
- J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for the device being protected:
  - 1. Solenoid valves.
  - 2. Thermostatic expansion valves.
  - 3. Hot-gas bypass valves.
  - 4. Compressor.
- K. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.
- L. Install receivers sized to accommodate pump-down charge.
- M. Install flexible connectors at compressors.

### 3.5 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
- B. Install refrigerant piping according to ASHRAE 15.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping adjacent to machines to allow service and maintenance.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Refer to Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC" for solenoid valve controllers, control wiring, and sequence of operation.
- K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083113 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.
- M. Install refrigerant piping in protective conduit where installed belowground.
- N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- O. Slope refrigerant piping as follows:
  - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
  - 2. Install horizontal suction lines with a uniform slope downward to compressor.
  - 3. Install traps and double risers to entrain oil in vertical runs.

4. Liquid lines may be installed level.

- P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- Q. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- R. Identify refrigerant piping and valves according to Section 230553 "Identification for HVAC Piping and Equipment."
- S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

### 3.6 PIPE 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. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
- D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
  - 1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
  - 2. Use Type BA9 (cadmium-free silver) alloy for joining copper with bronze or steel.

### 3.7 HANGERS AND SUPPORTS

- A. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Install the following pipe attachments:
  - 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.

2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
  3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
  4. Spring hangers to support vertical runs.
  5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- C. Install hangers for copper tubing with the following maximum spacing and minimum rod diameters:
1. NPS 1/2: Maximum span, 60 inches; minimum rod, 1/4 inch.
  2. NPS 5/8: Maximum span, 60 inches; minimum rod, 1/4 inch.
  3. NPS 1: Maximum span, 72 inches; minimum rod, 1/4 inch.
  4. NPS 1-1/4: Maximum span, 96 inches; minimum rod, 3/8 inch.
  5. NPS 1-1/2: Maximum span, 96 inches ; minimum rod, 3/8 inch.
  6. NPS 2: Maximum span, 96 inches; minimum rod, 3/8 inch.
  7. NPS 2-1/2: Maximum span, 108 inches; minimum rod, 3/8 inch.
  8. NPS 3: Maximum span, 10 feet ; minimum rod, 3/8 inch.
  9. NPS 4: Maximum span, 12 feet ; minimum rod, 1/2 inch.
- D. Support multifloor vertical runs at least at each floor.

### 3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
1. Comply with ASME B31.5, Chapter VI.
  2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
  3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.
    - a. Fill system with nitrogen to the required test pressure.
    - b. System shall maintain test pressure at the manifold gage throughout duration of test.
    - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.
- B. Prepare test and inspection reports.

### 3.9 SYSTEM CHARGING

- A. Charge system using the following procedures:
1. Install core in filter dryers after leak test but before evacuation.
  2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.

3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

### 3.10 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
  1. Open shutoff valves in condenser water circuit.
  2. Verify that compressor oil level is correct.
  3. Open compressor suction and discharge valves.
  4. Open refrigerant valves except bypass valves that are used for other purposes.
  5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

**END OF SECTION 232300**



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## **SECTION 233113**

### **METAL DUCTS**

#### **PART 1 - GENERAL**

##### 1.1 SUMMARY

###### A. Section Includes:

1. Rectangular ducts and fittings.
2. Round ducts and fittings.
3. Sheet metal materials.
4. Sealants and gaskets.
5. Hangers and supports.

###### B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

##### 1.2 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.
- B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

##### 1.3 ACTION SUBMITTALS

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

##### 1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
  2. Suspended ceiling components.

3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:
  - a. Lighting fixtures.
  - b. Air outlets and inlets.
  - c. Speakers.
  - d. Sprinklers.
  - e. Access panels.
  - f. Perimeter moldings.

#### 1.5 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 RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

## 2.2 ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Ductmate Industries, Inc.
    - b. Elgen Manufacturing.
    - c. Linx Industries (formerly Lindab).
    - d. McGill AirFlow LLC.
    - e. MKT Metal Manufacturing.
    - f. SEMCO LLC.
    - g. Sheet Metal Connectors, Inc.
    - h. Spiral Manufacturing Co., Inc.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
1. Transverse Joints in Ducts Larger Than 60 Inches Insert dimension in Diameter: Flanged.
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
1. Fabricate round ducts larger Than 90 inches in diameter with butt-welded longitudinal seams.
- D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

## 2.3 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60 or G90.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

- C. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

## 2.4 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

- B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 3 inches, 4 inches or 6 inches.
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
11. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

- C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

- D. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.

4. Class: 25.
  5. Use: O.
  6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- F. Round Duct Joint O-Ring Seals:
1. Seal shall provide maximum 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
  2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
  3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

## 2.5 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports:
1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
  2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
  3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

### **PART 3 - EXECUTION**

#### **3.1 DUCT INSTALLATION**

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install round ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. 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 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. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
  - 3. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
  - 4. Unconditioned Space, Exhaust Ducts: Seal Class C.
  - 5. Unconditioned Space, Return-Air Ducts: Seal Class B.
  - 6. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
  - 7. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
  - 8. Conditioned Space, Exhaust Ducts: Seal Class B.
  - 9. Conditioned Space, Return-Air Ducts: Seal Class C.

### 3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
  - 1. Where practical, install concrete inserts before placing concrete.
  - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.



3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
  4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
  5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

### 3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

### 3.6 DUCT CLEANING

- A. Clean new duct system(s) before testing, adjusting, and balancing.
- B. Use service openings for entry and inspection.
  1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "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. 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. Provide drainage and cleanup for wash-down procedures.
5. 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.

### 3.7 START UP

- A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

### 3.8 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated.
- B. Supply Ducts:
  1. Ducts Connected to RTUs and fan terminal units
    - a. Pressure Class: Positive 1-inch wg.
    - b. Minimum SMACNA Seal Class: A, B or C.
    - c. SMACNA Leakage Class for Rectangular: 12 or 24 I.
    - d. SMACNA Leakage Class for Round and Flat Oval: 12 or 24.
- C. Return Ducts:
  1. Ducts Connected to RTUs and fan terminal units:
    - a. Pressure Class: Positive or negative 1-inch wg or 2-inch wg.
    - b. Minimum SMACNA Seal Class: A, B or C.
    - c. SMACNA Leakage Class for Rectangular: 12 or 24.
    - d. SMACNA Leakage Class for Round and Flat Oval: 12 or 24.
- D. Exhaust Ducts:
  1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
    - a. Pressure Class: Negative 1-inch wg.
    - b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
    - c. SMACNA Leakage Class for Rectangular: 12.
    - d. SMACNA Leakage Class for Round and Flat Oval: 12.
- E. Outdoor-Air (Filtered, Heated, and Cooled) Ducts:
  1. Ducts Connected to Air-Handling Units:

- a. Pressure Class: Positive or negative 2-inch wg.
- b. Minimum SMACNA Seal Class: A.
- c. SMACNA Leakage Class for Rectangular: 12.
- d. SMACNA Leakage Class for Round and Flat Oval: 6.

F. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.

G. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
  - a. Velocity 1000 fpm or Lower:
    - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
    - 2) Mitered Type RE 4 without vanes.
  - b. Velocity 1000 to 1500 fpm:
    - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
    - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
    - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
  - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
  - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
  - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
  - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
    - 1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
    - 2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
    - 3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.

4) Radius-to Diameter Ratio: 1.5.

- b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
- c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

H. Branch Configuration:

- 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
  - a. Rectangular Main to Rectangular Branch: 45-degree entry.
  - b. Rectangular Main to Round Branch: Spin in.
- 2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
  - a. Velocity 1000 fpm or Lower: 90-degree tap.
  - b. Velocity 1000 to 1500 fpm: Conical tap.
  - c. Velocity 1500 fpm or Higher: 45-degree lateral.

**END OF SECTION 233113**

**SECTION 233300**  
**AIR DUCT ACCESSORIES**

**PART 1 - GENERAL**

1.1 SUMMARY

A. Section Includes:

1. Backdraft and pressure relief dampers.
2. Manual volume dampers.
3. Control dampers.
4. Flange connectors.
5. Turning vanes.
6. Duct-mounted access doors.
7. Flexible connectors.
8. Flexible ducts.
9. Duct accessory hardware.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
  - a. Special fittings.
  - b. Manual volume damper installations.
  - c. Control-damper installations.
  - d. Fire-damper and smoke-damper installations, including sleeves; and duct-mounted access doors.
  - e. Wiring Diagrams: For power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

## PART 2 - PRODUCTS

### 2.1 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

### 2.2 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
  - 1. Galvanized Coating Designation: G60 or G90.
  - 2. Exposed-Surface Finish: Mill phosphatized.
- B. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- C. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

### 2.3 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. American Warming and Ventilating; a Mestek Architectural Group company.
  - 2. Cesco Products; a division of MESTEK, Inc.
  - 3. Flex-Tek Group.
  - 4. Greenheck Fan Corporation.
  - 5. Lloyd Industries, Inc.
  - 6. Nailor Industries Inc.
  - 7. NCA Manufacturing, Inc.
  - 8. Pottorff.
  - 9. Ruskin Company.
  - 10. Safe Air - Dowco Products.
- B. Description: Gravity balanced.
- C. Maximum Air Velocity: 2000 fpm.
- D. Maximum System Pressure: 1-inch wg.

- E. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel, with welded corners or mechanically attached and mounting flange.
- F. Blades: Multiple single-piece blades, center pivoted, , off-center pivoted, or end pivoted, maximum 6-inch width, 0.025-inch-thick, roll-formed aluminum, 0.050-inch-thick aluminum sheet or noncombustible, tear-resistant, neoprene-coated fiberglass with sealed edges.
- G. Blade Action: Parallel.
- H. Blade Seals: Felt, Vinyl foam, Extruded vinyl, mechanically locked or Neoprene, mechanically locked.
- I. Blade Axles:
  - 1. Material: Nonferrous metal or Galvanized steel.
  - 2. Diameter: 0.20 inch.
- 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 minimum.
    - b. Sleeve Length: 6 inches minimum.
  - 6. Screen Mounting: Rear mounted.
  - 7. Screen Material: Galvanized steel.
  - 8. Screen Type: Bird.
  - 9. 90-degree stops.

#### 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:
    - a. Aire Technologies.
    - b. American Warming and Ventilating; a Mestek Architectural Group company.
    - c. Flexmaster U.S.A., Inc.
    - d. Flex-Tek Group.

- e. McGill AirFlow LLC.
  - f. Nailor Industries Inc.
  - g. Pottorff.
  - h. Ruskin Company.
  - i. Safe Air - Dowco Products.
  - j. Trox USA Inc.
2. Standard leakage rating, with linkage outside airstream.
  3. Suitable for horizontal or vertical applications.
  4. Frames:
    - a. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel.
    - b. Mitered and welded corners.
    - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
  5. Blades:
    - a. Multiple or single blade.
    - b. Parallel- or opposed-blade design.
    - c. Stiffen damper blades for stability.
    - d. Galvanized-steel, 0.064 inch thick.
  6. Blade Axles: Galvanized steel.
  7. Tie Bars and Brackets: Galvanized steel.
- B. Jackshaft:
1. Size: [0.5-inch] [1-inch] diameter.
  2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
  3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.
- C. Damper Hardware:
1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
  2. Include center hole to suit damper operating-rod size.
  3. Include elevated platform for insulated duct mounting.
- 2.5 CONTROL DAMPERS
- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. American Warming and Ventilating; a Mestek Architectural Group company.
  2. Arrow United Industries.
  3. Cesco Products; a division of MESTEK, Inc.



4. Flex-Tek Group.
5. Greenheck Fan Corporation.
6. Lloyd Industries, Inc.
7. McGill AirFlow LLC.
8. Metal Form Manufacturing, Inc.
9. Nailor Industries Inc.
10. Pottorff.
11. Ruskin Company.

B. Frames: Per Manufacturer's standards.

C. Blades: Per Manufacturer's standards.

D. Blade Axles: 1/2-inch-diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.

1. Operating Temperature Range: From minus 40 to plus 200 deg F.

E. Bearings:

1. Oil-impregnated bronze, Molded synthetic, Oil-impregnated stainless-steel sleeve or Stainless-steel sleeve.
2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
3. Thrust bearings at each end of every blade.

## 2.6 FLANGE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. CL WARD & Family Inc.
2. Ductmate Industries, Inc.
3. Hardcast, Inc.
4. Nexus PDQ.

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.

## 2.7 TURNING VANES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Aero-Dyne Sound Control Co.
2. Ductmate Industries, Inc.
3. Duro Dyne Inc.

4. Hardcast, Inc.
5. METALAIRE, Inc.

- B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
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, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."
- E. Vane Construction: Single wall.

## 2.8 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Aire Technologies.
  2. American Warming and Ventilating; a Mestek Architectural Group company.
  3. Cesco Products; a division of MESTEK, Inc.
  4. CL WARD & Family Inc.
  5. Ductmate Industries, Inc.
  6. Elgen Manufacturing.
  7. Flexmaster U.S.A., Inc.
  8. Greenheck Fan Corporation.
  9. McGill AirFlow LLC.
  10. Nailor Industries Inc.
  11. Pottorff.
  12. Ventfabrics, Inc.
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
1. Door:
    - a. Double wall, rectangular.
    - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
    - c. Vision panel.
    - d. Hinges and Latches: 1-by-1-inchbutt or piano hinge and cam latches.
    - e. Fabricate doors airtight and suitable for duct pressure class.
  2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

3. Number of Hinges and Locks:
  - a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
  - b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
  - c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
  - d. Access Doors Larger Than 24 by 48 Inches: 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 with metal thickness applicable for duct pressure class.
3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
4. Factory set at 3.0- to 8.0-inch wg.
5. Doors close when pressures are within set-point range.
6. Hinge: Continuous piano.
7. Latches: Cam.
8. Seal: Neoprene or foam rubber.
9. Insulation Fill: 1-inch-thick, fibrous-glass or polystyrene-foam board.

2.9 DUCT ACCESS PANEL ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. 3M.
  2. Ductmate Industries, Inc.
- B. Labeled according to UL 1978 by an NRTL.
- C. Panel and Frame: Minimum thickness 0.0528-inch carbon or 0.0428-inch 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.
- F. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.10 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. Elgen Manufacturing.
4. Hardcast, Inc.
5. JP Lamborn Co.
6. Ventfabrics, Inc.

- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 5-3/4 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
1. Minimum Weight: 26 oz./sq. yd..
  2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
  3. Service Temperature: Minus 40 to plus 200 deg F.

## 2.11 FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Flexmaster U.S.A., Inc.
  2. JP Lamborn Co.
  3. McGill AirFlow LLC.
  4. Thermaflex; a Flex-Tek Group company.
- 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 positive and 1.0-inch wg negative.
  2. Maximum Air Velocity: 4000 fpm.
  3. Temperature Range: Minus 10 to plus 160 deg F.
- C. Insulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor-barrier film.
1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
  2. Maximum Air Velocity: 4000 fpm.
  3. Temperature Range: Minus 20 to plus 210 deg F.
  4. Insulation R-value: Comply with ASHRAE/IESNA 90.1.
- D. 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, to suit duct size.

2. Non-Clamp Connectors: Adhesive Liquid adhesive plus tape Adhesive plus sheet metal screws.

## 2.12 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 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 dampers according to UL listing.
- H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
  1. On both sides of duct coils.
  2. Upstream and downstream from duct filters.
  3. At outdoor-air intakes and mixed-air plenums.
  4. At drain pans and seals.
  5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.

6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
  7. At each change in direction and at maximum 50-foot spacing.
  8. Upstream and downstream from turning vanes.
  9. Upstream or downstream from duct silencers.
  10. Control devices requiring inspection.
  11. Elsewhere as indicated.
- I. Install access doors with swing against duct static pressure.
- J. Access Door Sizes:
1. One-Hand or Inspection Access: 8 by 5 inches.
  2. Two-Hand Access: 12 by 6 inches.
  3. Head and Hand Access: 18 by 10 inches.
  4. Head and Shoulders Access: 21 by 14 inches.
  5. Body Access: 25 by 14 inches.
  6. Body plus Ladder Access: 25 by 17 inches.
- K. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- L. Install flexible connectors to connect ducts to equipment.
- M. Connect terminal units to supply ducts directly or with maximum 12-inch Insert value lengths of flexible duct. Do not use flexible ducts to change directions.
- N. Connect diffusers or light troffer boots to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- O. Connect flexible ducts to metal ducts with draw bands and adhesive plus sheet metal screws.
- P. Install duct test holes where required for testing and balancing purposes.

### 3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:
1. Operate dampers to verify full range of movement.
  2. Inspect locations of access doors and verify that purpose of access door can be performed.
  3. Operate fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
  4. Inspect turning vanes for proper and secure installation.

**END OF SECTION 233300**

**SECTION 233423**  
**HVAC POWER VENTILATORS**

**PART 1 - GENERAL**

1.1 SUMMARY

A. Section Includes:

1. In-line centrifugal fans.
2. Propeller fans.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Include rated capacities, furnished specialties, and accessories for each fan.
2. Certified fan performance curves with system operating conditions indicated.
3. Certified fan sound-power ratings.
4. Motor ratings and electrical characteristics, plus motor and electrical accessories.
5. Material thickness and finishes, including color charts.
6. Dampers, including housings, linkages, and operators.

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show fan room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

**PART 2 - PRODUCTS**

2.1 IN-LINE CENTRIFUGAL FANS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Acme Engineering & Manufacturing Corp.
  - 2. American Coolair Corporation.
  - 3. Carnes Company.
  - 4. Greenheck Fan Corporation.
  - 5. Hartzell Fan Incorporated.
  - 6. Loren Cook Company.
  - 7. Peerless Blowers.
  - 8. PennBarry.
- B. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.
- C. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing; with wheel, inlet cone, and motor on swing-out service door.
- D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.
- E. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.
- F. Accessories:
  - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
  - 2. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
  - 3. Companion Flanges: For inlet and outlet duct connections.
  - 4. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
  - 5. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.
- G. Capacities and Characteristics: Refer to schedule on mechanical plans.



## 2.2 PROPELLER FANS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Acme Engineering & Manufacturing Corp.
  2. Aerovent; a division of Twin City Fan Companies, Ltd.
  3. American Coolair Corporation.
  4. Carnes Company.
  5. Loren Cook Company.
  6. Peerless Blowers.
  7. PennBarry.
  8. Greenheck Fan Corporation.
- B. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring with baked-enamel finish coat applied after assembly.
- C. Steel Fan Wheels: Formed-steel blades riveted to heavy-gage steel spider bolted to cast-iron hub.
- D. Fan Wheel: Replaceable, cast or extruded-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.
- E. Fan Drive, Direct: Direct-drive motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.
- F. Accessories:
1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
  2. Motorized Dampers: Parallel-blade dampers with electric actuator wired to close when fan stops.
  3. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
  4. Wall Sleeve: Galvanized steel to match fan and accessory size.
  5. Weathershield Hood: Galvanized steel to match fan and accessory size.
  6. Weathershield Front Guard: Galvanized steel with expanded metal screen.
- G. Capacities and Characteristics: Refer to schedule on mechanical sheets.

## 2.3 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

- B. Enclosure Type: Totally enclosed, fan cooled.

#### 2.4 SOURCE QUALITY CONTROL

- A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

### **PART 3 - EXECUTION**

#### 3.1 INSTALLATION

- A. Equipment Mounting:
  - 1. Comply with requirements for vibration isolation devices.
- B. Secure roof-mounted fans to roof curbs with cadmium-plated hardware. See Section 077200 "Roof Accessories" for installation of roof curbs.
- C. Support suspended units from structure using threaded steel rods and spring hangers or spring hangers with vertical-limit stops Insert device having a static deflection of 1 inch Inse deflection. Install units with clearances for service and maintenance.
- D. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."
- E. Install units with clearances for service and maintenance.

#### 3.2 CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."
- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

### 3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
  - 1. Verify that shipping, blocking, and bracing are removed.
  - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
  - 3. Verify that cleaning and adjusting are complete.
  - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
  - 5. Adjust damper linkages for proper damper operation.
  - 6. Verify lubrication for bearings and other moving parts.
  - 7. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
  - 8. Shut unit down and reconnect automatic temperature-control operators.
  - 9. Remove and replace malfunctioning units and retest as specified above.
- C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Prepare test and inspection reports.

### 3.4 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- C. Replace fan and motor as required to achieve design airflow.
- D. Lubricate bearings.

**END OF SECTION 233423**

## **SECTION 233713**

### **DIFFUSERS, REGISTERS, AND GRILLES**

#### **PART 1 - GENERAL**

##### 1.1 SUMMARY

###### A. Section Includes:

1. Rectangular and square ceiling diffusers.
2. Perforated diffusers.
3. Louver face diffusers.
4. Adjustable bar registers and grilles.
5. Fixed face registers and grilles.

###### B. Related Sections:

1. Section 089116 "Operable Wall Louvers" and Section 089119 "Fixed Louvers" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
2. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

##### 1.2 ACTION SUBMITTALS

###### A. Product Data: For each type of product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

#### **PART 2 - RODUCTS**

##### 2.1 CEILING DIFFUSERS

###### A. Rectangular and Square Ceiling Diffusers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Carnes Company.
  - b. Hart & Cooley Inc.
  - c. Krueger.

- d. METALAIRE, Inc.
  - e. Nailor Industries Inc.
  - f. Price Industries.
  - g. Titus.
2. Devices shall be specifically designed for variable-air-volume flows.
  3. Material: Per schedule.
  4. Finish: Baked enamel, white.
  5. Face Size: 24 by 24 inches, 20 by 20 inches or 12 by 12 inches.
  6. Face Style: Three cone, four cone or Plaque.
  7. Mounting: Per schedule.
  8. Pattern: Fixed, Two position or Adjustable.
  9. Dampers: Radial opposed blade, Butterfly or Combination damper and grid.
  10. Accessories:
    - a. Equalizing grid.
    - b. Plaster ring.
    - c. Safety chain.
    - d. Wire guard.
    - e. Operating rod extension.
- B. Perforated Diffuser:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Carnes Company.
    - b. Hart & Cooley Inc.
    - c. Krueger.
    - d. METALAIRE, Inc.
    - e. Nailor Industries Inc.
    - f. Price Industries.
    - g. Titus.
    - h. Tuttle & Bailey.
  2. Devices shall be specifically designed for variable-air-volume flows.
  3. Material: Steel backpan and pattern controllers, with steel or aluminum face.
  4. Finish: Baked enamel, white.
  5. Face Size: Per schedule.
  6. Duct Inlet: Round or Square.
  7. Face Style: Flush or Drop extended.
  8. Mounting: Per schedule.
  9. Pattern Controller: Four louvered deflector patches, Fixed with curved blades at inlet or Adjustable with louvered pattern modules at inlet.
  10. Dampers: Opposed blade, Radial opposed blade, Butterfly or Combination damper and grid.
  11. Accessories:
    - a. Equalizing grid.
    - b. Plaster ring.
    - c. Safety chain.
    - d. Wire guard.
    - e. Operating rod extension.

C. Louver Face Diffuser:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Anemostat Products; a Mestek company.
  - b. Carnes Company.
  - c. METALAIRE, Inc.
  - d. Nailor Industries Inc.
  - e. Price Industries.
  - f. Titus.
2. Devices shall be specifically designed for variable-air-volume flows.
3. Material: Per schedule.
4. Finish: Baked enamel, white.
5. Face Size: Per schedule.
6. Mounting: Per schedule.
7. Pattern: Three-way, Four-way or Adjustable core style.
8. Dampers: Radial opposed blade, Butterfly or Combination damper and grid.
9. Accessories:
  - a. Square to round neck adaptor.
  - b. Adjustable pattern vanes.
  - c. Throw reducing vanes.
  - d. Equalizing grid.
  - e. Plaster ring.
  - f. Safety chain.
  - g. Wire guard.
  - h. Operating rod extension.

2.2 REGISTERS AND GRILLES

A. Adjustable Bar Register:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Carnes Company.
  - b. Hart & Cooley Inc.
  - c. Krueger.
  - d. METALAIRE, Inc.
  - e. Nailor Industries Inc.
  - f. Price Industries.
  - g. Titus.
2. Material: Per schedule.
3. Finish: Baked enamel, white.
4. Face Blade Arrangement: Horizontal or vertical spaced 1-1/2 inches or 3/4 inch apart.
5. Core Construction: Integral or Removable.

6. Rear-Blade Arrangement: Horizontal or Vertical spaced 3/4 inch or 1/2 inch apart.
7. Frame: 1-1/4 inches or 1 inch wide.
8. Mounting Frame: Per schedule.
9. Mounting: Countersunk screw, Concealed or Lay in.
10. Damper Type: Adjustable opposed blade.
11. Accessories:
  - a. Front or Rear-blade gang operator.
  - b. Filter.

B. Adjustable Bar Grille:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Carnes Company.
  - b. Hart & Cooley Inc.
  - c. Krueger.
  - d. METALAIRE, Inc.
  - e. Nailor Industries Inc.
  - f. Price Industries.
  - g. Titus.
2. Material: Per schedule.
3. Finish: Baked enamel, white or Baked enamel, color selected by Architect.
4. Face Blade Arrangement: Horizontal or vertical spaced 3/4 inch or 1/2 inch apart.
5. Core Construction: Integral or Removable.
6. Rear-Blade Arrangement: Horizontal or Vertical spaced 3/4 inch or 1/2 inch apart.
7. Frame: 1-1/4 inches or 1 inch wide.
8. Mounting Frame: Per schedule.
9. Mounting: Countersunk screw, Concealed or Lay in.

C. Fixed Face Register:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Carnes Company.
  - b. Hart & Cooley Inc.
  - c. Krueger.
  - d. Nailor Industries Inc.
  - e. Price Industries.
  - f. Titus.
2. Material: Per schedule.
3. Finish: Baked enamel, white.
4. Face Arrangement: 1/2-by-1/2-by-1/2-inch grid or perforated core.
5. Core Construction: Integral or Removable.

6. Frame: 1-1/4 inches or 1 inch wide.
7. Mounting Frame: Per schedule.
8. Mounting: Countersunk screw, Concealed or Lay in.
9. Damper Type: Adjustable opposed blade.
10. Accessory: Filter.

D. Fixed Face Grille:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Carnes Company.
  - b. Hart & Cooley Inc.
  - c. Krueger.
  - d. Nailor Industries Inc.
  - e. Price Industries.
  - f. Titus.
2. Material: Per schedule.
3. Finish: Baked enamel, white.
4. Face Arrangement: 1/2-by-1/2-by-1/2-inch grid or perforated core.
5. Core Construction: Integral or Removable.
6. Frame: 1-1/4 inches or 1 inch wide.
7. Mounting Frame: Per schedule.
8. Mounting: Countersunk screw, Concealed or Lay in.
9. Accessory: Filter.

2.3 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

**PART 3 - EXECUTION**

3.1 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.



3.2 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

**END OF SECTION 233713**

## **SECTION 237433**

### **DEDICATED OUTDOOR AIR UNITS**

#### **PART 1 - GENERAL**

##### 1.1 SUMMARY

- A. This Section includes cooling heating rooftop dedicated outside-air units.

##### 1.2 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories.
- B. Shop Drawings: Include details of installation and wiring diagrams.
- C. Coordination Drawings: Rooftop replacement-air units to roof-curb mounting 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. Size and location of rooftop replacement-air unit mounting 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.
- D. Startup service reports.
- E. Operation and maintenance data.
- F. Warranty.

##### 1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.4 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components listed below that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
  - 2. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than 10 years from date of Substantial Completion.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. AAON, Inc.
  - 2. Addison Products Company.
  - 3. Carrier
  - 4. Daikin
  - 5. Des Champs Laboratories, Incorporated.
  - 6. LCSystems.
  - 7. Reznor-Thomas & Betts Corporation; Mechanical Products Division.
  - 8. Trane
  - 9. Johnson Controls

2.2 CABINET

- A. Construction: Double wall.
- B. Exterior Casing: Galvanized steel with baked-enamel paint finish and with lifting lugs and knockouts for electrical and piping connections.
- C. Interior Casing: Galvanized steel.
- D. Base Rails: Galvanized steel rails for mounting on roof curb.
- E. Service Doors: Hinged access doors with neoprene gaskets.
- F. Internal Insulation: Fibrous-glass duct lining complying with ASTM C 1071, Type II.
  - 1. Thickness: 2 inches.
  - 2. Insulation Adhesive: Comply with ASTM C 916, Type I.
  - 3. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to casing without damaging

liner and without causing air leakage when applied as recommended by manufacturer.

- G. Condensate Drain Pans: Formed sections of stainless-steel sheet designed for self-drainage. Fabricate pans and drain connection to comply with ASHRAE 62.1-2004.
- H. Roof Curb: Full-perimeter curb of sheet metal, minimum 12 inches high, with wood nailer, neoprene sealing strip, and welded Z-bar flashing.
- I. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

### 2.3 SUPPLY-AIR FAN/EXHAUST FAN

- A. Fan: Forward-curved centrifugal; statically and dynamically balanced, galvanized coated steel, mounted on solid-steel shaft with self-aligning, permanently lubricated ball bearings Retain "two" option in first paragraph below for units required to operate when exhaust hoods are not operating. Coordinate with "Controls" Article.
- B. Motor: Open drip-proof.
- C. Drive: V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly with minimum 1.4 service factor.
- D. Mounting: Fan wheel, motor, and drives shall be mounted in fan casing with spring isolators.

### 2.4 REFRIGERATION SYSTEM

- A. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."
- B. Compressors: Direct drive hermetic, scroll type compressors with integral vibration isolators, internal overcurrent and overtemperature protection, internal pressure relief, and crankcase heater.
  - 1. Variable speed compressor shall be capable of speed modulation from 15Hz to a maximum of 75Hz. The minimum unit capacity shall be 25% of full load or less. Each variable speed compressor shall be matched with a variable frequency drive which modulates the speed of the compressor motor and provides several compressor protection functions.
- C. Minimum Efficiency: As defined by ASHRAE/IESNA 90.1-2004, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."
- D. Refrigerant: R-407C or R-410A.
- E. 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.
  7. Operating charge of refrigerant.
  8. Hot-gas bypass refrigerant control for capacity control with continuous dehumidification for single-speed compressor.
  9. Hot Gas Reheat refrigerant control with modulating single circuit
- F. Capacity Control: Compressor with evaporator and condenser coil within the refrigerant section to provide initial precooling and reheat for humidity control.
- G. Capacity Control: Heat-pipe heat exchanger shall wrap around the evaporator coil to precool the air entering the evaporator coil and reheat the air leaving the evaporator coil to control humidity.
- H. Refrigerant Coils: Evaporator and condenser coils shall be designed, tested, fabricated, and rated according to ARI 410 and ASHRAE 33. Coils shall be leak tested under water with air at 315 psig.
1. Capacity Reduction: Circuit coils for interleaved control.
  2. Tubes: Copper.
  3. Fins: Aluminum with minimum fin spacing of 0.071 inch.
  4. Fin and Tube Joint: Mechanical bond.
  5. Suction and Distributor: Seamless copper tube with brazed joints.
  6. Coating: Phenolic epoxy corrosion-protection coating on both coils.
  7. Source Quality Control: Test to 450 psig, and to 300 psig underwater.
- I. Condenser Fan: Propeller type, directly driven by motor.
- J. Safety Controls:
1. Compressor motor and outside-coil fan motor low ambient lockout.
  2. Overcurrent protection for compressor motor and outside-coil fan motors.
- 2.5 ROTARY HEAT EXCHANGER
- A. Casing:
1. Galvanized steel, stainless steel, or aluminum with manufacturer's standard factory-painted finish.
  2. Integral purge section limiting carryover of exhaust air to between 0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wgdifferential pressure.
  3. Casing seals on periphery of rotor and on duct divider and purge section.
  4. Support vertical rotor on grease-lubricated ball bearings having extended grease fittings or permanently lubricated bearings. Support horizontal rotors on tapered roller bearings.

- B. Rotor - Aluminum, Metallic, or Polymer: Aluminum, metallic, or polymer segmented wheel, strengthened with radial spokes impregnated with nonmigrating, water-selective, molecular-sieve desiccant coating.
- C. Drive: Fractional horsepower motor and gear reducer with speed changed by variable-frequency controller. Provide permanently lubricated wheel bearings.
- D. Controls:
  - 1. Starting relay, factory mounted and wired, and manual motor starter for field wiring.
  - 2. Variable-frequency controller, factory mounted and wired, permitting input of 4-20 mA or 1-10 V control signal.
  - 3. Control energy recovery to permit air economizer operation.
    - a. Bypass dampers to assist energy recovery control.
  - 4. Pilot-Light Indicator: Display rotor rotation and speed.
  - 5. Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.
  - 6. Integral purge section limiting carryover of exhaust air to between 0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wgdifferential pressure.
  - 7. Defrost Cycle.

## 2.6 ELECTRIC-RESISTANCE HEATING COILS: COMPLY WITH UL 1995

- 1. Casing Assembly: Flanged type with galvanized-steel frame.
- 2. Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.
- 3. Overtemperature Protection: Disk-type, automatically resetting, thermal-cutout, safety device; serviceable through terminal box without removing heater from coil section.
- 4. Secondary Protection: Load-carrying, manually resetting or manually replaceable, thermal cutouts; factory wired in series with each heater stage.
- 5. Control Panel: Unit/Remote mounted with disconnecting means and overcurrent protection.
  - a. Magnetic contactor.
  - b. Solid-state, stepless pulse controller.
  - c. Toggle switches, one per step.
  - d. SCR controller.
  - e. Time-delay relay.
  - f. Pilot lights, one per step.
- 6. Airflow proving switch.

## 2.7 OUTDOOR-AIR INTAKE, RELIEF AND DAMPERS

- A. Dampers: Leakage rate, according to AMCA 500, shall not exceed 2 percent of air quantity at face velocity of 2000 fpm through damper and pressure differential of 4-inch wg.
- B. Damper Operators: Electric.
- C. Outdoor-Air Intake Hoods: Galvanized or Stainless steel, with bird screen complying with ASHRAE 62.1-2004 and finish to match cabinet.

## 2.8 FILTERS

- A. Comply with NFPA 90A.
- B. Cleanable Filters: 2-inch- thick, cleanable metal mesh.
- C. Disposable Panel Filters: 2-inch- thick, factory-fabricated, flat-panel-type, disposable air filters with holding frames, with a minimum efficiency report value of 6 according to ASHRAE 52.2 and 90 percent average arrestance according to ASHRAE 52.1.
  - 1. Media: Interlaced glass fibers sprayed with nonflammable adhesive.
  - 2. Frame: Galvanized steel.

## 2.9 CONTROLS

- A. Factory-wire connection for controls' power supply.
- B. Control devices, including sensors, transmitters, relays, switches, thermostats, humidistats, detectors, operators, actuators, and valves, shall be manufacturer's standard items to accomplish indicated control functions.
- C. Unit Controls: Solid-state control board and components with field-adjustable control parameters.
- D. Supply-Fan Control: Units shall be electrically interlocked with corresponding exhaust fans, to operate continuously when exhaust fans are running. Time clock shall switch operation from occupied to unoccupied. Night setback thermostat shall cycle fan during unoccupied periods to maintain space temperature.
  - 1. Timer: Seven-day electronic clock.
  - 2. Electrically interlock kitchen hood fire-extinguishing system to de-energize replacement-air unit when fire-extinguishing system discharges.
- E. Remote or Unit-Mounted Status Panel:
  - 1. Cooling/Off/Heating Controls: Control operational mode.
  - 2. Damper Position: Indicates position of outdoor-air dampers.
  - 3. Status Lights:

- a. Filter dirty.
- b. Fan operating.
- c. Cooling operating.
- d. Heating operating.

F. Refrigeration System Controls:

1. Unit-mounted enthalpy controller shall lock out refrigerant system when outdoor-air enthalpy is less than 28 Btu/lb of dry air or outdoor-air temperature is less than 60 deg F (adj).
2. Outdoor-air sensor de-energizes dehumidifier operation when outdoor-air temperature is less than 60 deg F (adj).
3. Relative-humidity sensor energizes dehumidifier operation when relative humidity is more than 60 percent.

G. Heating Controls:

1. Factory-mounted sensor in supply-fan outlet with sensor adjustment located in control panel modulates heating output (SCR control) to maintain space temperature.
2. Wall-mounting, space-temperature sensor with temperature adjustment or adjustment on remote-control panel that modulates heating output (SCR control) to maintain space temperature.
3. Remote Setback Thermostat: Adjustable room thermostat selected by timer, set at 60 deg F (adj); cycles supply fan and SCR control to maintain space temperature.
4. Electric Heat Control: SCR control.

H. Damper Controls: In cooling mode, unit will enable outdoor air damper to open outdoor airflow setpoint (60 deg F (adj) and 60% relative humidity) and unit will enable exhaust air damper in open position. In Economizer mode, outdoor air damper shall maintain the supply air temperature at the supply air temperature setpoint. Pressure operated relief damper is fully open to maintain the building from over pressurization.

I. Integral Smoke Alarm: Smoke detector installed in supply air.

J. DDC Temperature Control: Stand-alone control module for link between unit controls and DDC temperature-control system. Control module shall be compatible with temperature-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. Heating system operating.



## 2.10 ROOF CURBS

- A. Roof curbs with vibration isolators and wind or seismic restraints are specified in Section 230548 "Vibration and Seismic Controls for HVAC." Roof curbs with vibration isolators and wind restraints are specified in Section 230548.13 "Vibration Controls for HVAC."
- B. Curb Dimensions: Height of 14 inches.
- C. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match unit, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for wind-load requirements.

## 2.11 MOTORS

- A. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

# **PART 3 - EXECUTION**

## 3.1 INSTALLATION

- A. Install roof curb on roof structure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install and secure rooftop replacement-air units on curbs and coordinate roof penetrations and flashing with roof construction.
- B. Install wall- and duct-mounting sensors, thermostats, and humidistats furnished by manufacturers for field installation. Install control wiring and make final connections to control devices and unit control panel.
- C. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- D. Duct Connections: Duct installation requirements are specified in Division 23 Section "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply ducts to rooftop replacement-air units with flexible duct connectors. Flexible duct connectors are specified in Division 23 Section "Air Duct Accessories."
- E. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.
- F. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

### 3.2 STARTUP SERVICE

- A. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
1. Inspect for visible damage to compressor, air-cooled outside coil, and fans.
  2. Inspect casing insulation for integrity, moisture content, and adhesion.
  3. Verify that controls are connected and operable.
  4. Clean outside coil and inspect for construction debris.
  5. Verify that clearances have been provided for servicing.
  6. Inspect operation of power vents.
  7. Verify bearing lubrication.
  8. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
  9. Adjust fan belts to proper alignment and tension.
  10. Start unit.
  11. Start refrigeration system when outdoor-air temperature is within normal operating limits.
  12. Inspect and record performance of interlocks and protective devices including response to smoke detectors by fan controls and fire alarm.
  13. Operate unit for run-in period.
  14. Calibrate thermostats.
  15. Adjust and inspect high-temperature limits.
  16. Inspect outdoor-air dampers for proper stroke and interlock with return (exhaust)air dampers.
  17. Measure and record the following airflows. Plot fan volumes on fan curve.
    - a. Outside-air volume.
    - b. Relief (Exhaust)-air flow.
  18. Start refrigeration system and measure and record the following:
    - a. Coil leaving-air, dry- and wet-bulb temperatures.
    - b. Coil entering-air, dry- and wet-bulb temperatures.
    - c. Outdoor-air, dry-bulb temperature.
    - d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
  19. Verify operational sequence of controls.
- B. After startup and performance testing, change filters, verify bearing lubrication, and adjust belt tension.
- C. Remove and replace components that do not pass tests and inspections and retest as specified above.
- D. Prepare written report of the results of startup services.

### 3.3 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.

#### 3.4 CLEANING

After completing system installation; testing, adjusting, and balancing dedicated outdoor-air unit and air-distribution systems; and completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, casings, dampers, coils, and filter housings, and install new, clean filters.

#### 3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain dedicated outside air unit. Refer to Division 01 Section "Demonstration and Training."

**END OF SECTION 237433**

## **SECTION 237433**

### **PACKAGED, OUTDOOR, HEATING AND COOLING CONDITIONERS**

#### **PART 1 - GENERAL**

##### 1.1 SUMMARY

- A. This Section includes cooling heating rooftop replacement-air units.

##### 1.2 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories.
- B. Shop Drawings: Include details of installation and wiring diagrams.
- C. Coordination Drawings: Rooftop replacement-air units to roof-curb mounting 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. Size and location of rooftop replacement-air unit mounting 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.
- D. Startup service reports.
- E. Operation and maintenance data.
- F. Warranty.

##### 1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2010, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IESNA 90.1-2016 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2016, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.4 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components listed below that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
  - 2. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than 10 years from date of Substantial Completion.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. AAON, Inc.
  - 2. Addison Products Company.
  - 3. Carrier
  - 4. Daikin
  - 5. Des Champs Laboratories, Incorporated.
  - 6. LCSystems.
  - 7. Reznor-Thomas & Betts Corporation; Mechanical Products Division.
  - 8. Trane
  - 9. Johnson Controls

2.2 CABINET

- A. Construction: Double wall.
- B. Exterior Casing: Galvanized steel with baked-enamel paint finish and with lifting lugs and knockouts for electrical and piping connections.
- C. Interior Casing: Galvanized steel.
- D. Base Rails: Galvanized steel rails for mounting on roof curb.
- E. Service Doors: Hinged access doors with neoprene gaskets.
- F. Internal Insulation: Fibrous-glass duct lining complying with ASTM C 1071, Type II.
  - 1. Thickness: 2 inches.
  - 2. Insulation Adhesive: Comply with ASTM C 916, Type I.
  - 3. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to casing without damaging

liner and without causing air leakage when applied as recommended by manufacturer.

- G. Condensate Drain Pans: Formed sections of stainless steel sheet designed for self-drainage. Fabricate pans and drain connection to comply with ASHRAE 62.1-2004.
- H. Roof Curb: Full-perimeter curb of sheet metal, minimum 14 inches high, with wood nailer, neoprene sealing strip, and welded Z-bar flashing.
- I. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2010.

## 2.3 SUPPLY-AIR FAN / EXHAUST FAN

- A. Fan: Forward-curved centrifugal; statically and dynamically balanced, galvanized coated steel, mounted on solid-steel shaft with self-aligning, permanently lubricated ball bearings Retain "two" option in first paragraph below for units required to operate when exhaust hoods are not operating. Coordinate with "Controls" Article.
- B. Motor: Open drip-proof.
- C. Drive: V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly with minimum 1.4 service factor.
- D. Mounting: Fan wheel, motor, and drives shall be mounted in fan casing with spring isolators.

## 2.4 REFRIGERATION SYSTEM

- A. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."
- B. Compressors: Direct drive hermetic, scroll type compressors with integral vibration isolators, internal overcurrent and overtemperature protection, internal pressure relief, and crankcase heater.
  - 1. Variable speed compressor shall be capable of speed modulation from 15Hz to a maximum of 75Hz. The minimum unit capacity shall be 25% of full load or less. Each variable speed compressor shall be matched with a variable frequency drive which modulates the speed of the compressor motor and provides several compressor protection functions.
- C. Minimum Efficiency: As defined by ASHRAE/IESNA 90.1-2016, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."
- D. Refrigerant: R-407C or R-410A.
- E. 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.
  7. Operating charge of refrigerant.
  8. Hot-gas bypass refrigerant control for capacity control with continuous dehumidification for single-speed compressor.
- F. Capacity Control: Compressor with evaporator and condenser coil within the refrigerant section to provide initial precooling and reheat for humidity control.
- G. Capacity Control: Heat-pipe heat exchanger shall wrap around the evaporator coil to precool the air entering the evaporator coil and reheat the air leaving the evaporator coil to control humidity.
- H. Refrigerant Coils: Evaporator and condenser coils shall be designed, tested, fabricated, and rated according to ARI 410 and ASHRAE 33. Coils shall be leak tested under water with air at 315 psig.
1. Capacity Reduction: Circuit coils for interleaved control.
  2. Tubes: Copper.
  3. Fins: Aluminum with minimum fin spacing of 0.071 inch.
  4. Fin and Tube Joint: Mechanical bond.
  5. Suction and Distributor: Seamless copper tube with brazed joints.
  6. Coating: Phenolic epoxy corrosion-protection coating on both coils.
  7. Source Quality Control: Test to 450 psig, and to 300 psig underwater.
- I. Condenser Fan: Propeller type, directly driven by motor.
- J. Safety Controls:
1. Compressor motor and outside-coil fan motor low ambient lockout.
  2. Overcurrent protection for compressor motor and outside-coil fan motors.
- 2.5 OUTDOOR-AIR INTAKE AND DAMPERS
- A. Dampers: Leakage rate, according to AMCA 500, shall not exceed 2 percent of air quantity at face velocity of 2000 fpm through damper and pressure differential of 4-inch wg.
- B. Damper Operators: Electric.
- C. Mixing Boxes: Parallel-blade, galvanized-steel dampers mechanically fastened to steel operating rod inside cabinet. Connect operating rods with common interconnecting linkages so dampers operate simultaneously.
- D. Outdoor-Air Intake Hoods: Galvanized or Stainless steel, with bird screen complying with ASHRAE 62.1-2004 and finish to match cabinet.

## 2.6 FILTERS

- A. Comply with NFPA 90A.
- B. Cleanable Filters: 2-inch- thick, cleanable metal mesh.
- C. Disposable Panel Filters: 2-inch- thick, factory-fabricated, flat-panel-type, disposable air filters with holding frames, with a minimum efficiency report value of 6 according to ASHRAE 52.2 and 90 percent average arrestance according to ASHRAE 52.1].
  - 1. Media: Interlaced glass fibers sprayed with nonflammable adhesive.
  - 2. Frame: Galvanized steel.

## 2.7 CONTROLS

- A. Factory-wire connection for controls' power supply.
- B. Control devices, including sensors, transmitters, relays, switches, thermostats, humidistats, detectors, operators, actuators, and valves, shall be manufacturer's standard items to accomplish indicated control functions.
- C. Unit Controls: Solid-state control board and components with field-adjustable control parameters.
- D. Supply-Fan Control: Units shall be electrically interlocked with corresponding exhaust fans, to operate continuously when exhaust fans are running. Time clock shall switch operation from occupied to unoccupied. Night setback thermostat shall cycle fan during unoccupied periods to maintain space temperature.
  - 1. Timer: Seven-day electronic clock.
  - 2. Electrically interlock kitchen hood fire-extinguishing system to de-energize replacement-air unit when fire-extinguishing system discharges.
- E. Remote or Unit-Mounted Status Panel:
  - 1. Cooling/Off/Heating Controls: Control operational mode.
  - 2. Damper Position: Indicates 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.
- F. Refrigeration System Controls:
  - 1. Unit-mounted enthalpy controller shall lock out refrigerant system when outdoor-air enthalpy is less than 28 Btu/lb of dry air or outdoor-air temperature is less than 60 deg F (adj).



2. Outdoor-air sensor de-energizes dehumidifier operation when outdoor-air temperature is less than 60 deg F (adj).
3. Wall-mounting, relative-humidity sensor energizes dehumidifier operation when relative humidity is more than 60 percent.

G. Heating Controls:

1. Factory-mounted sensor in supply-fan outlet with sensor adjustment located in control panel modulates gas furnace burner to maintain space temperature.
2. Wall-mounting, space-temperature sensor with temperature adjustment or adjustment on remote-control panel that modulates gas furnace burner to maintain space temperature.
3. Remote Setback Thermostat: Adjustable room thermostat selected by timer, set at 60 deg F (adj); cycles supply fan and gas furnace burner to maintain space temperature.
4. Staged Burner Control: Two or Four steps of control.

H. Damper Controls: In cooling mode, unit will modulate outdoor air damper to minimum outdoor airflow setpoint (60 deg F (adj) and 60% relative humidity) and unit will modulate return air damper open to 100% less outside air damper position. In Economizer mode, outdoor air damper shall maintain the supply air temperature at the supply air temperature setpoint. Pressure operated relief damper is fully open to maintain the building from over pressurization.

I. Integral Smoke Alarm: Smoke detector installed in supply air.

J. DDC Temperature Control: Stand-alone control module for link between unit controls and DDC temperature-control system. Control module shall be compatible with temperature-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.

2.8 MOTORS

A. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install roof curb on roof structure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install and secure rooftop replacement-air units on curbs and coordinate roof penetrations and flashing with roof construction.
- B. Install wall- and duct-mounting sensors, thermostats, and humidistats furnished by manufacturers for field installation. Install control wiring and make final connections to control devices and unit control panel.
- C. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- D. Install piping adjacent to machine to allow service and maintenance.
  - 1. Gas Burner Connections: Comply with requirements in Division 23 Section Facility Natural-Gas Piping. Connect gas piping to burner, full size of gas train inlet, and connect with union, pressure regulator, and shutoff valve with sufficient clearance for burner removal and service.
- E. Duct Connections: Duct installation requirements are specified in Division 23 Section "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply ducts to rooftop replacement-air units with flexible duct connectors. Flexible duct connectors are specified in Division 23 Section "Air Duct Accessories."
- F. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.
- G. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

#### **3.2 STARTUP SERVICE**

- A. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
  - 1. Inspect for visible damage to furnace combustion chamber.
  - 2. Inspect for visible damage to compressor, air-cooled outside coil, and fans.
  - 3. Inspect casing insulation for integrity, moisture content, and adhesion.
  - 4. Verify that controls are connected and operable.
  - 5. Clean outside coil and inspect for construction debris.
  - 6. Clean furnace flue and inspect for construction debris.
  - 7. Inspect operation of power vents.
  - 8. Purge gas line.
  - 9. Verify bearing lubrication.
  - 10. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.

11. Adjust fan belts to proper alignment and tension.
  12. Start unit.
  13. Start refrigeration system when outdoor-air temperature is within normal operating limits.
  14. Inspect and record performance of interlocks and protective devices including response to smoke detectors by fan controls and fire alarm.
  15. Operate unit for run-in period.
  16. 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.
  17. Calibrate thermostats.
  18. Adjust and inspect high-temperature limits.
  19. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
  20. Start refrigeration system and measure and record the following:
    - a. Coil leaving-air, dry- and wet-bulb temperatures.
    - b. Coil entering-air, dry- and wet-bulb temperatures.
    - c. Outdoor-air, dry-bulb temperature.
    - d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
  21. Verify operational sequence of controls.
  22. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
    - a. High-limit heat exchanger.
    - b. Alarms.
- B. After startup and performance testing, change filters, verify bearing lubrication, and adjust belt tension.
- C. Remove and replace components that do not pass tests and inspections and retest as specified above.
- D. Prepare written report of the results of startup services.
- 3.3 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.

#### 3.4 CLEANING

After completing system installation; testing, adjusting, and balancing dedicated outdoor-air unit and air-distribution systems; and completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, casings, dampers, coils, and filter housings, and install new, clean filters

#### 3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain rooftop replacement-air units. Refer to Division 01 Section "Demonstration and Training."

**END OF SECTION 237433**

## **SECTION 237433**

### **DEDICATED OUTDOOR AIR UNITS**

#### **PART 1 - GENERAL**

##### 1.1 SUMMARY

- A. This Section includes cooling heating rooftop dedicated outside-air units.

##### 1.2 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories.
- B. Shop Drawings: Include details of installation and wiring diagrams.
- C. Coordination Drawings: Dedicated Outside air to roof-curb mounting 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. Size and location of dedicated outside air unit mounting 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.
- D. Startup service reports.
- E. Operation and maintenance data.
- F. Warranty.

##### 1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.4 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components listed below that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
  - 2. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than 10 years from date of Substantial Completion.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. AAON, Inc.
  - 2. Addison Products Company.
  - 3. Carrier
  - 4. Daikin
  - 5. Des Champs Laboratories, Incorporated.
  - 6. LCSystems.
  - 7. Reznor-Thomas & Betts Corporation; Mechanical Products Division.
  - 8. Trane
  - 9. Johnson Controls

2.2 CABINET

- A. Construction: Double wall.
- B. Exterior Casing: Galvanized steel with baked-enamel paint finish and with lifting lugs and knockouts for electrical and piping connections.
- C. Interior Casing: Galvanized steel.
- D. Base Rails: Galvanized steel rails for mounting on roof curb.
- E. Service Doors: Hinged access doors with neoprene gaskets.
- F. Internal Insulation: Fibrous-glass duct lining complying with ASTM C 1071, Type II.
  - 1. Thickness: 2 inches.
  - 2. Insulation Adhesive: Comply with ASTM C 916, Type I.
  - 3. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to casing without damaging

liner and without causing air leakage when applied as recommended by manufacturer.

- G. Condensate Drain Pans: Formed sections of stainless-steel sheet designed for self-drainage. Fabricate pans and drain connection to comply with ASHRAE 62.1-2004.
- H. Roof Curb: Full-perimeter curb of sheet metal, minimum 14 inches high, with wood nailer, neoprene sealing strip, and welded Z-bar flashing.
- I. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

### 2.3 SUPPLY-AIR FAN/EXHAUST FAN

- A. Fan: Forward-curved centrifugal; statically and dynamically balanced, galvanized coated steel, mounted on solid-steel shaft with self-aligning, permanently lubricated ball bearings Retain "two" option in first paragraph below for units required to operate when exhaust hoods are not operating. Coordinate with "Controls" Article.
- B. Motor: Open drip-proof.
- C. Drive: V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly with minimum 1.4 service factor.
- D. Mounting: Fan wheel, motor, and drives shall be mounted in fan casing with spring isolators.

### 2.4 REFRIGERATION SYSTEM

- A. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."
- B. Compressors: Direct drive hermetic, scroll type compressors with integral vibration isolators, internal overcurrent and overtemperature protection, internal pressure relief, and crankcase heater.
  - 1. Variable speed compressor shall be capable of speed modulation from 15Hz to a maximum of 75Hz. The minimum unit capacity shall be 25% of full load or less. Each variable speed compressor shall be matched with a variable frequency drive which modulates the speed of the compressor motor and provides several compressor protection functions.
- C. Minimum Efficiency: As defined by ASHRAE/IESNA 90.1-2016, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."
- D. Refrigerant: R-407C or R-410A.
- E. 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.
  7. Operating charge of refrigerant.
  8. Hot-gas bypass refrigerant control for capacity control with continuous dehumidification for single-speed compressor.
  9. Hot Gas Reheat refrigerant control with modulating single circuit
- F. Capacity Control: Compressor with evaporator and condenser coil within the refrigerant section to provide initial precooling and reheat for humidity control.
- G. Capacity Control: Heat-pipe heat exchanger shall wrap around the evaporator coil to precool the air entering the evaporator coil and reheat the air leaving the evaporator coil to control humidity.
- H. Refrigerant Coils: Evaporator and condenser coils shall be designed, tested, fabricated, and rated according to ARI 410 and ASHRAE 33. Coils shall be leak tested under water with air at 315 psig.
1. Capacity Reduction: Circuit coils for interleaved control.
  2. Tubes: Copper.
  3. Fins: Aluminum with minimum fin spacing of 0.071 inch.
  4. Fin and Tube Joint: Mechanical bond.
  5. Suction and Distributor: Seamless copper tube with brazed joints.
  6. Coating: Phenolic epoxy corrosion-protection coating on both coils.
  7. Source Quality Control: Test to 450 psig, and to 300 psig underwater.
- I. Condenser Fan: Propeller type, directly driven by motor.
- J. Safety Controls:
1. Compressor motor and outside-coil fan motor low ambient lockout.
  2. Overcurrent protection for compressor motor and outside-coil fan motors.
- 2.5 ROTARY HEAT EXCHANGER
- A. Casing:
1. Galvanized steel, stainless steel, or aluminum with manufacturer's standard factory-painted finish.
  2. Integral purge section limiting carryover of exhaust air to between 0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wgdifferential pressure.
  3. Casing seals on periphery of rotor and on duct divider and purge section.
  4. Support vertical rotor on grease-lubricated ball bearings having extended grease fittings or permanently lubricated bearings. Support horizontal rotors on tapered roller bearings.



- B. Rotor - Aluminum, Metallic, or Polymer: Aluminum, metallic, or polymer segmented wheel, strengthened with radial spokes impregnated with nonmigrating, water-selective, molecular-sieve desiccant coating.
- C. Drive: Fractional horsepower motor and gear reducer with speed changed by variable-frequency controller. Provide permanently lubricated wheel bearings.
- D. Controls:
  - 1. Starting relay, factory mounted and wired, and manual motor starter for field wiring.
  - 2. Variable-frequency controller, factory mounted and wired, permitting input of 4-20 mA or 1-10 V control signal.
  - 3. Control energy recovery to permit air economizer operation.
    - a. Bypass dampers to assist energy recovery control.
  - 4. Pilot-Light Indicator: Display rotor rotation and speed.
  - 5. Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.
  - 6. Integral purge section limiting carryover of exhaust air to between 0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wgdifferential pressure.
  - 7. Defrost Cycle.

## 2.6 ELECTRIC-RESISTANCE HEATING COILS: COMPLY WITH UL 1995

- 1. Casing Assembly: Flanged type with galvanized-steel frame.
- 2. Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.
- 3. Overtemperature Protection: Disk-type, automatically resetting, thermal-cutout, safety device; serviceable through terminal box without removing heater from coil section.
- 4. Secondary Protection: Load-carrying, manually resetting or manually replaceable, thermal cutouts; factory wired in series with each heater stage.
- 5. Control Panel: Unit/Remote mounted with disconnecting means and overcurrent protection.
  - a. Magnetic contactor.
  - b. Solid-state, stepless pulse controller.
  - c. Toggle switches, one per step.
  - d. SCR controller.
  - e. Time-delay relay.
  - f. Pilot lights, one per step.
- 6. Airflow proving switch.

## 2.7 OUTDOOR-AIR INTAKE, RELIEF AND DAMPERS

- A. Dampers: Leakage rate, according to AMCA 500, shall not exceed 2 percent of air quantity at face velocity of 2000 fpm through damper and pressure differential of 4-inch wg.
- B. Damper Operators: Electric.
- C. Outdoor-Air Intake Hoods: Galvanized or Stainless steel, with bird screen complying with ASHRAE 62.1-2004 and finish to match cabinet.

## 2.8 FILTERS

- A. Comply with NFPA 90A.
- B. Cleanable Filters: 2-inch- thick, cleanable metal mesh.
- C. Disposable Panel Filters: 2-inch- thick, factory-fabricated, flat-panel-type, disposable air filters with holding frames, with a minimum efficiency report value of 6 according to ASHRAE 52.2 and 90 percent average arrestance according to ASHRAE 52.1.
  - 1. Media: Interlaced glass fibers sprayed with nonflammable adhesive.
  - 2. Frame: Galvanized steel.

## 2.9 CONTROLS

- A. Factory-wire connection for controls' power supply.
- B. Control devices, including sensors, transmitters, relays, switches, thermostats, humidistats, detectors, operators, actuators, and valves, shall be manufacturer's standard items to accomplish indicated control functions.
- C. Unit Controls: Solid-state control board and components with field-adjustable control parameters.
- D. Supply-Fan Control: Units shall be electrically interlocked with corresponding exhaust fans, to operate continuously when exhaust fans are running. Time clock shall switch operation from occupied to unoccupied. Night setback thermostat shall cycle fan during unoccupied periods to maintain space temperature.
  - 1. Timer: Seven-day electronic clock.
  - 2. Electrically interlock kitchen hood fire-extinguishing system to de-energize replacement-air unit when fire-extinguishing system discharges.
- E. Remote or Unit-Mounted Status Panel:
  - 1. Cooling/Off/Heating Controls: Control operational mode.
  - 2. Damper Position: Indicates position of outdoor-air dampers.
  - 3. Status Lights:

- a. Filter dirty.
- b. Fan operating.
- c. Cooling operating.
- d. Heating operating.

F. Refrigeration System Controls:

1. Unit-mounted enthalpy controller shall lock out refrigerant system when outdoor-air enthalpy is less than 28 Btu/lb of dry air or outdoor-air temperature is less than 60 deg F (adj).
2. Outdoor-air sensor de-energizes dehumidifier operation when outdoor-air temperature is less than 60 deg F (adj).
3. Relative-humidity sensor energizes dehumidifier operation when relative humidity is more than 60 percent.

G. Heating Controls:

1. Factory-mounted sensor in supply-fan outlet with sensor adjustment located in control panel modulates heating output (SCR control) to maintain space temperature.
2. Wall-mounting, space-temperature sensor with temperature adjustment or adjustment on remote-control panel that modulates heating output (SCR control) to maintain space temperature.
3. Remote Setback Thermostat: Adjustable room thermostat selected by timer, set at 60 deg F (adj); cycles supply fan and SCR control to maintain space temperature.
4. Electric Heat Control: SCR control.

H. Damper Controls: In cooling mode, unit will enable outdoor air damper to open outdoor airflow setpoint (60 deg F (adj) and 60% relative humidity) and unit will enable exhaust air damper in open position. In Economizer mode, outdoor air damper shall maintain the supply air temperature at the supply air temperature setpoint. Pressure operated relief damper is fully open to maintain the building from over pressurization.

I. Integral Smoke Alarm: Smoke detector installed in supply air.

J. DDC Temperature Control: Stand-alone control module for link between unit controls and DDC temperature-control system. Control module shall be compatible with temperature-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. Heating system operating.

2.10 ROOF CURBS

- A. Roof curbs with vibration isolators and wind or seismic restraints are specified in Section 230548 "Vibration and Seismic Controls for HVAC." Roof curbs with vibration isolators and wind restraints are specified in Section 230548.13 "Vibration Controls for HVAC."
- B. Curb Dimensions: Height of 14 inches.
- C. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match unit, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for wind-load requirements.

2.11 MOTORS

- A. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

**PART 3 - EXECUTION**

3.1 INSTALLATION

- A. Install roof curb on roof structure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install and secure rooftop replacement-air units on curbs and coordinate roof penetrations and flashing with roof construction.
- B. Install wall- and duct-mounting sensors, thermostats, and humidistats furnished by manufacturers for field installation. Install control wiring and make final connections to control devices and unit control panel.
- C. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- D. Duct Connections: Duct installation requirements are specified in Division 23 Section "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply ducts to rooftop replacement-air units with flexible duct connectors. Flexible duct connectors are specified in Division 23 Section "Air Duct Accessories."
- E. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.
- F. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

### 3.2 STARTUP SERVICE

- A. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
1. Inspect for visible damage to compressor, air-cooled outside coil, and fans.
  2. Inspect casing insulation for integrity, moisture content, and adhesion.
  3. Verify that controls are connected and operable.
  4. Clean outside coil and inspect for construction debris.
  5. Verify that clearances have been provided for servicing.
  6. Inspect operation of power vents.
  7. Verify bearing lubrication.
  8. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
  9. Adjust fan belts to proper alignment and tension.
  10. Start unit.
  11. Start refrigeration system when outdoor-air temperature is within normal operating limits.
  12. Inspect and record performance of interlocks and protective devices including response to smoke detectors by fan controls and fire alarm.
  13. Operate unit for run-in period.
  14. Calibrate thermostats.
  15. Adjust and inspect high-temperature limits.
  16. Inspect outdoor-air dampers for proper stroke and interlock with return (exhaust)air dampers.
  17. Measure and record the following airflows. Plot fan volumes on fan curve.
    - a. Outside-air volume.
    - b. Relief (Exhaust)-air flow.
  18. Start refrigeration system and measure and record the following:
    - a. Coil leaving-air, dry- and wet-bulb temperatures.
    - b. Coil entering-air, dry- and wet-bulb temperatures.
    - c. Outdoor-air, dry-bulb temperature.
    - d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
  19. Verify operational sequence of controls.
- B. After startup and performance testing, change filters, verify bearing lubrication, and adjust belt tension.
- C. Remove and replace components that do not pass tests and inspections and retest as specified above.
- D. Prepare written report of the results of startup services.

### 3.3 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.

#### 3.4 CLEANING

After completing system installation; testing, adjusting, and balancing dedicated outdoor-air unit and air-distribution systems; and completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, casings, dampers, coils, and filter housings, and install new, clean filters.

#### 3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain dedicated outside air unit. Refer to Division 01 Section "Demonstration and Training."

**END OF SECTION 237433**

## **SECTION 238130**

### **DUCTLESS SPLIT-SYSTEM AIR-CONDITIONERS**

#### **PART 1 - GENERAL**

##### 1.1 SUMMARY

- A. Section includes split-system air-conditioning units consisting of separate evaporator-fan and compressor-condenser components.

##### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. For units mounted outdoors: A valid Notice of Acceptance issued by Miami-Dade County, Florida Building Code Compliance Office showing compliance with the Florida Building Code High Velocity Hurricane Zone criteria.
- C. LEED Submittals:
  - 1. Product Data for Credit EA 4: Documentation indicating that equipment and refrigerants comply.
  - 2. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
- D. 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.

##### 1.3 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

##### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

## 1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:
  - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
  - 2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Procedures," and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

## 1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period:
    - a. For Compressor: Five year(s) from date of Substantial Completion.
    - b. For Parts: Five year(s) from date of Substantial Completion.
    - c. For Labor: Five year(s) 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. Carrier Corporation; Home Comfort and HVAC Building & Industrial Systems.
  - 2. Friedrich Air Conditioning Company.
  - 3. Mitsubishi Electric & Electronics USA, Inc.; HVAC Advanced Products Division.
  - 4. Daikin Applied.
  - 5. SANYO North America Corporation; SANYO Fisher Company.
  - 6. Trane; a business of American Standard companies.
  - 7. YORK; a Johnson Controls company.

### 2.2 INDOOR UNITS

- A. Concealed Evaporator-Fan Components:



1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
  2. Insulation: Faced, glass-fiber duct liner.
  3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 210/240.
  4. Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch; leak tested to 300 psig underwater; with a two-position control valve.
  5. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.
  6. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
  7. Fan Motors:
    - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
    - b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
    - c. Wiring Terminations: Connect motor to chassis wiring with plug connection.
  8. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
  9. Filters: Permanent, cleanable.
  10. Condensate Drain Pans:
    - a. Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
      - 1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
      - 2) Depth: A minimum of 2 inches deep.
    - b. Single-wall, stainless-steel sheet.
    - c. Double-wall, stainless-steel sheet with space between walls filled with foam insulation and moisture-tight seal.
    - d. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on both ends of pan.
      - 1) Minimum Connection Size: NPS  $\frac{3}{4}$ ".
    - e. Pan-Top Surface Coating: Asphaltic waterproofing compound.
    - f. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.
- B. Wall-Mounted, Evaporator-Fan Components:

1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 210/240.
3. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for over-current protection.
4. Fan: Direct drive, centrifugal.
5. Fan Motors:
  - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
  - b. Multi-tapped, multispeed with internal thermal protection and permanent lubrication.
  - c. Enclosure Type: Totally enclosed, fan cooled.
  - d. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
  - e. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
  - f. Mount unit-mounted disconnect switches on exterior of unit.
6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
7. Condensate Drain Pans:
  - a. Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
    - 1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
    - 2) Depth: A minimum of 1 inch deep.
  - b. Single-wall, stainless-steel sheet.
  - c. Double-wall, stainless-steel sheet with space between walls filled with foam insulation and moisture-tight seal.
  - d. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on both ends of pan.
    - 1) Minimum Connection Size: NPS 3/4".
  - e. Pan-Top Surface Coating: Asphaltic waterproofing compound.
8. Air Filtration Section:
  - a. General Requirements for Air Filtration Section:
    - 1) Comply with NFPA 90A.
    - 2) Minimum Arrestance: According to ASHRAE 52.1 and MERV according to ASHRAE 52.2.

- 3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

b. Disposable Panel Filters:

- 1) Factory-fabricated, viscous-coated, flat-panel type.
- 2) Thickness: 1 inch
- 3) Initial Resistance: 0.125 inches wg.
- 4) Recommended Final Resistance: 0.25 inches wg
- 5) Arrestance according to ASHRAE 52.1:
- 6) Merv according to ASHRAE 52.2: 5.
- 7) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.

## 2.3 OUTDOOR UNITS

A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel in color selected by Architect, 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 with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
  - a. Compressor Type: Scroll.
  - b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
  - c. Refrigerant Charge R-407C or R-410A.
  - d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 210/240.

## 2.4 ACCESSORIES

- A. Control equipment and sequence of operation are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls."
- B. Thermostat: Low voltage with sub-base to control compressor and evaporator fan.
- C. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:
  1. Compressor time delay.
  2. 24-hour time control of system stop and start.
  3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
  4. Fan-speed selection including auto setting.

- D. Automatic-reset timer to prevent rapid cycling of compressor.
- E. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.
- F. Drain Hose: For condensate.
- G. Additional Monitoring:
  - 1. Monitor constant and variable motor loads.
  - 2. Monitor variable-frequency-drive operation.
  - 3. Monitor economizer cycle.
  - 4. Monitor cooling load.
  - 5. Monitor air distribution static pressure and ventilation air volumes.

2.5 CAPACITIES AND CHARACTERISTICS – Refer to schedule on plans.

### **PART 3 - EXECUTION**

#### 3.1 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install roof-mounted, compressor-condenser components on equipment supports specified in Division 07 Section "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.
- D. Install seismic restraints.
- E. Install and connect pre-charged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

#### 3.2 CONNECTIONS

- A. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

#### 3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports.
- 3.4 DEMONSTRATION
- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

**END OF SECTION 238130**

**SECTION 238239.19**  
**CEILING UNIT HEATERS**

**PART 1 - GENERAL**

1.1 SUMMARY

- A. Section includes ceiling heaters with propeller fans and electric-resistance heating coils.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings:
  - 1. Include plans, elevations, sections, and details.
  - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Include details of anchorages and attachments to structure and to supported equipment.
  - 4. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
  - 5. Wiring Diagrams: Power, signal, and control wiring.
- C. Samples: For each exposed product and for each color and texture specified.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Berko; Marley Engineered Products.
  - 2. Chromalox, Inc.
  - 3. Indeeco.

4. Markel Products Company; TPI Corporation.
5. Marley Engineered Products.
6. QMark; Marley Engineered Products.
7. Trane Inc.

## 2.2 DESCRIPTION

- A. Assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## 2.3 CABINET

- A. Front Panel: Stamped-steel louver or Extruded-aluminum bar grille, with removable panels fastened with tamperproof fasteners.
- B. Finish: Baked enamel over baked-on primer with manufacturer's standard color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.
- C. Surface-Mounted Cabinet Enclosure: Steel with finish to match cabinet.

## 2.4 COIL

- A. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high-temperature protection. Provide integral circuit breaker for overcurrent protection.

## 2.5 FAN AND MOTOR

- A. Fan: Aluminum propeller directly connected to motor.
- B. Motor: Permanently lubricated, multispeed. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

## 2.6 CONTROLS

- A. Controls: Unit-mounted thermostat. Low-voltage relay with transformer kit.
- B. Electrical Connection: Factory wire motors and controls for a single field connection with disconnect switch.

2.7 CAPACITIES AND CHARACTERISTICS – Refer to schedule on mechanical plans.

### **PART 3 - EXECUTION**

#### 3.1 INSTALLATION

- A. Install ceiling unit heaters to comply with NFPA 90A.
- B. Install ceiling unit heaters level and plumb.
- C. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.
- D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

**END OF SECTION 238239.19**



## **SECTION 26 05 00**

### **ELECTRICAL REQUIREMENTS**

#### **PART 1 - GENERAL**

##### 1.1 RELATED DOCUMENTS

- A. This Section supplements Division 1, General Requirements.
- B. Where contradictions occur between this Section and Division 1, the more stringent of the two shall apply. Architect shall decide which is most stringent.
- C. Provisions of Divisions 21, 22, 23, 27 and 28 shall also apply to the work of this section as if fully repeated here.
- D. Provision indicate Section 23 05 01/26 05 01 "Mechanical and Electrical Coordination" shall also apply to the work of this section as if fully repeated here.

##### 1.2 REGULATORY REQUIREMENTS

- A. All materials shall conform to the current applicable industry standards. Workmanship and neat appearance shall be as important as electrical and mechanical operation. Defective or damaged materials shall be replaced or repaired prior to final acceptance in a manner meeting approval of the Architect and at no additional cost to the Owner.
- B. The latest editions of the following standards are minimum requirements.
  - 1. Underwriters' Laboratories, Inc. (UL)
  - 2. National Electrical Manufacturer's Assoc. (NEMA)
  - 3. American National Standards Institute (ANSI)
  - 4. Institute of Electrical and Electronic Engineers (IEEE)
  - 5. International Electrical Testing Association (NETA)
  - 6. Insulated Cable Engineer's Association (ICEA)
- C. All work and materials shall comply with latest rules, codes and regulations including, but not limited to the following:
  - 1. OSHA.
  - 2. National Fire Codes of National Fire Protection Assoc. (NFPA)
  - 3. National Electrical Safety Code (NESC, ANSI C2)
  - 4. National Electrical Code 2017 with city, county and state Amendments.
  - 5. International Building Code 2018 with city, county and state Amendments.
  - 6. 2010 ADAAG Americans with Disabilities Accessibility Guidelines.
  - 7. All applicable Federal, state and local laws, code amendments and regulations.

- D. Code compliance is mandatory. Nothing in these drawings and specifications permits work not conforming to these codes.
- E. No work shall be concealed until after inspection and approval by proper authorities. If work is concealed without inspection and approval, Contractor shall be responsible for all work required to open and restore the concealed area including all required modifications.
- F. Contradictions: Where Codes are contradictory, follow the most stringent. Architect/Engineer shall determine which is most stringent.

### 1.3 CONTRACT DOCUMENTS

- A. Drawings indicate general arrangement of circuits and locations of outlets, conduit, and other work. Information shown on drawings is as accurate as planning can determine, but not guaranteed and field verification of all dimensions, locations, levels, etc., to suit field conditions is directed. Review all architectural, structural and mechanical drawings, and adjust all work to conform to all conditions shown therein. Architectural drawings shall take precedence over all other drawings. Discrepancies between different drawings or between drawings and specifications or regulations and codes governing installation shall be brought to attention of the Architect.
- B. Where the Drawings and Specifications do not comply with the minimum requirements of the Codes, either notify the Architect/Engineer in writing during the Bidding Period of the revisions required to meet Code requirements, or provide an installation which complies with the Code requirements. After entering into contract, Contractor will be held to complete all work necessary to meet these requirements without additional expense to the Owner.
- C. Follow Drawings and Specifications where they are superior to Code requirements. The more stringent of plans and drawing shall apply.

### 1.4 COORDINATION DRAWINGS

- A. Prepare coordination drawings in accordance with Division 1 "Submittals" to a scale of 1/4" = 1'-0" or larger; detailing major elements, components, and systems of electrical equipment (i.e., all transformer vaults, switchgear rooms, generator rooms, electrical rooms and technology rooms) and materials in relationship with other systems, installations, and building components. Where equipment is located outdoors, prepare shop drawings indicating electrical equipment locations and exterior elements in the equipment areas. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are important to the efficient flow of the work, including (but not necessarily limited to) the following:
  - 1. Indicate the proposed locations of major raceway systems, and materials. Include the following:
    - a. Exterior wall and foundation penetrations.
    - b. Fire-rated wall and floor penetrations.
    - c. Support details.

- d. Sizes and location of required concrete pads and bases.
2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
3. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installation.
4. Electrical and Transformer Vault Rooms indicating conduit stub-up locations.
5. Medium-voltage, normal and emergency underground conduit and duct bank routing.

#### 1.5 RECORD DRAWINGS

- A. Refer to Division 1 for additional requirements.
- B. Maintain a blue-line set of Electrical Contract Drawings in clean, undamaged condition, for mark-up of installations which vary from the Contract Drawings. These drawings shall be a separate set of drawings, not used for construction purposes, and shall be kept up to date as the job progresses. This set shall be made available for inspection by the Engineer or Architect at all times. Upon completion of the contract a set of computerized "as built" capable of interfacing with AutoCAD software, shall be delivered to the Architect.
- C. Prepare record documents in accordance with the requirements in Division 1 Section "Project Closeout." In addition to the requirements specified in Division 1, indicate installed conditions for:
  1. Major raceway systems, size and location, for both exterior and interior and locations of handholes and conduit stub-up locations.
  2. Panelboard circuit directories reflecting all field changes.
  3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
  4. Results of all testing performed as specified in the specification.
  5. Certification of inspection from Authorities Having Jurisdiction.
- D. Record the locations and invert elevations of underground installations.

#### 1.6 OPERATING AND MAINTENANCE MANUALS

- A. Refer to Division 1 for additional requirements.
- B. Submission:
  1. Submit an electronic copy of Operating and Maintenance Manuals prior to scheduling systems demonstration for the Owner.
- C. Requirement Contents:
  1. Manuals shall have either a combined file with bookmarks for each section or individual file for each section. If individual files, each digital file shall include section number and title in the file name.

2. Submittal for each section shall identify all equipment and materials installed on the project.
3. Manual to include contact information for a local supplier that can provide the specific piece of equipment.
4. Provide certificates for such items of equipment which have warranties in excess of one year.
5. Provide test results for each specification section identified herein.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.
- B. Protection of Equipment:
  1. All electrical equipment to be used in the construction shall be properly stored and protected against the elements. All equipment shall be stored under cover, and shall not be stored at the construction site on the ground, in mud, water, rain, sleet, or dust. Large diameter cables may be stored on reels outside; however, all cable ends shall be waterproofed and the reels covered with weatherproof materials. Such weatherproof materials shall be heavy-duty, securely fastened, and made impervious to the elements.
  2. Conventional electrical construction materials such as building wire, outlet and junction boxes, wiring devices, conduit, lighting fixtures, fittings, etc., shall be stored in construction buildings, covered trailers, or portable covered warehouses. Any equipment subject to damage or corrosion from excessive moisture shall be stored in dry, heated areas. Any equipment containing plastic or material subject to damage caused by excessive heat or sunlight shall be stored to prevent such damage. This includes plastic ducts and lenses.
  3. Equipment damaged as a result of the above conditions shall be properly repaired at the contractor's expense or shall be replaced at the contractor's expense, if in the opinion of the Engineer, the equipment has been damaged to such an extent that it cannot operate properly after repairs are made.
  4. All electrical enclosures exposed to construction damaged such as paint spots, spackling or plaster spatter, grout splashes, waterproofing compound, tar spots or runs, and pipe covering compound splashes, shall be completely covered and protected against damage.
  5. In the event leakage into the building of any foreign material or fluid occurs or may occur, the contractor shall take all steps as described above to protect any and all equipment.
  6. After connections to electrical equipment are complete and the equipment is ready for operation, all construction debris shall be removed from all enclosures. Such debris includes dust, dirt, wire clippings, tape, and insulation removed in order to make the connection.

#### 1.8 SAFETY AND INDEMNITY

- A. The Contractor shall be solely and completely responsible for conditions of the job site, including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal working hours. See also General Conditions.

- B. No act, service, drawings review or construction review by the Architect or Engineer, is intended to include review of the adequacy of the Contractor's safety measures in, on, or near the construction site.

## 1.9 WARRANTIES

- A. The warranty period is generally one year after Date of Acceptance.
  - 1. During this period, provide labor and materials as required to repair or replace defects in the electrical systems at no cost to the Owner. Provide certificate with O & M manual submittal which guarantees same day service response to the Owner's call for such warranty service.
  - 2. Provide certificates for such items of equipment which have warranties in excess of one year. Insert copies of O & M manual. Such equipment shall include:
    - a. Lighting fixtures
    - b. Fire alarm system
    - c. Lighting control
    - d. Static Uninterruptable Power Supply
  - 3. Provide extended manufacturers warranties to cover one full year from Date of Acceptance if standard manufacturers' warranty ends any time prior to that date.

## **PART 2 - PRODUCTS**

### 2.1 EQUIPMENT AND MATERIALS

- A. All equipment and materials installed shall be new, unless otherwise specified.
- B. All major equipment components shall have manufacturers' name, address, model number and serial number permanently attached in a conspicuous location.
- C. All equipment shall be UL listed and bear the UL label.
- D. Specifications list approved products for the project, if not listed follow substitution request process.
- E. All areas directly exposed to outside air shall be considered exterior. This includes concourses, rooftops of buildings located on concourses, videoboard and field lighting catwalk systems, covered areas below precast seating sections, etc. Contractor's electrical installation, means and methods and materials used shall be appropriate for outdoor installations in these areas.

### 2.2 GENERAL SUBMITTAL REQUIREMENTS

- A. Coordination and Sequencing:

1. After receipt of notice to proceed, the Contractor shall submit to the Architect a typed list of submittals and the scheduled date of submission. List shall include submittal number, section number and scheduled date of submission. Submittals shall be grouped and submitted in no more than ten complete packages.
2. The contractor shall not submit any shop drawings or product data that does not comply with the contract documents. Prior to submitting shop drawings, review submittal for compliance with Contract Documents and place a stamp or other confirmation thereon which states that submittals have been reviewed. Submittals without such verification will be returned disapproved without review.
3. Submittal is for information and record, unless otherwise indicated, and is not a change order request.

B. Preparation of Submittals:

1. Refer to Division 1 requirements.
2. The Contractor shall submit for approval by the Architect data of materials and equipment to be incorporated in the work. Submittals shall be supported by descriptive material, catalogs, cuts, diagrams, performance curves, and charts published by the manufacturer to show conformance to specification and drawing requirements; model numbers alone will not be acceptable. Provide complete electrical characteristics for all equipment. Submit product submittals on items as outlined in sections hereinafter.
3. Product submittals shall be made by specification section. All items of a section, requiring submission, shall be submitted together in one individual electronic file.
4. If two or more sections require inter-coordination (e.g., emergency generator and transfer switch; short circuit study, coordination study, electrical room layouts and electrical switchboards, fire alarm and fire command center layout), they shall be submitted at the same time. If electrical gear is submitted without electrical room layouts, short circuit study, coordination study, the submittal will be returned without review.
5. Each section shall be submitted as an individual file with section number and section name in the file name of the submittal.
6. Submittals of an entire product catalog will be rejected without review. Products to be used on the project must be indicated on cut sheets.
7. Provide cover letter in electronic file identifying project name, Contractor, Subcontractor, submittal name, date of submission, specification section, and information to distinguish it from other submittals.
8. Submittals not presented in individual electronic files or neat and legible fashion will returned "Without Action."
9. Submittals shall show Contractor's executed review and approval marking. Submittals which are received from sources other than through Contractor's office will be returned "Without Action."
10. Provide space for Architect's "Action" marking.

C. Substitutions

1. Refer to the General Conditions, which govern "Substitution" of specified equipment or materials.
2. Indicate any portions of work which deviate from the Contract Documents.
  - a. Explain the reasons for the deviations.

- b. Show how such deviations coordinate with interfacing portions of other work.
3. Where substitution of materials alters space requirements indicated on the drawings, submit shop drawings indicating proposed layout of space, all equipment to be installed therein and clearances between equipment (i.e., electrical rooms). All clearances required by the National Electrical Code and applicable state and local regulations must be maintained.

D. Review Process

1. The Architect reserves the right to require a sample of any equipment to be submitted for approval and to retain its possession.
2. Refer to the individual sections for identified equipment and material for which submittals are required. In addition, provide shop drawings and product data on the following equipment:

Electrical Power Conductors and Cables  
Grounding and Bonding  
Hangers and Supports  
Raceway and Boxes  
Vibration and Seismic Controls  
Identification  
Central Dimming Controls  
Network Lighting Control  
Low-Voltage Distribution Transformers  
Panelboards  
Enclosed Bus Assemblies  
Wiring Devices  
Fuses  
Enclosed Controllers  
Surge Protection Device  
Lighting Fixtures  
Poles and Standards  
Enclosed Switches and Circuit Breakers  
Fire Alarm System  
Static Uninterruptable Power Supply (UPS)

Do not submit on equipment or materials not requested in the specifications.

3. Review of shop drawings and product data by the Architect/Engineer, including any review annotations or stamp notations, does not relieve the contractor from the required compliance with the contract documents.
4. The shop drawing and product data review stamp notation requirements are defined as follows:
  - a. "NO EXCEPTION TAKEN:" The reviewer did not observe any items which were not in compliance with the contract documents. All dimensions, details, and coordination with other trades are the responsibility of the contractor.
  - b. "MAKE CORRECTIONS NOTED:" The reviewer indicated items observed that were not in compliance with the contract documents. The

- contractor shall not resubmit, but shall make corrections and provide corrected documents with the "Record Drawings."
- c. "REJECTED, REVISE AND RESUBMIT:" The reviewer indicated items observed which were not in compliance with the contract documents. The contractor shall resubmit showing corrections of all noted items. Delays for resubmittal do not relieve the contractor from meeting project schedules.
  - d. "REJECTED:" The submission does not comply with the contract requirements. The entire submittal must be corrected and submitted for review. Delays for resubmittal do not relieve the contractor from meeting project schedules.
5. If shop drawings are submitted and returned as "NO EXCEPTION TAKEN" or "MAKE CORRECTIONS NOTED" and meet contract requirements, the contractor shall not resubmit any other shop drawings for these items.
  6. If resubmittals are necessary, they shall be made as specified above for submittals. Resubmittals shall highlight all revisions made and cover shall include the phrase "RESUBMITTAL NO. \_\_\_\_\_."
  7. Resubmittal requirements do not entitle the Contractor to additional time and are not a cause for delay of the project.

### **PART 3 - EXECUTION**

#### 3.1 CONDITIONS AT SITE

- A. Visit to site is required of all bidders prior to submission of bid. All bidders will be held to have familiarized themselves with all discernible conditions, and no extra payment will be allowed for work required because of these conditions, whether specifically mentioned or not.
- B. Lines of other services and/or equipment that are damaged as a result of this work shall promptly be repaired at no expense to the Owner.

#### 3.2 LICENSES, FEES AND PERMITS

- A. Arrange for required inspections and pay all license, permit and inspection fees. Furnish a certificate of final inspections and approvals from local authority having jurisdiction over electrical installation.

#### 3.3 WORKMANSHIP AND CONTRACTOR'S QUALIFICATIONS

- A. Only professional quality workmanship will be accepted. Haphazard or poor installation practice will be cause for rejection of work.
- B. Provide foreman in charge of this work at all times. Foremen for this work shall have had experience in installing not less than 5 such electrical systems of equal or greater complexity.



- C. Where specifications call for an installation to be made in accordance with manufacturers' recommendations, a copy of such recommendations shall at all times be kept in job superintendent's office.

### 3.4 RELATION WITH OTHER TRADES

- A. Contractor shall coordinate work of this Division with other trades to avoid conflict and to provide rough-ins and other connections for equipment furnished under other divisions that require electrical connections. Inform other trades of required clearances of accesses for or around electrical equipment to maintain serviceability and code compliance.
- B. Verify equipment dimensions and rough-in requirements for Divisions 2 through 28 with provisions specified under this Section of work, and report discrepancies to the Architect in ample time to prevent delays or unwarranted changes of work.

### 3.5 TESTING

- A. Provide all labor, materials, and equipment necessary to make required tests. Tests shall be complete and results approved before final inspection is begun.

### 3.6 PROGRESS OF WORK

- A. Order progress of electrical work so as to conform to progress of work of other trades, and complete entire installation as soon as condition of building will permit. Assume any cost resulting from defective or ill-timed work performed under this Division.

### 3.7 CUTTING AND PATCHING

- A. General: Perform cutting and patching in accordance with Division 1 Section "Cutting and Patching." In addition to the requirement specified in Division 1, the following requirements apply:
  - 1. Perform cutting, fitting, and patching of electrical equipment and materials required to:
    - a. Uncover work to provide for installation of ill-timed work.
    - b. Remove and replace defective work.
    - c. Remove and replace work not conforming to requirements of the Contract documents.
    - d. Remove samples of installed work as specified for testing.
    - e. Install equipment and materials in newly installed structures.
    - f. Upon written instructions from the architect, uncover and restore work to provide for Architect observation of concealed work.

### 3.8 SLEEVES

- A. Place sleeve in forms of walls, floor slabs and partitions for passage of all conduits, pipes, and ducts installed under Divisions 26, 27 and 28. Sleeves shall be set in place a sufficient time ahead of concrete work so as not to delay that work. Install sleeves and raceways through exterior walls so as to provide a waterproof installation. All floor penetrations shall be made watertight. Conduits passing through walls shall be installed to preserve integrity of the wall rating (i.e., fire rating, sound rating, air, etc.). All penetration made through existing concrete slabs or walls shall be x-rayed and approved by Structural Engineer prior to cutting.

### 3.9 EXCAVATION, TRENCHING, AND BACKFILLING

- A. Perform all excavation to install conduit and duct banks indicated on the drawings or specified herein. During excavation, pile material for backfilling back from the banks of the trench to avoid overloading and to prevent slides and cave-ins. Remove and dispose of all excavated materials not to be used for backfill. Grade to prevent surface water from flowing into trenches and excavation. Remove any water accumulating therein by pumping. Do all excavation by open cut. No tunneling shall be done unless indicated on the drawings or unless written permission is received from the Architect.
- B. Grade the bottom of trenches to provide uniform bearing and support for conduits or duct bank on undisturbed soil at every point along its entire length. Tamp over depths with loose, granular, moist earth. Remove unstable soil that is not capable of supporting equipment or installation and replace with specified material for a minimum of 12" below invert of equipment or installation.
- C. Backfill the trenches with excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand and gravel or soft shale. These materials should be free from large clods of earth and stones, deposited in 6" layers and rammed until the installation has cover of not less than the adjacent ground but not greater than 2" above existing ground. Backfilling shall be carried on simultaneously on both sides of the trench so that injurious pressures do not occur. Compaction of the filled trench shall be at least equal to that of the surrounding undisturbed material. Do not settle backfill with water. Reopen any trenches not meeting compaction requirements or where settlement occurs, refill, compact, and restore surface to grade and compaction indicated on the drawings, mounded over and smoothed off.
- D. In addition, all excavation and backfilling shall comply with Division 2. The most stringent requirement shall apply.

### 3.10 CLEANUP

- A. Remove all materials, scrap, etc., relative to electrical installations and leave premises in a clean, orderly condition. Any costs to the Owner for cleanup of site will be charged to the Contractor. At completion, all equipment, raceways, etc., shall be thoroughly cleaned and all residue removed from the inside and outside surfaces. Defaced finish shall be refinished.

3.11 TEMPORARY POWER

- A. Provide temporary power as requested by the general contractor and in accordance with OSHA and local code requirements. Lighting and power outlets shall be provided throughout the project. Check with construction manager or general contractor prior to bid for special lighting and power outlets and provide as needed.

3.12 MINOR CHANGES

- A. The Owner reserves the right to make minor changes in the locations of outlets and equipment up to the time of electrical rough-in without any cost to the Owner.

3.13 ELEVATOR COORDINATION

- A. Provide control wiring and conduit from ATS to elevator controllers, as required by elevator vendor.
  - 1. 2# 12-1"C from auxiliary contact (closed when switch in emergency position) on transfer switch to each elevator machine room which is served via that transfer switch. Terminate as and where required by the elevator vendor.
  - 2. 2# 12-1"C from auxiliary contact (closed before switch returns to normal power) on transfer switch serving elevators to each elevator machine room which is served via that transfer switch. Terminate as and where required by the elevator vendor.
- B. Provide 1" conduit from elevator controller to fire alarm control panel for elevator communication system, as required by elevator vendor.

3.14 ELECTRICAL SYSTEMS OPERATIONAL TESTS, CERTIFICATION, AND DESIGN AUTHORITY ASSISTANCE

- A. Testing
  - 1. Refer to the individual specification sections for test requirements.
  - 2. Prior to the final inspection, the systems or equipment shall be tested and reported as herein specified. One electronic copy of the tests shall be submitted to the Architect/Engineer for approval.
  - 3. All electrical systems shall be tested for compliance with the specifications.
- B. Manufacturers' Certifications
  - 1. The electrical systems specified herein shall be reviewed for compliance with these specifications, installation in accordance with the manufacturers' recommendations and system operation by a representative of the manufacturer. The manufacturer shall submit certification that the system has been installed in accordance with the manufacturers' recommendations and is operating as specified in the contract documents.
  - 2. Provide manufacturers' certification for the emergency generator set/automatic transfer system, central dimming controls, network lighting control, fire alarm system and lightning protection.

C. Design Authority Assistance

1. The Contractor shall provide personnel to assist the Architect/Engineer or their representative during all construction review visits. The Contractor shall provide all necessary tools and equipment to demonstrate the system operation and provide access to equipment, including screwdrivers, wrenches, ladders, flashlights, circuit testing devices, meters, keys, etc.
2. Remove equipment covers (i.e., switchgears, switchboards, panelboard trims, panelboards, motor controls, device plates, and junction box covers) as directed for inspection of internal wiring. Accessible ceiling shall be removed as directed for inspection of equipment installed above ceilings. Reinstall all covers or ceilings after inspection.
3. Energize and de-energize circuits and equipment as directed. Demonstrate operation of equipment as directed by Architect/Engineer.
4. The Contractor shall provide authorized representatives of the manufacturers to demonstrate to the Architect/Engineer compliance with the specifications of their respective system during or prior to the final inspection at a time designated by the Architect. Refer to the appropriate specification section for additional testing requirements. Representatives of the emergency generator/automatic transfer switch and fire alarm systems are required for demonstrations.

3.15 COMMISSIONING

- A. After startup and testing of each system has been completed, the Owner shall have an independent firm conduct detailed observations of the equipment and systems to confirm compliance with the Contract Documents.
- B. The Division 26 Contractor shall include, as part of the work of his contract, costs to cover manpower, equipment, tools, ladders, instruments, etc., necessary to expedite the system performance observations.
- C. The independent firm shall develop systems, equipment checkout procedures and data forms for recording compliance of the systems to the Contract Documents, performance, and construction observation lists, and will assist in developing schedules for checkout and Owner acceptance, at a future date during the construction phase.

**END OF SECTION**

**SECTION 26 05 02**

**BASIC MATERIAL AND METHODS**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

- A. This Section supplements Division 1, General Requirements.

1.2 DESCRIPTION OF WORK

- A. Work included in this section consists of conduits, wires and other miscellaneous materials not specifically mentioned in other sections of Division 26, 27 and 28 but necessary or required for equipment or system operation or function, and the labor to install them.

1.3 SUBMITTALS

- A. Materials list with manufacturer, style, series or model identified.
- B. Manufacturer's descriptive literature and/or sample if requested by the Architect/Engineer.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

- A. Refer to Section 26 05 03.

2.2 CONDUIT RACEWAYS

- A. Refer to Section 26 05 33.

2.3 ELECTRICAL POWER CONDUCTORS AND CABLES

- A. Refer to Section 26 05 19.

2.4 MEDIUM-VOLTAGE CABLES

- A. Refer to Section 26 05 13.

2.5 WIRING DEVICES

- A. Refer to Section 26 27 26.

2.6 OUTLET BOXES, JUNCTION AND PULL BOXES

- A. Outlet Boxes: Hot-dipped galvanized or sherardized of required size, 4" square minimum, for flush-mounted devices and lighting fixtures. Cast-type FD with gasketed covers for surface-mounted devices.
- B. Junction and Pull Boxes: Use outlet boxes as junction boxes wherever possible. Larger junction and pull boxes shall be fabricated from code-gauge sheet steel, with screw-on covers; of types, shapes and sizes, to suit each respective location and installation; with welded seams and equipped with stainless-steel nuts, bolts, screws, and washers. Pull and junction boxes installed in finished spaces must be flush-mounted cabinets provided with trim, hinged door and flush latch and lock to match flush-mounted panelboard trim. Provide galvanized code-gauge steel where required for outdoor exposure.
- C. All exterior boxes shall be in use gasketed, weatherproof type with cast metallic covers.
- D. Refer to Section 26 05 33 for additional requirements.

2.7 WIRE CONNECTORS

- A. For wires that are #8 AWG and smaller: Insulated pressure type with live spring, rated 105°C, 600-Volt, for building wiring and 1000-Volt in signs or fixtures.
- B. For wires that are #6 AWG and larger: Compression type with 3M #33 or equal tape insulation.

2.8 CONDUIT HANGERS

- A. Refer to Section 26 05 29 for additional requirements.

2.9 FUSES

- A. Refer to Section 26 28 16.

2.10 ACCESS PANELS

- A. Electrical Contractor to provide access panels for electrical equipment which are required for accessibility by code.

2.11 CONDUIT SLEEVES

- A. Sleeves for Conduit Penetration: Hilti, Inc., model CP 6820-P; or 3M Corp. MCID or PCID. Refer to Division 7 "Firestopping" for additional requirements.
- B. Exterior Wall Penetration Seals: Provide seals at all foundation of exterior wall locations. Link Seal or approved manufacturer.
  - 1. New Construction – Cast in place shall be Century Line (HDPE) or Steel Wall Sleeve
  - 2. Existing Construction – Core Drilled
- C. Seal Product:

	Seal Element	Intended Application
C	EPDM (Black)	Direct ground burial, occasional or periodic water contact.
L	EPDM (Blue)	Use with fragile pipe and tubing. Direct ground burial, occasional or periodic water contact.
O	Nitrile	Oil, fuel and solvent resistant.
T	Silicone	Extreme temperatures rated (-55°C - +204°C).
S-316	EPDM (Black)	Chemical processing & wastewater treatment. High level of water resistance, inorganic acids and alkalis, and most organic chemicals.
LS-316	EPDM (Blue)	Use with fragile pipe and tubing. Chemical processing & wastewater treatment. High level of water resistance, inorganic acids and alkalis, and most organic chemicals.
OS-316	Nitrile	Oil resistant rubber with stainless steel hardware.

2.12 INTERNAL CONDUIT SEALANT

- A. Conduit sealant shall be used in all conduits penetrating the building envelope or moisture barrier to prevent rodents and moisture. Sealant shall be able to be removed without damaging the conductors.
  - 1. Conduits 2" or greater – Polywater FST or approved equal.
  - 2. Conduits <2" – Poly Water FST Mini or approved equal.

2.13 EQUIPMENT MOUNTING AND SUPPORT HARDWARE

- A. Steel channels, bolts and washers, used for mounting or support of electrical equipment shall be galvanized typed. Where installed in corrosive atmosphere, stainless-steel type hardware shall be used.
- B. Refer to Section 26 05 29 for additional requirements.

### **PART 3 - EXECUTION**

#### 3.1 GENERAL

- A. Provide complete raceway systems for all conductors including control wiring and low-voltage wiring unless otherwise noted.
- B. Electrical system layouts indicated on drawings are generally diagrammatic, but shall be followed as closely as actual construction and work of other trades will permit. Govern exact routing of raceways and locations of outlets by structure and equipment served. Take all dimensions from architectural drawings.
- C. All home runs to panelboards are indicated as starting from the outlet nearest to the panel and continuing in the general direction of that panel. Continue such circuits to panel as though routes were completely indicated.
- D. Avoid cutting and boring holes through structure or structural members wherever possible. Obtain prior approval of the Architect, and conform to all structural requirements when cutting or boring structure.
- E. Furnish and install all necessary hardware, hangers, blocking, brackets, bracing, runners, etc., required for equipment specified under this Section.
- F. Furnish and install all raceways from elevator machine room to fire command center for elevator status.

#### 3.2 RACEWAYS

- A. Refer to Section 26 05 33.

#### 3.3 OUTLETS

- A. Exact location of outlets and equipment shall be governed by structural conditions and obstructions or other equipment items. When necessary, relocate outlets so that when fixtures or equipment are installed, they will be symmetrically located according to room layout and will not interfere with other work or equipment. Verify final location of all outlets, panels, equipment, etc., with the Architect/Engineer.
- B. Provide zinc-coated or cadmium-plated sheet steel outlet boxes not less than 4" octagonal or square, unless otherwise noted. Equip fixture outlet boxes with 3/8" no-bolt fixture studs. Where fixtures are mounted on or in an accessible type ceiling, provide a junction box and extend flexible conduit to each fixture. Outlet boxes in finished ceilings or walls shall be fitted with appropriate covers, set to come flush with the finished surface. Where more than one switch or device is located on one point, use gang boxes and covers unless otherwise indicated. Sectional switch boxes or utility boxes will not be permitted. Provide tile box or a 4" square box with tile ring in masonry walls which will not be plastered or furred, or where "dry-wall" type materials are applied. Through the wall type boxes are not permitted. Install minimum 12" lateral separation for back to back boxes.



- C. Surface-mounted devices are to be mounted in cast type boxes with gasketed covers: (Crouse-Hinds FS/FD or equal).
- D. Dimensions unless shown on drawings are given below and are from finished floor to center line of outlets unless noted otherwise. Adjust heights of outlets in masonry walls to correspond with consistent brick or block course. Outlets in block walls shall be installed in core of block.

Wall Switches	4' - 0" (to top of box)
Convenience outlets	1' - 4" (to bottom of box) – gyp or 8" block
	1' - 6" (to bottom of box) – 6" block
Hallways	1' - 6" (to bottom of box)
Above counter wall outlet	0' - 8" (above counter to top of box, maximum 44" AFF, field verify height of backsplash)
Panelboards wall mounted	6' - 6" (to top of back box)
Wall phone outlet	4' - 0" (to top of box)
Tele/Data outlets	1' - 6" (to bottom of outlet)
Fire alarm horns, speakers	ceiling or wall
Fire alarm pull stations	4' - 0" (to top of device)
Fire alarm strobes	6' - 8" or 6" below ceiling (whichever is lower)
Television outlets	Refer to A/V or architectural drawing.

Confirm final location and heights of all outlets, wall switches, and television outlets with architectural drawings and furniture plans prior to installation.

- E. Outlets except over counters, benches, special equipment, baseboards, fin tube radiators, etc., or at wainscoting, shall be at a height to prevent interference to service equipment, or as noted on drawings.
- F. Refer to Section 26 05 33 for additional requirements.

### 3.4 JUNCTION PULL BOXES

- A. Construct junction or pull boxes not over 150 cubic inches in size shall be standard outlet boxes, and those over 150 cubic inches shall be constructed the same as "Cabinets," with screw covers of same gauge metal. Removal covers must be accessible at all times.
- B. Provide a standard access panel having a hinged metal door neatly fitted into a flush metal trim, where a junction box or equipment is located above non-accessible ceilings or behind finished walls. Coordinate location and type with the Architect.

**END OF SECTION**

## **SECTION 26 05 05**

### **ELECTRICAL DEMOLITION AND RELOCATION**

#### **PART 1 - GENERAL**

##### 1.1 RELATED DOCUMENTS

- A. This Section supplements Division 1, General Requirements. Where contradictions occur between this Section and Division 1, the more stringent of the two shall apply. The Architect shall decide which is more stringent.
- B. Requirements of the following Divisions and Sections apply to this Section:
  - 1. Division 26 Section 26 05 00 "Electrical Requirements."
  - 2. Division 9 Section "Painting" for related requirements.
- C. Refer to other Division 26 Sections for additional specific electrical demolition or relocation associated with specific items.

##### 1.2 SUMMARY

- A. This Section includes basic requirements for demolition and relocation of electrical materials, equipment, and installations. The Contractor shall be responsible for visiting the site prior to bid to determine the actual conditions, which might affect the bid or contract price. No allowance will be made subsequently resulting from the neglect to visit the site and make such determinations.
- B. Generally, electrical items that are to be replaced with other equipment in the same location are work covered by this section. Also covered by this section are electrical items that are to be removed in their entirety or that are to be relocated to another place.

##### 1.3 UTILITY SERVICES

- A. Maintain existing utility services. Where necessary to cut existing conduits, wires, cables, etc. of utility services or fire protection systems, they shall be cut and capped at suitable places or where directed by the Owner's representative.
- B. Electrical service in demolition area shall be reduced to a minimum and identified to eliminate uncertainty about which circuits are energized.
- C. The Contractor shall notify the Owner's representative in writing of any planned utility interruptions including interruptions of power to communications and fire protection systems at least 48 hours in advance or as otherwise specified. The request shall state the reason, date, beginning time, and expected duration of such interruptions. No interruptions shall be made without the Owner's written concurrence and such interruptions shall be coordinated with the Owner to cause

the least inconvenience to the Owner's operations. Service interruptions which cannot wait for written approval may be granted with verbal approval from the Owner's representative. After verbal approval is granted, written confirmation shall be issued by the Contractor as soon as practical.

#### 1.4 PROTECTIVE MEASURES

- A. Provide the following protective measures:
  - 1. Wherever existing roofing surfaces are penetrated by electrical conduit, they shall be protected against water infiltration. Water leaks shall be repaired immediately upon discovery when they occur.
  - 2. Temporary protection against damage for all portions of existing structures and grounds where work is to be done, materials handled, and equipment moved or relocated.
  - 3. Contractor shall patch and fill openings in floors, walls and ceilings for removed equipment or piping with the same material, fire and structural integrity that would have existed prior to the penetration including concrete, block, gyp wallboard, exterior walls, roof membranes, etc. except for steel and wood beams which shall have the openings capped with similar material.
- B. The Contractor shall be responsible for contacting utilities or locating services and obtaining locations of all underground services in the general area of demolition work.

### **PART 2 - PRODUCTS**

#### 2.1 EQUIPMENT AND MATERIALS

- A. The Contractor shall provide all equipment and materials necessary for the removal or relocation of electrical equipment.
- B. Materials used in restoration or repairing work related to demolition and relocation shall conform in type, quality, and function to that of the original existing construction or as otherwise indicated.

#### 2.2 DISPOSAL AND RETENTION

- A. Materials and equipment resulting from work and removed from the building or structures, or parts thereof, shall become the property of the Contractor and shall be removed from the site by the Contractor except as follow:
  - 1. Light fixtures, lamps, and ballasts.
  - 2. Fire, heat, and smoke detection devices.
  - 3. Telephones and telephone equipment other than outlet devices.
  - 4. Fire alarm notification devices and pull stations.
  - 5. Paging speakers, clocks, and intercom call stations.
- B. Items removed or noted to be retained by the Owner but which are declined to be retained by the Owner shall be removed from the site by the Contractor.

- C. Combustible waste material and rubbish shall not be stored or allowed to accumulate within a building or its vicinity, but shall be kept in a suitable trash container for subsequent removal or shall be removed from the premises as rapidly as practical.
- D. All hazard waste shall be properly disposed of by a licensed hazard waste disposal facility. Items shall include but not limited to fluorescent lamps, diesel fuel, radiator coolant, etc.

### **PART 3 - EXECUTION**

- A. Remove or relocate all items indicated on the drawings or as otherwise indicated.
- B. Where the drawings indicate that equipment is to be replaced or where other equipment requires the relocation of existing equipment, the existing equipment shall be removed or relocated as though it was specifically noted to be removed or relocated.
- C. Wherever electrical materials have been removed from surfaces of the building or structure, those surfaces shall be patched and repaired.
- D. Remove, cut, alter, replace, patch, and repair existing work as necessary to install new work. Unless otherwise indicated or specified, do not cut, alter, or remove any structural members, ducts, piping, or service lines without approval of the Owner's representative.
- E. Existing work or equipment to be altered or extended and found to be defective shall be reported to the Owner's representative before it is disturbed or any further work is performed on it.
- F. Where electrical equipment is indicated to be removed or relocated, the work shall include the complete disconnection from its source, dismantling as necessary, and removal or installation of all conduit, wires, cables, etc. Unless noted otherwise, wires shall be removed from conduits back to the last utilization device or to the panelboard. No wiring shall be removed that prevents operation of other equipment not scheduled or indicated to be removed.
- G. Perform and schedule all demolition work with other trades and work of the contract as necessary for the efficient progress and flow of the work.

### **END OF SECTION**

## **SECTION 26 05 10**

### **TESTING**

#### **PART 1 - GENERAL**

##### 1.1 RELATED WORK SPECIFIED ELSEWHERE

- A. Acceptance and startup testing requirements for electrical power distribution equipment and systems. Contractor shall retain and pay for the services of a recognized independent testing firm for purpose of performing inspections and tests as herein specified.
1. The testing firm shall provide all material, equipment, labor, and technical supervision to perform such tests and inspections.
  2. It is the purpose of these tests to assure that all tested electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications.
  3. The tests and inspections shall determine suitability for startup and energization.
  4. The following equipment shall be tested and calibrated:  
Electrical Power Conductors and Cables – Section 26 05 19  
Grounding and Bonding – Section 26 05 26  
Service Entrance Switchboards – 26 24 15  
Low-Voltage Distribution Transformers – Section 26 22 13  
Distribution Switchboards – Section 26 24 13  
Panelboards – Section 26 24 16  
Diesel-Engine Driven Generator Set - Section 26 32 13  
Automatic Transfer Switch – Section 26 36 23  
Static Uninterruptable Power Supply – Section 26 33 53

##### 1.2 SUBMITTALS

- A. Provide submittal per Contract General Conditions, Division 1, and Section 26 05 00.
- B. Qualification of testing firm.
- C. Submit one electronic copy of certified test reports to Engineer for approval.
- D. One electronic copy of blank forms for checklists, test reports, and other related forms for Engineer's review and approval.

##### 1.3 GENERAL REQUIREMENTS

- A. The Contractor shall perform routine insulation resistance, continuity, and rotation tests for all distribution and utilization equipment prior to and in addition to any acceptance testing.

- B. The Contractor shall test all lighting, low-voltage relays and circuits to ensure proper operating conditions prior to acceptance testing.
- C. The Contractor shall perform visual and mechanical inspections, verifying that the equipment nameplate information meets the intent of the drawings and specifications.
- D. The Contractor shall be responsible for all final settings and adjustments on protective devices and tap changes, submitting settings to the Architect/Engineer for review.
- E. Provide a complete short-circuit study, equipment interrupting/withstand evaluation, and a protective device coordination study for the electrical distribution system described herein. This study shall be submitted with electrical equipment submission and electrical room layouts.
- F. The Contractor shall engage the services of a recognized corporate and financially independent testing firm for the purpose of performing inspections and tests as herein specified.
- G. The firm shall provide all material, equipment, labor, and technical supervision to perform such tests and inspections.
- H. It is the purpose of these tests to assure that all tested electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications.
- I. The tests and inspections shall determine suitability for energization. Equipment shall not be energized until accepted by the testing firm.

#### 1.4 QUALIFICATIONS OF TESTING FIRM

- A. The testing firm shall be a recognized corporate and financially independent testing organization which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems evaluated by the testing firm.
- B. The testing firm shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.
- C. The testing firm shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, or be a Full Member company of the InterNational Electrical Testing Association (NETA).
- D. The lead, on-site, technical person shall be currently certified by the InterNational Electrical Testing Association (NETA) or National Institute for Certification in Engineering Technologies (NICET) in electrical power distribution system testing.
- E. The testing firm shall utilize engineers and technicians who are regularly employed by the firm for testing and engineering services. All studies, tests, and reports shall be sealed by a registered electrical professional engineer with a current Georgia stamp.

- F. The testing firm shall submit proof of the above qualifications with bid documents, when requested.
- G. The terms used herewith, such as test agency, test contractor, testing laboratory, or contractor test company, shall be construed to mean the testing firm.

#### 1.5 APPLICABLE CODES, STANDARDS, AND REFERENCES

- A. All inspections and tests shall be in accordance with the following codes and standards except as provided otherwise herein:
  - 1. National Electrical Manufacturer's Association - NEMA
  - 2. American Society for Testing and Materials - ASTM
  - 3. Institute of Electrical and Electronic Engineers - IEEE
  - 4. InterNational Electrical Testing Association - NETA Acceptance Testing Specifications - ATS-2021
  - 5. American National Standards Institute - ANSI C2: National Electrical Safety Code
  - 6. State and City of Augusta, GA Codes and Ordinances
  - 7. Insulated Cable Engineers Association - ICEA
  - 8. Association of Edison Illuminating Companies - AEIC
  - 9. Occupational Safety and Health Administration - OSHA
  - 10. National Fire Protection Association - NFPA
    - a. ANSI/NFPA 70: National Electrical Code
    - b. ANSI/NFPA 70B: Electrical Equipment Maintenance
    - c. NFPA 70E: Electrical Safety Requirements for Employee Workplaces
    - d. ANSI/NFPA 780: Lightning Protection Code
    - e. ANSI/NFPA 101: Life Safety Code
- B. All inspections and tests shall utilize the following references:
  - 1. Project design specifications.
  - 2. Project design drawings.
  - 3. Short-circuit and coordination study.
  - 4. Manufacturer's instruction manuals applicable to each particular apparatus.
  - 5. Project list of equipment to be inspected and tested as stated above.

### **PART 2 - SHORT-CIRCUIT, COORDINATION, AND ARC FLASH STUDIES**

#### 2.1 SHORT-CIRCUIT STUDY

The electrical equipment manufacturer shall perform a short-circuit analysis of the specified electrical power distribution system. This analysis shall include:

- A. Calculation of the maximum RMS symmetrical three-phase short-circuit current available at significant locations in the electrical system. The results shall represent the highest short-circuit currents to which the equipment might be subjected under the reported system conditions. The short-circuit currents shall be calculated with the aid of a digital computer. Appropriate motor short-circuit contribution shall be included in the calculation.

- B. The study shall include all portions of the electrical distribution system from the normal and alternate sources of power throughout the low-voltage distribution system. Normal system operating method, alternate operation, and operations which could result in maximum fault conditions shall be thoroughly covered in the study.
- C. The study shall be calculated from the utility meter to the unit substation to the lowest overcurrent device or equipment on the electrical distribution system. The utility conductors shall not be used for calculations.
- D. An evaluation of the adequacy of the short-circuit ratings of the electrical equipment supplied by that manufacturer.
- E. Provide one electronic copy of the short-circuit analysis for the engineer's approval.
- F. A computer printout of input data, a computer printout of calculated results and an explanation of how to interpret the printouts.
- G. A one-line diagram identifying all bus locations and the maximum available short-circuit current at each bus.
- H. A bus-to-bus listing of the maximum available short-circuit current expressed in RMS symmetrical amperes and the X/R ratio of the fault current.
- I. A table of equipment short-circuit ratings versus calculated short-circuit current values.
- J. An analysis of the results in which any inadequacies shall be called to the attention of the Engineer and recommendations made for improvements. These recommendations shall be incorporated by the electrical equipment manufacturer to the electrical equipment at no cost to the Owner, where approved by the Engineer.

## 2.2 PROTECTIVE DEVICE COORDINATION STUDY

The electrical equipment manufacturer shall perform a protective device time-current coordination analysis of the entire electrical power distribution system. This analysis shall include:

- A. A determination of settings or ratings for the over-current protective devices supplied. Where necessary, an appropriate compromise shall be made between system protection and service continuity with system protection and service continuity considered to be of equal importance. The time-current coordination analysis shall be performed with the aid of a digital computer.
- B. An evaluation to the degree of system protection and service continuity possible with overcurrent devices supplied.
- C. Provide one electronic copy of the protective device time-current coordination analysis for the Engineer's approval.
- D. Log-Log plots of time-current characteristic curves.



- E. A tabulation of the suggested settings of the adjustable overcurrent protective devices supplied.
- F. The key or limiting overcurrent device characteristics, load characteristics, and protection requirements affecting the setting or ratings of the overcurrent protective devices supplied.
- G. The degree of service continuity and system protection achieved with the overcurrent protective devices supplied.
- H. An analysis of the results in which any inadequacies shall be called to the attention of the Engineer and recommendations made for improvements. These recommendations shall be incorporated by the electrical equipment manufacturer to the electrical equipment at no cost to the Owner, where approved by the Engineer.

### 2.3 ARC FLASH HAZARD ANALYSIS

- A. Provide with the coordination and short circuit studies an Arc Flash study and device by device listing of PPE requirements and ratings as required by the NEC and NFPA 70E. All equipment shall have appropriate labeling installed in the field by the electrical contractor as determined by the study.
- B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchgear, switchboards, panelboards, busway, etc.) where work could be performed on energized parts.

## **PART 3 - INSPECTION AND TEST PROCEDURES**

### 3.1 PROCEDURE

- A. Testing firm to provide and comply with the following:
  - 1. Acceptance test procedures for each individual equipment listed in Part 1 of this section for Engineer review and approval prior to any test and after thorough evaluation of the system. Testing shall conform to the latest version of InterNational Electrical Testing Association (NETA) specifications and standards for electrical power distribution equipment and systems and manufacturer's instructions.
  - 2. Refer to each individual specification section for testing requirements and comply.
  - 3. Inspect installed equipment, record results and report any discrepancy and deficiency with contract documents and governing codes prior to testing. All results shall be submitted to the Engineer for approval.

### 3.2 SYSTEM FUNCTION TESTS

- A. General:

1. Perform system function tests upon completion of equipment component tests as define in this specification. It is the purpose of system function tests to prove the proper interaction of all sensing, processing, and action devices.
2. Implementation:
  - a. Develop test parameters for the purpose of evaluating performance of all integral components and their functioning as a complete unit within design requirements.
  - b. Test all interlock devices, and trip settings on breakers.
  - c. Record the operation of alarms and indicating devices.

### 3.3 DEFICIENCIES

- A. All deficiencies reported by testing firm to be corrected by Contractor and Acceptance Test to be re-done accordingly.

**END OF SECTION**

**SECTION 26 05 19**

**ELECTRICAL POWER CONDUCTORS AND CABLES**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Requirement of the following Division 26 Sections apply to this section:
  - 1. Electrical Requirements

1.2 SUMMARY

- A. This Section includes wires, cables, and connectors for power, lighting, signal, control and related systems rated 600-Volts and less.
- B. Related Sections: The following Sections contain requirements that relate to this section:
  - 1. Division 31 Section "Earthwork" for trenching and backfilling.
  - 2. Division 26 Section "Electrical Boxes and Fittings" for connectors for terminating cables in boxes and other electrical enclosures.
  - 3. Division 26 Section "Raceways and Boxes" for MC cable, raceway and boxes.

1.3 SUBMITTALS

- A. Product Data for electrical wires, cables and connectors.
- B. Submit pulling tension calculations for all underground feeders.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with provisions of the following code:
- B. NFPA 70 "National Electrical Code."
  - 1. Conform to applicable codes and regulations regarding toxicity of combustion products of insulating materials.
- C. UL Compliance: Provide components, which are listed and labeled by UL under the following standards.
  - 1. UL Standard 44 Rubber Insulated Wires and Cables

2. UL Standard 83 Thermoplastic-Insulated Wires and Cables
  3. UL Standard 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors
  4. UL Standard 854 Service Entrance Cable
  5. UL Standard 2196 Testing for Fire Resistive Cables
  6. UL Standard 1424 Cables for Power-Limited Fire-Alarm Circuits
- D. NEMA/ICEA Compliance: Provide components which comply with the following standards:
1. WC-5: Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
  2. WC-7: Cross Linked Thermosetting Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
- E. IEEE Compliance: Provide components, which comply with the following standard.
1. Standard 82: Test procedures for Impulse Voltage Tests on Insulated Conductors.

## **PART 2 - PRODUCTS**

### 2.1 WIRES AND CABLES (600-VOLT COPPER CONDUCTORS – BASE DESIGN)

- A. General: Provide suitable wire and cable for the temperature, conditions and location where installed. All wires and cables shall be new and delivered to the site in unbroken packages and reels.
- B. All wires and cables shall be of the same manufacturer throughout the entire project.
- C. Conductors: Provide solid conductors for power and lighting circuits #10 AWG and smaller. Provide stranded conductors for #8 AWG and larger.
- D. Conductor Material: All wires and cables shall be copper, single conductor rated at 600-Volts, which conform to or exceed ICEA specifications and the following:
1. In sizes 1/0 AWG to 4/0: Cross-linked polyethylene insulation type XHHW-2 (90°C) or THWN-2.
  2. In sizes 250 KCMIL and larger: Type XHHW-2 (90°C) or THWN.
  3. In sizes 1 AWG and smaller: All conductors shall have heat/moisture resistant thermoplastic insulation type THWN-2 (90°C) except as follows:
    - a. Where conduit temperature will exceed 100°F, use type THHN (90°C).
    - b. In 120-Volt incandescent fixtures, type SF-2 or SFF-2 (150 - 200°C).
    - c. In wireway of fluorescent lighting fixtures type THHN (90°C).
- E. Rated Conductor Material: Where required by these specifications and code, provide 2-hour rated cable conforming to the following requirements:
1. Cabling must meet current UL requirements for fire alarm resistance.
  2. Cabling must meet current NEC 517, 700 and 760 requirements.

- F. Grounding conductors: Shall be of the same type as its associated phase conductors.
- G. All conductors shall be label with wire size, insulation rating, etc. using an engraved process, computer scan on labels are not permitted.
- H. Color Coding for phase identification in accordance with Table 1 in Part 3 herein.
- I. Connectors for Conductors:
  - 1. Provide UL-listed factory-fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types and classes for applications and for services indicated. Use connectors with temperature ratings equal to or greater than those of the wires upon which used.
  - 2. For wires that are #8 AWG and smaller: Insulated pressure type with live spring, rated 105°C, 600-Volt, for building wiring and 1000-Volt in signs or fixtures.
  - 3. For wires that are #6 AWG and larger: Compression type with 3M #33 or equal tape insulation.
- J. Splices and Taps:
  - 1. No. 10 AWG and smaller - Connectors for solid conductors shall be solderless, screw-on, spring pressure cable type, 600-Volt, 105°C with integral insulation and UL approved for aluminum and copper conductors. Connectors for stranded conductors shall be crimp-on type with integral insulating cover.
  - 2. No. 8 AWG and larger - Hydraulically applied crimping sleeve or tap connector sized for the conductors. Insulate the hydraulically applied connector with 90-degree, 600-Volt insulating cover provided by the connector manufacturer. Insulator materials and installation shall be approved for the specific application, location, voltage, and temperature and shall not have an insulation value less than the conductors being joined.

## 2.2 ALUMINUM WIRES AND CABLES (ALTERNATE DESIGN)

- A. Where indicated on drawings as AL: aluminum alloy, compact stranded, Type XHHW-2 or THHN/THWN, 90°C meeting requirements of UL#44 and Federal Spec A-A-59544 with XLPE insulation and AA-8000 series alloy only may be used in lieu of copper conductors.
- B. Terminations shall be compression bolted lug with appropriate joint compounds and Belleville spring washers.
- C. Installation and terminations shall be in strict accordance with manufacturer's recommendations and as identified in specifications.
- D. Uses not allowed:
  - 1. For service-entrance conductors where Utility Company standards prohibit aluminum conductors
  - 2. For any feeders or branch circuits to mechanical and vibrating equipment.
  - 3. For any applications under 200Amps.
  - 4. Where terminations that are unable to utilize compression, bolted lug fittings.

5. For use as emergency and standby system feeders or branch circuits.
- E. All grounding conductors shall be copper.
- F. Refer to feeder table on drawings for conductor and conduit sizes to correspond with over current protection device size.

### 2.3 TWO-HOUR RATED CABLE ASSEMBLY

- A. Two Hour Rated Cable Assemblies: Complete cable system shall have a two-hour fire rating as Listed and Classified by Underwriters Laboratories, Inc. or ETL.
  1. Two-hour rated cable assemblies or two-hour rated cable systems that are approved by the authority having jurisdiction shall be used in lieu of two (2) inch concrete encasement or routing in two (2) hour fire rated enclosure for the following applications:
    - a. Trunk cabling for fire alarm detection and annunciation.
    - b. Feeders for fire pumps.
    - c. Emergency feeders.
    - d. Life Safety feeders.
    - e. Cabling for Area of Rescue Assistance System.
  2. Conduit sizes shall be adjusted to accommodate the larger diameter conductors per the national electrical code.

## **PART 3 - EXECUTION**

### 3.1 WIRING METHOD

- A. Use the following wiring methods as indicated:
  1. Install all wire in raceway. Power and control wiring shall be installed in separate raceways.

### 3.2 INSTALLATION OF WIRES AND CABLES

- A. General: Install electrical cables, wires, and connectors in compliance with NEC.
- B. Coordinate cable and wire installation with other Work.
- C. Do not install more conductors in a raceway than indicated on the drawings. A maximum of three ungrounded conductors are to be installed in any one conduit on a 3-phase, 4-wire system, unless specifically noted otherwise on the drawings. When more than three ungrounded conductors are installed in a raceway, the conductor size shall be increase per code for derating. No two ungrounded conductors of the same phase are to be installed in the same conduit, unless specifically noted otherwise on the drawings.

1. Where multi-wire circuits are permitted by these specifications, all grounded and ungrounded conductors shall be grouped by wire markers, cable ties or similar means with the panelboard or wireway at least one location.
- D. Provide dedicated neutral conductor for all single phase circuits. Shared neutral conductor is not acceptable on single phase circuits.
- E. Minimum wire size shall be a No.12 AWG except for control or signal circuits, which may be No. 14 AWG.
- F. Unless otherwise indicated on drawings, all wiring for branch circuits shall be a minimum No. 12 AWG in  $\frac{3}{4}$ " conduit, protected by 20 amperes circuit breakers. If distance from panel to first outlet is 75 feet or greater for 120-Volt circuits, and 125 feet or greater for 277-Volt circuits, No. 10 AWG shall be installed throughout the circuit, unless noted otherwise on the drawings.
- G. Size of current carrying conductors, unless noted otherwise on drawings, shall be determined from Table 310.15(B)(16) of the latest National Electric Code for the load served.
- H. Pull conductors simultaneously where more than one is being installed in same raceway. Use UL listed pulling compound or lubricant, where necessary.
- I. Use pulling means including fish tape, cable, rope, and basket weave wire/cable grips which will not damage cables or raceways. Do not use rope hitches for pulling attachment to wire or cable.
- J. Size of conduits, unless specifically shown, shall be determined from Appendix C of the latest National Electrical Code.
- K. Keep conductor splices to a minimum. All splices shall be made within junction boxes, wiring troughs and other enclosures as permitted by the National Electrical Code.
  1. Splices shall not be permitted within 25 feet of any panel or electrical room.
  2. Do not splice conductors in panelboards, safety switches, switchboards, motor control centers or motor control enclosures.
  3. Splices in conductors installed below grade will not be permitted, unless approved in writing by the Architect and Engineer.
- L. Install splice and tap connectors, which possess equivalent or better mechanical strength and insulation rather than conductors being spliced.
- M. Use splice and tap connectors which are compatible with conductor material.
- N. Provide adequate length of conductors within electrical enclosures and train the conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than No. 10 AWG cabled in individual circuits. Make terminations so there is no more than  $\frac{3}{16}$ " of bare conductor at the terminal.
- O. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturers' published torque tightening values. Where manufacturers' torque requirements are not indicated, tighten connectors and terminals to comply with tightening torque values specified in UL 486A and UL

486B. After tightening the connection/terminal, mark the bolt surface and that of the product or workpiece. Then loosen the bolt. Re-tighten it until the markings re-align. The torque needed to return the bolt to its original position is the torque value of the bolt.

### 3.3 FIELD QUALITY CONTROL

- A. Prior to energizing, check installed wires and cables with megohm meter to determine insulation resistance levels to assure requirements are fulfilled.
- B. Prior to energizing, test wires and cables for electrical continuity and for short circuits.
- C. Subsequent to wire and cable hook-ups, energize circuits and demonstrate proper functioning. Correct malfunctioning units, and retest to demonstrate compliance.
- D. Prior to completion of project, an infrared scan of switchgear and panelboard feeder equipment connection shall be performed when all loads are energized.
- E. TABLE I: Color Coding for Phase Identification:

- 1. Color code secondary service, feeder, and branch circuit conductors with factory applied color as follows:

<u>208V/120-Volts</u>	<u>Phase</u>	<u>480V/277-Volts</u>
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray
Green	Ground	Green

### 3.4 FEEDER TESTING

- A. Products
  - 1. Material: Contractor shall provide all necessary testing equipment and devices required to perform the test described in this section.
- B. Execution
  - 1. Visual and Mechanical Inspection
    - a. Inspect cables for physical damage and proper connection in accordance with one-line diagrams.
    - b. Test cable mechanical connections to manufacturer's recommended values using a calibrated torque wrench.
    - c. Check cable color coding with specification section 26 05 53 and National Electrical Code standards.
  - 2. Electrical Tests



- a. Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 1000-Volts D.C. for 1 minute.
  - b. Perform continuity test to insure proper cable connection.
3. Test Values
- a. Evaluate results by comparison with cables of same length and type. Investigate any insulation-resistance values less than 50 megohms.
  - b. Submit results to Engineer for approval in accordance with Section 26 05 10.

**END OF SECTION**

## **SECTION 26 05 26**

### **GROUNDING AND BONDING**

#### **PART 1 - GENERAL**

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Division 26 Basic Materials and Methods sections apply to work of this section.
- C. Requirements of this section apply to electrical grounding and bonding work specified elsewhere in these specifications.

##### 1.2 SUMMARY

- A. Extent of electrical grounding and bonding work is indicated by drawings and schedules and as specified herein. Grounding and bonding work is defined to encompass systems, circuits, and equipment.
- B. Type of electrical grounding and bonding work specified in this section includes the following:
  - 1. Solidly grounded.
- C. Applications of electrical grounding and bonding work in this section includes the following:
  - 1. Underground metal piping.
  - 2. Underground metal water piping.
  - 3. Underground metal structures.
  - 4. Building frames - structural steel.
  - 5. Electrical power systems.
  - 6. Grounding electrodes.
  - 7. Separately derived systems.
  - 8. Raceways.
  - 9. Service equipment.
  - 10. Enclosures.
  - 11. Equipment.
  - 12. Lighting Standards.
  - 13. Landscape Lighting.
  - 14. Signs.
- D. Refer to other Division 26 sections for wires/cables, electrical raceways, boxes and fittings, and wiring devices which are required in conjunction with electrical grounding and bonding work; not work of this section.

### 1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's data on grounding and bonding products and associated accessories.
- B. Wiring Diagrams: Submit wiring diagrams for electrical grounding and bonding work which indicates layout of ground rods, location of system grounding electrode connections, routing of grounding electrode conductors, also include diagrams for circuits and equipment grounding connections.
- C. Submit ground riser diagram for entire project. Show bus bars with transformer ground electrode conductors, etc.

### 1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of grounding and bonding products, of types, and ratings required, and ancillary grounding materials, including stranded cable, copper braid and bus, grounding electrodes and plate electrodes, and bonding jumpers whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Firms with at least 5 years of successful installation experience on projects with electrical grounding work similar to that required for project.
- C. Codes and Standards:
  - 1. Electrical Code Compliance: Comply with applicable local electrical code requirements of the authority having jurisdiction, and NEC as applicable to electrical grounding and bonding, pertaining to systems, circuits and equipment.
  - 2. ANSI Compliance: C119.4 Electrical Connectors,
  - 3. UL Compliance: Comply with applicable requirements of UL Standards No.'s 467, Electrical Grounding and Bonding Equipment", and 869 "Electrical Service Equipment", pertaining to grounding and bonding of systems, circuits and equipment. In addition, comply with UL Standard 486A-486B, "Wire Connectors and soldering Lugs for Use with Copper Conductors." UL Standard 486C "Splicing Wire Connectors" UL1059 "Terminal Blocks. Provide grounding and bonding products which are UL-listed and labeled for their intended usage.
  - 4. IEEE Compliance: Comply with applicable requirements and recommended installation practices of IEEE Standards 80, 81, 141 and 142 pertaining to grounding and bonding of systems, circuits and equipment.
  - 5. NFPA Compliance: NFPA 70 National Electrical Code, NFPA 780" Standard for the Installation of Lightning Protection Systems", NFPA 99 "Standard for Health Care Facilities.

## **PART 2 - PRODUCTS**

### 2.1 GENERAL

#### A. Materials and Components:

1. Provide electrical grounding and bonding system; with assembly of materials, including, but not limited to, cables/wires, connectors, solderless lug terminals, grounding electrodes and plate electrodes, bonding jumper braid, surge arresters, and additional accessories needed for a complete installation. Where more than one type component product meets indicated requirements, selection is installer's option. Where materials or components are not indicated provide products which comply with NEC, UL, and IEEE requirements and with established industry standards for those applications indicated.

### 2.2 CONDUCTORS

#### A. Insulated Conductors: Copper wire or cable insulated for 600V unless otherwise required by applicable Code or authorities having jurisdiction.

#### B. Bare Copper Conductors:

1. Solid Conductors: ASTM B3.
2. Stranded Conductors: ASTM B8.
3. Tinned Conductors: ASTM B33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductors, 1/4 inch (6 mm) in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductors.
6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

#### C. Bare Grounding Conductor and Conductor Protector for Wood Poles:

1. No. 4 AWG minimum, soft-drawn copper.
2. Conductor Protector: Half-round PVC or wood molding. If wood, use pressure-treated fir or cypress or cedar.

#### D. Grounding Bus: Rectangular bars of annealed copper 1/4 by 3 by 12 inches (6 by 76 by 300 mm) in cross section, unless otherwise indicated; with insulators.

### 2.3 CONNECTORS

#### A. Listed and labeled by a nationally recognized testing laboratory 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 Mechanical Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts. Of type recommended by ABB (Blackburn/Color-Keyed) Installation Products, (Burndy) Hubbell Inc or equal.
    - 1. Pipe Connectors: Clamp type, sized for pipe.
  - C. Irreversible Compression Connectors: Use for connections to structural steel and for underground connections except those at test well. Install connection to ground rods. Comply with manufacturer's written recommendations and training. Must be factory filled with an oxide inhibitor and installed with manufacturers recommend dies. The die index must match the listed index for the connector. Use of a 14 Ton or larger hydraulic compression tool to provide correct circumferential pressure for compression connectors and index die numbers are properly indented. Use tools and dies recommended by manufacturer of connectors. Provide embossing die code method to make visible indication that the connector has been adequately compressed on the ground conductor, ground rod or ground plate. Irreversible compression connectors may be used below grade, above grade and concrete incased applications. Of types recommended by ABB (Blackburn) Installation Products, Burndy (Hubbell Inc). or approved equal.
  - D. Welded Connectors: Exothermic-welding kits of types recommended by ABB (Furseweld) Installation Products, Burndy (Thermoweld) Hubbell Inc. Erico – nVent (Cadweld) (or approved equal) manufacturer for materials being joined and installation conditions. Exothermically welded connections are required on all grounding electrode conductors other than water pipes, all connections to building steel (connections to structural member), all grounding conductors run under the earth, connection to ground rods and in any case where grounding conductors are subject to a hostile environment.
    - 1. The exothermic welding system furnished under these specifications shall meet the applicable requirements of IEEE80, Chapter 9, Section of conductors and joints.
    - 2. Molds shall be made from graphite or other material that is so designed to provide an average life of not less than 50 exothermic welds under normal conditions. Molds shall bear permanent marking, indicating the name of the manufacturer, the mold model, the type and size of welding mixture compatible with the welding process, and the size of the conductor. Instructions detailing general safety information, and welding procedures shall be provided with each mold.
    - 3. Starting material, if used, shall consist of aluminum and copper/copper oxide and iron oxides. It shall not contain phosphorous or any caustic, toxic or explosive substance. Weld metal used for grounding connections shall contain copper oxide, aluminum. Where welding is done in enclosed structures, the Erico Exolon smokeless system shall be used.
  - E. Exothermic connections are to be performed by manufacturer's trained personnel with a qualification and/or training certificate on file with the contractor.
- 2.4 GROUNDING ELECTRODES
- A. Ground Rods: Copper-bonded steel; 3/4 inch by 10 feet (19 mm by 3 m) in diameter.

- B. Chemical-Enhanced Grounding Electrodes: Copper tube, straight or L-shaped, charged with nonhazardous electrolytic chemical salts.
  - 1. Termination: Factory-attached No. 4/0 AWG bare conductor at least 48 inches (1200 mm) long.
  - 2. Backfill Material: Electrode manufacturer's recommended material.
  - 3. Electrolytic Chemical Ground Rods of types recommended by Lyncole Grounding or approved equal.

### **PART 3 - EXECUTION**

#### 3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No.10 AWG and smaller, and stranded conductors for No.8 AWG and larger, unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare tinned copper conductor, No.3/0 AWG minimum.
  - 1. Bury at least 24 inches (600 mm) below grade. In areas subject to long term and deeper freezing a lower depth may be in order.
  - 2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.
  - 3. Copper Ground Loop: Bury a minimum of 30" below grade.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
  - 1. Install bus on insulated spacers 1 inch (25 mm), minimum, from wall 6 inches (150 mm) 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, down to specified height above floor, and connect to horizontal bus.
- E. Conductor Terminations and Connections:
  - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
  - 2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
  - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
  - 4. Connections to Structural Steel: Welded connectors.

#### 3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements

- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls with 8", minimum bend radius and no angles less than 90m degrees. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.
- D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No.3/0 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches (150 mm) from the foundation.

### 3.3 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits. The conduit shall not be acceptable as an equipment ground.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
  - 1. Feeders and branch circuits.
  - 2. Lighting circuits.
  - 3. Receptacle circuits.
  - 4. Single-phase motor and appliance branch circuits.
  - 5. Three-phase motor and appliance branch circuits.
  - 6. Flexible raceway runs.
  - 7. Armored and metal-clad cable runs.
  - 8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
  - 9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
- C. Protection:
  - 1. All grounding electrode conductors smaller than #6 AWG shall be routed in conduit – EMT or Rigid/IMC if exposed to damage or weather.
  - 2. All grounding electrode conductors #6 AWG and larger shall be routed in conduit – EMT or Rigid/IMC if exposed to weather.

- D. 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.
- E. 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.
- F. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal in addition to the 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. 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.
- H. Signal and Communication Equipment: 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. Refer to technology specifications and drawings for additional information.
  - 1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-3-by-12-inch (6-by-76-by-300-mm) grounding bus.
  - 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- I. 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.

### 3.4 EXAMINATION

- A. Examine areas and conditions under which electrical grounding and bonding connections are to be made and notify Engineer in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.

### 3.5 INSTALLATION OF ELECTRICAL GROUNDING AND BONDING SYSTEMS

- A. General: Install electrical grounding and bonding systems in accordance with manufacturer's instructions and applicable portions of NEC, NECA's "Standard of



Installation", and in accordance with recognized industry practices to ensure that products comply with requirements.

- B. Coordinate with other electrical work as necessary to interface installation of electrical grounding and bonding system work with other work.
- C. 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.
- D. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96A when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
- E. Ground Rods: Drive rods until tops are 2 inches (50 mm) 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 an adjacent grounding means (such as Ufer, building steel or cold water pipe).AND/OR two-rod lengths from an adjacent rod (i.e. 16' apart for 8' rods & 20' apart for 10' rods), and connect to the service grounding electrode conductor.
- F. Test Wells: Provide test wells as required by the NEC.
  - 1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
  - 2. Manhole Test Wells: Ground rod driven through drilled hole in bottom of manholes. Manholes are specified in Division 26 Section "Underground Services and Manholes," and shall be at least 12 inches (300 mm) deep, with cover.
- G. 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 so vibration is not transmitted to rigidly mounted equipment
  - 3. Use exothermic-welded connectors or irreversible compression connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
- H. Grounding and Bonding for Piping:
  - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, each unit substation, or each main electrical room grounding bus, to main metal water service

- entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, 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.
  3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- I. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.
- J. 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 (18 m) apart.
- K. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building.
1. Install tinned-copper conductor not less than No.4/0 AWG for ground ring and for taps to building steel.
  2. Bury ground ring not less than 24 inches (600 mm) from building foundation.
- L. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet (6m) of bare copper conductor not smaller than No. 4/0 AWG.
1. If concrete foundation is less than 20 feet (6 m) long, coil excess conductor within base of foundation.
  2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.
- M. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.
- N. Apply corrosion-resistant finish to field-connections, buried metallic grounding and bonding products, and places where factory applied protective coatings have been destroyed, which are subjected to corrosive action.
- O. Install all connectors on clean metal contact surfaces, to ensure electrical conductivity and circuit integrity.

3.6 FIELD QUALITY CONTROL

- A. Upon completion of installation of electrical grounding and bonding systems, test ground resistance with ground resistance tester. Where tests show resistance to ground is over 5 ohms, take appropriate action to reduce resistance to 5 ohms, or less, by driving additional ground rods; then retest to demonstrate compliance.

**END OF SECTION**

## **SECTION 26 05 29**

### **HANGERS AND SUPPORTS**

#### **PART 1 - GENERAL**

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Requirements of the following Division 26 Sections apply to this section:
  - 1. "Electrical Requirements."

##### 1.2 SUMMARY

- A. This Section includes secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.
- B. Related Sections: The following Sections contain requirements that related to this Section:
  - 1. Division 3 Section "Mild Steel Concrete Reinforcement" for inserts, anchors, and sleeves to be installed in concrete for use with supporting devices.
  - 2. Division 5 Section "Metal Fabrications" for requirements for miscellaneous metal items involved in supports and fastenings.
  - 3. Division 7 Section "Firestopping" for requirements for firestopping at sleeves through walls and floors that are fire barriers.
  - 4. Refer to Division 26 Sections for additional specific support requirements that may be applicable to specific items.

##### 1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data for each type of product specified.
  - 1. Hanger and support schedule showing manufacturer's figure number, size, spacing, features, and application for each required type of hanger, support, sleeve, seal, and fastener to be used.
- C. Shop drawings indicating details of fabricated products and materials.
- D. Engineered Design consisting of details and engineering analysis for supports for the following items:

1. Cable Tray.
2. Conduit (racked)
3. Ceiling-mounted boxes, transformers.
4. Conduit - Ceiling mounted, concrete encased.

#### 1.4 QUALITY ASSURANCE

- A. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."
- B. Electrical components shall be listed and labeled by UL, ETL, CSA, or other approved, nationally recognized testing and listing agency that provides third-party certification follow-up services.
- C. Installation shall comply with local authorities seismic requirements.

### **PART 2 - PRODUCTS**

#### 2.1 COATINGS

- A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors shall be hot-dip galvanized and where installed in corrosive atmosphere, stainless-steel type channel and hardware shall be used.

#### 2.2 MANUFACTURED SUPPORTING DEVICES

- A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.
- B. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads. Aircraft cable and other non-rigid supports shall not be permitted for use as supporting material for conduit.
- C. Fasteners: Types, materials, and construction features as follows:
  1. Expansion Anchors: Carbon steel wedge or sleeve type.
  2. Toggle Bolts: All steel springhead type.
- D. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.
- E. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish.

- F. U-Channel Systems: 16-gauge steel channels, with 9/16-inch-diameter holes, at a minimum of 8 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacture.

### 2.3 FABRICATED SUPPORTING DEVICES

- A. General: Shop- or field-fabricated supports or manufactured supports assembled from U-channel components.
- B. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.

## **PART 3 - EXECUTION**

### 3.1 INSTALLATION

- A. Install supporting devices to fasten electrical components securely and permanently in accordance with NEC requirements.
- B. Coordinate with the building structural system and with other electrical installation.
- C. Raceway Supports: Comply with the NEC and the following requirements:
  - 1. Conform to manufacturer's recommendations for selection and installation of supports.
  - 2. Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 lbs., provide additional strength until there is a minimum of 200 lbs safety allowance in the strength of each support.
  - 3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
  - 4. Support parallel runs of horizontal raceways together on trapeze-type hangers. All supporting rods shall be rigid. Aircraft cable and other similar non-rigid cable shall not be used to support horizontal conduit.
  - 5. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1 1/2 inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use 1/4-inch diameter or larger threaded steel. Use spring fasteners that are specifically designed for supporting single conduits or tubing.
  - 6. Space supports for raceway in accordance with NEC.
  - 7. Support exposed and concealed raceway within 1 foot of an unsupported box and access fittings. In horizontal runs, supports at the box and access fittings may be omitted where box or access fittings are independently supported and raceway terminals are not made with chase nipples of threadless box connectors.

8. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.
- D. Vertical Conductor Supports: Install simultaneously with installation of conductors (i.e., strain reliefs).
  1. Support shall be at each individual conductor.
- E. Miscellaneous Supports: Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.
- F. In open overhead spaces, cast boxes threaded to raceways need not be supported separately except where used for fixture support; support sheet metal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to the raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24 inches from the box.
- G. Sleeves: Install in concrete slabs and walls and all other fire-rated floors and wall for raceways and cable installations. For sleeves through fire-rated wall or floor construction, apply UL-listed firestopping sealant in gaps between sleeves and enclosed conduits and cables in accordance with "Fire Stopping" requirement of Division 7.
- H. Conduit Seals: Install seals for conduit penetrations of slabs on grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.
- I. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with the following:
  1. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions or light steel construction, use sheet metal screws.
  2. Holes cut to depth of more than 1 1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used.
  3. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration- and shock-resistant fasteners for attachments to concrete slabs.
- J. Provide a manufactured support system for horizontally routed rooftop conduits consisting of the following:
  1. A mounting base, nominal 6-7/16" high x 6" wide x 9-1/2" long, manufactured from 100% recycled rubber, UV resistant.

2. The base shall be combined with a 2-7/16" high, 12 gauge galvanized steel U-channel, fastened to the base, to form the basic support system. A single base with U-channel shall provide an ultimate load capacity of 500 lbs per linear foot.
  3. The base shall be suitable for mounting on any type of roofing material or other flat surfaces.
  4. Provide multiple bases with length of U-channel required at any location where there are multiple runs of parallel conduits.
  5. Provide conduit clamps and straps that are designed for fastening to U-channels. All fastening hardware shall be hot-dip galvanized steel or equivalent ASTM recognized coating approved for exterior applications.
  6. Include, with the manufacturers' product data in the shop drawing submittal, a rooftop conduit layout drawing that indicates routing, the location of the conduit supports and the anticipated total weight at typical multiply conduit locations.
- K. TESTS: Test pull-out resistance of one of each type, size, and anchorage material for the following fastener types:
1. Expansion anchors.
  2. Toggle bolts.
- L. Provide all jacks, jigs, fixtures, and calibrated indicating scales required for reliable testing. Obtain the structural Engineer's approval before transmitting loads to the structure. Test to 90 percent of rated proof load for fastener. If fastening fails test, revise all similar fastener installations and retest until satisfactory results are achieved.

**END OF SECTION**



## **SECTION 26 05 33**

### **RACEWAYS AND BOXES**

#### **PART 1 - GENERAL**

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.
- B. Requirements of the following Division 26 Sections apply to this Section:
  - 1. "Electrical Requirements."
  - 2. "Basic Material and Methods"

##### 1.2 SUMMARY

- A. Drawings are diagrammatic. All bends, boxes, fittings, couplings are not necessarily shown. Supply as necessary to comply with the National Electric Code.
- B. Provide complete raceway systems for all conductors including control wiring and low-voltage wiring unless otherwise noted.
- C. This Section includes raceways for electrical wiring. Types of raceways, boxes and fittings in this section include the following:
  - 1. Electrical metallic tubing (EMT).
  - 2. Flexible metal conduit.
  - 3. Intermediate metal conduit (IMC).
  - 4. Liquid-tight flexible conduit.
  - 5. Rigid metallic conduit (RMC).
  - 6. Metal clad cable (MC).
  - 7. Surface raceways.
  - 8. Rigid non-metallic conduit.
  - 9. Electrical non-metallic tubing (ENT)
  - 10. Wireway.
  - 11. Outlet boxes.
  - 12. Junction boxes.
  - 13. Pull boxes.
  - 14. Bushings.
  - 15. Locknuts.
  - 16. Knockout closures.
- D. Related Sections: The following section contains requirements that relate to this section:
  - 1. Division 26 Section "Raceway and Boxes" for conduit connectors, fittings, and couplings.

2. Division 7 Section "Firestopping" for conduit penetrations through rated walls and slabs.

E. Section only applies for electrical systems to be installed within raceways. This excludes beverage piping and pneumatic systems pulled within raceways.

### 1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of contract and Division 1 Specification Section.

B. Product Data for the following products:

1. Raceways and fittings.
2. Wireways and fittings.
3. Boxes and fittings.

C. Installation Instructions: Manufacturer's written installation instructions for wireway, surface raceway, and nonmetallic raceway products.

### 1.4 QUALITY ASSURANCE

A. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."

B. NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.

C. UL Compliance and Labeling: Comply with applicable requirements of UL standards pertaining to electrical raceway systems. Provide raceway products and components listed and labeled by UL.

D. Manufacturers: Firms regularly engaged in manufacture of electrical boxes and fittings, of types, sizes, and capacities required, whose products have been in satisfactory use in similar service for not less than five years.

E. Installer's Qualifications: Firms with at least five years of successful installation experience on projects utilizing electrical boxes and fittings similar to those required for this project.

F. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical wiring boxes and fittings.

G. UL Compliance: Comply with applicable requirements of UL 50, UL 514-Series, and UL 886 pertaining to electrical boxes and fittings. Provide electrical boxes and fittings which are UL-listed and labeled.

H. NEMA Compliance: Comply with applicable requirements of NEMA Standards/Pub No.'s OS1, OS2 and PUB 250 pertaining to outlet and device boxes, covers and box supports.

- I. Federal Specification Compliance: Comply with applicable requirements of FS W-C 586, "Electrical Cast Metal Conduit Outlet Boxes, Bodies, and Entrance Caps."

## **PART 2 - PRODUCTS**

### 2.1 METAL CONDUIT AND TUBING

- A. Rigid Steel Conduit: ANSI C80.1
- B. PVC Coated Rigid Galvanized Steel Conduit: ANSI C80.1, UL6 & NEMA RN-1 2018
- C. Intermediate Steel Conduit: UL 1242.
- D. Electrical Metallic Tubing and Fittings: ANSI C80.3.
- E. Flexible Metal Conduit: UL 1, zinc-coated steel.
- F. Liquid-tight Flexible Metal Conduit and Fittings: UL 360.

### 2.2 METAL CLAD CABLE, TYPE MC

- A. The multi-conductor metal clad cable shall comply with UL 1569 "Metal Clad, Type MC," UL 83 "Thermoplastic Insulated Wires and Cables" Federal Specification J-C-30B "Wire and Cable," Local and National Electrical Codes.
- B. The metal clad cable shall be THHN insulation, copper conductors in sizes #12 through #8 AWG only for continuous operation at a maximum conductor temperature of 90 degree C dry.
- C. These cables shall bear appropriate Underwriters Laboratories labels for metal clad cable and be suitable for use as branch circuits in both exposed and concealed work in accordance with applicable sections of the National Electrical Code.
- D. An insulated grounding conductor sized in accordance with Table 5.3 Underwriter's Standard UL 1569 shall be cabled with the circuit conductors and shall be identified in compliance with Section 29 of UL 1569. The grounding conductor shall not be smaller than size indicated in NEC Article Table 250.122.
- E. A galvanized steel or aluminum armor shall be applied over the inner cable assembly with a positive interlock in compliance with Section 10 of UL 1569. MC cable with a PVC jacket shall not be permitted to be installed in slabs.

### 2.3 NONMETALLIC CONDUIT AND DUCTS

- A. Rigid Nonmetallic Conduit (RNC): NEMA TC 2 and UL 651, Schedule 40 or 80 PVC.
- B. PVC Conduit and Tubing Fittings: NEMA TC 3; match to conduit or conduit/tubing type and material.

- C. Conduit, Tubing and Duct Accessories: Types, sizes and materials complying with manufacturer's published product information. Mate and match accessories with raceway.
- D. Electrical non-metallic tubing (ENT): NEMA TC13 and UL1653.

#### 2.4 PVC COATED RIGID GALVANIZED STEEL CONDUIT

- A. PVC Coated Rigid Galvanized Steel Conduit shall comply with ANSI C80.1, C80.5, UL6 and NEMA RN-1.
- B. The Rigid Galvanized Steel Conduit shall be hot dipped galvanized inside and out and shall have hot dipped galvanized threads.
- C. The external PVC coating shall be a nominal 40 mils of PVC coating with 2mils of interior urethane coating.
- D. The factory applied hot dipped galvanizing shall not be disturbed in any fashion prior to the application of PVC coatings applied during manufacturing.
- E. The PVC coated RGS Conduit shall comply with all UL listings providing the hot dipped galvanized coating as the primary means of corrosion protection and the PVC shall be listed as the secondary means of corrosion protection.

#### 2.5 CONDUIT BODIES AND FITTINGS

- A. General: Types, shapes, and sizes as required to suit individual applications and NEC requirements. Provide matching gasketed covers secured with corrosion-resistant screws.
- B. Metallic Conduit and Tubing: Use metallic conduit bodies. Use bodies with threaded hubs for threaded raceways.
- C. EMT Conduit Bodies 1 Inch and Smaller: Use bodies with steel set screw connectors and couplings for interior applications and steel compression gland connectors and couplings for exterior applications.
- D. EMT Conduit Bodies 1 Inch and Larger: Use bodies with steel set screw connectors and couplings for interior applications and steel compression gland connectors and couplings for exterior applications.
- E. Nonmetallic Conduit and Tubing: Use nonmetallic conduit bodies conforming to UL514B.
- F. PVC Coated RGS Conduit Bodies: Conduit bodies shall have a nominal 40mils of PVC and 2mils of interior urethane and shall be NEMA 4X listed with encapsulated stainless-steel screws.
- G. Liquid-Tight Flexible Conduit Fittings: With threaded grounding cone, steel, nylon or equal plastic compression ring, and a gland for tightening. Either steel or malleable iron only with insulated throats and male thread and locknut or male bushing with or without O-ring seal. Each connector shall provide a low resistance ground

connection between the flexible conduit and the outlet box, conduit or other equipment to which it is connected.

- H. Bushings: Insulated type, designed to prevent abrasion of wires without impairing the continuity of the conduit grounding system, for rigid steel conduit, IMC and EMT, larger than 3/4" size.
- I. Expansion Fittings: Each conduit that is buried in or secured to the buildings construction on opposite sides of a building expansion joint and each long run of exposed conduit that may be subject to excessive stresses shall be provided with an expansion fitting. Expansion fittings for rigid steel conduit shall be hot-dipped galvanized malleable iron with factory installed packing and a grounding ring and internal bonding jumper. Expansion fittings for rigid non-metallic conduit shall be of the short type in runs 25' or less, and the long type in runs 26' to 80'. The long type shall be a two piece barrel and piston joint, providing 6" of the total movement range in 3/4" through 6" conduit sizes. The short type shall be a one piece, coupling with O-ring, providing 2" of total movement range in 3/4" to 2" conduit sizes.
- J. Seal Off Fittings: Refer to section 26 05 02 for additional requirements.
- K. Sleeves for Conduit Penetration: Refer to section 26 05 02 for additional requirements.

## 2.6 WIREWAYS

- A. General: Electrical wireways shall be of types, sizes, and number of channels as indicated. Fittings and accessories including but not limited to couplings, offsets, elbows, expansion joints, adapters, hold-down straps, and end caps shall match and mate with wireway as required for complete system. Where features are not indicated, select to fulfill wiring requirements and comply with applicable provisions of NEC.
- B. Wireway covers shall be hinged type.

## 2.7 SURFACE RACEWAYS

- A. General: Sizes and channels as indicated on drawings. Provide fittings that match and mate with raceway. Provide internal barriers for areas with power and communications sections.
- B. Surface Metal Raceway: Construct of two piece galvanized steel with snap-on covers, with 9/32-inch mounting screw knockouts in base approximately 8 inches o.c. Finish with manufacturer's standard prime coating suitable for painting. Provide raceways of types suitable for each application required. Sizes 1-3/4" H x 4-3/4" W.
- C. Accessories:
  - 1. Couplings for joining raceway sections.
  - 2. Wire clips for conductors.
  - 3. Blank end fittings.
  - 4. Circuit breaker housings for single pole breakers.

5. Device brackets for single or two gang devices.
6. Combination receptacle and tele/data outlet covers.
7. Outlet boxes with hubs for conduit connectors.

## 2.8 FABRICATED MATERIALS - BOXES

- A. Outlet Boxes: Provide galvanized flat rolled sheet-steel outlet wiring boxes, of shapes, cubic inch capacities, and sizes (minimum 4-inch square, 1 ½-inch deep), including box depths as required, suitable for installation at respective locations. Construct outlet boxes with mounting holes, and with cable and conduit-size knockout openings in bottom and sides. Provide boxes with threaded screw holes, with corrosion-resistant cover and grounding screws for fastening surface and device type box covers, and for equipment type grounding.
  1. Outlet Box Accessories: Provide outlet box accessories as required for each installation, including box supports, mounting ears and brackets, wallboard hangers, box extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used to fulfill installation requirements for individual wiring situations. Choice of accessories is Installer's code-compliance option.
- B. Device Boxes: Provide galvanized coated flat rolled sheet-steel non-gangable device boxes, of shapes, cubic inch capacities, and sizes (minimum 4-inch square, 1 ½-inches deep), including box depths as indicated, suitable for installation at respective locations. Construct device boxes for flush mounting with mounting holes, and with conduit-size knockout openings in bottom and ends, and with threaded screw holes in end plates for fastening devices. Provide conduit connectors and corrosion-resistant screws for equipment type grounding.
  1. Device Box Accessories: Provide device box accessories as required for each installation, including mounting brackets, device box extensions, switch box supports, plaster ears, and plaster ears, and plasterboard expandable grip fasteners, which are compatible with device boxes being utilized to fulfill installation requirements for individual wiring situations. Choice of accessories is Installer's code-compliance option.
- C. Raintight Outlet Boxes: Provide corrosion-resistant cast-metal raintight outlet wiring boxes, of types, shapes and sizes, including depth of boxes, with threaded conduit holes for fastening electrical conduit, cast-metal face plates with spring-hinged watertight caps suitably configured for each application, including face plate gaskets and corrosion-resistant plugs and fasteners.
- D. Junction and Pull Boxes: Provide code-gauge sheet steel junction and pull boxes, with screw-on covers; of types, shapes and sizes, to suit each respective location and installation; with welded seams and equipped with stainless-steel nuts, bolts, screws, and washers. Pull boxes installed in finished spaces must be flush-mounted cabinets provided with trim, hinged door and flush latch and lock to match flush-mounted panelboard trim. Provide galvanized code-gauge steel where required for outdoor exposure.
- E. Exterior junction or pull boxes, flush with grade:

1. All exterior pull box locations shall be submitted and approved by landscape architect prior to installation.
  2. Junction or pull box to be mounted flush with grade shall be polymer composite raintight with screw cover lids. Box dimensions shall be 30"W x 48"L x 36"D. Covers shall be polymer composite suitable for pedestrian traffic secured to box with stainless-steel screws. Box to be furnished with continuous neoprene gasket to seal cover. Conduit entry shall be on side of box with bell ends.
- F. Bushings, Knockout Closures and Locknuts: Provide corrosion-resistant box knockout closures, conduit locknuts and malleable iron conduit bushings, offset connectors, of types and sizes, to suit respective installation requirements and applications.

### **PART 3 - EXECUTION**

#### 3.1 WIRING METHOD

- A. Outdoors: Use the following wiring methods:
1. Exposed: Intermediate metal conduit, rigid steel conduit, raintight box.
  2. Concealed: Intermediate metal conduit, rigid steel conduit.
  3. Underground, Single Run: Rigid non-metallic conduit. PVC coated GRC 90° elbows.
  4. Underground, Grouped: Rigid non-metallic conduit. PVC coated GRC 90° elbows.
  5. Connection to Vibrating Equipment including transformers, pneumatic or electrical solenoid, and motor-operated equipment: Liquid-tight flexible metal conduit.
- B. Indoors: Use the following wiring methods:
1. Exposed (below 10 ft. to floor): Intermediate metal conduit, rigid steel conduit.
  2. Exposed (above 10ft. or in electrical room): Electrical metallic tubing.
  3. Concealed: Electrical metallic tubing.
  4. Concealed: Metal clad cable will be allowed as final branch wiring of receptacles (maximum total length of 25' from homerun J-box or hard piped J-box to first outlet on circuit). MC is not allowed for homeruns to panels, connections to mechanical equipment. Maximum conductor size is in MC cable #8 AWG. MC is acceptable for final light fixture connection, maximum 6' length.
  5. Connection to Vibrating Equipment including transformers, pneumatic or electrical solenoid, and motor-operated equipment: Flexible metal conduit.
  6. Connection to Vibrating Equipment in Moist/Humid or Corrosive Atmosphere including pneumatic or electric solenoid, and motor-operated equipment: Liquid-tight flexible metal conduit.
  7. Within concrete slabs: Rigid non-metallic conduit. PVC coated MC cable and ENT is not allowed. Homeruns shall be in conduit. Maximum sizes and locations as approved by the Structural Engineer.
  8. Raceway mounted to underside of metal-corrugated sheet roof decking shall be Rigid Metal Conduit or intermediate Metal Conduit.

9. Exposed Wet Locations: Intermediate metal conduit, rigid steel conduit, raintight box.
  - a. Provide conduit bodies or exterior boxes with a minimum of 1/8" drain. Drain shall be located to allow exterior raceway system to drain.
10. Corrosive Environment, including areas where pool equipment is installed or areas where chemicals are stored: Rigid Metal Conduit, intermediate Metal Conduit, PVC or fiberglass.

### 3.2 INSTALLATION OF RACEWAYS

- A. General: Install electrical raceways in accordance with manufacturers' written installation instructions, applicable requirements of NEC, and as follows.
- B. Electrical system layouts indicated on drawings are generally diagrammatic, but shall be followed as closely as actual construction and work of other trades will permit. Govern exact routing of raceways and locations of outlets by structure and equipment served. Take all dimensions from architectural drawings.
- C. All home runs to panelboards are indicated as starting from the outlet nearest to the panel and continuing in the general direction of that panel. Continue such circuits to panel as though routes were completely indicated.
- D. Avoid cutting and boring holes through structure or structural members wherever possible. Obtain prior approval of the Architect, and conform to all structural requirements when cutting or boring structure.
- E. Furnish and install all necessary hardware, hangers, blocking, brackets, bracing, runners, etc., required for equipment specified under this Section.
- F. Minimum size conduit shall be 3/4" for power circuits and 1" for telecommunications devices.
- G. Conceal conduit and EMT, unless indicated otherwise, within finished wall, ceilings, and floors. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot water pipes. Install raceways level and square and at proper elevations.
- H. Elevation of Raceway: Where possible, install horizontal raceway runs above water and steam piping.
- I. Complete installation of electrical raceways before starting installation of conductors within raceways.
- J. Provide supports for raceways as specified elsewhere in Division 26 and in accordance with NEC and local authorities' seismic requirements.
- K. Prevent foreign matter from entering raceways by using temporary closure protection.
- L. PVC coated rigid galvanized steel conduit systems: Provide onsite installation training course by company representative. The representative shall conduct onsite



training course to qualify for the installation certificate. After the onsite training installation, the representative shall then register the installer in his data base and provide certification for installation.

- M. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bends is not visible above the finished slab. All elbow penetration through the slab shall be PVC coated rigid metallic conduit ELLs. Where elbows end below the slab, extend PVC coated rigid conduit a minimum of 6 inches above the finished slab.
- N. Make bends and offsets so the inside diameter is not effectively reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel.
- O. Use raceway fittings that are of types compatible with the associated raceway and suitable for the use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings except as otherwise indicated.
- P. Run concealed raceways with a minimum of bends in the shortest practical distance considering the type of building construction and obstructions except as otherwise indicated.
- Q. Raceways embedded in slabs shall only be permitted with the strict written approval of the Structural Engineer and Architect. For bidding purpose, conduit shall not be permitted in slab.
- R. Install exposed raceways parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical. All exposed conduit runs shall be approved by the Architect prior to installing.
- S. All exposed conduits in public areas shall be painted to match surrounding walls. Verify exact color with the Architect. Coordinate painting of all exposed conduits with Construction Manager / General Contractor.
- T. Run exposed, parallel, or banked raceways together. Make bends in parallel or banked runs from the same center line so that the bends are parallel. Factory elbows may be used in banked runs only where they can be installed parallel. This requires that there be a change in the plane of the run such as from wall to ceiling and that the raceways are of the same size. In other cases, provide field bends for parallel raceways. All exposed conduit routing shall be approved by the Architect prior to installing.
- U. Join raceways with fittings designed and approved for the purpose and make joints tight. Where joints cannot be made tight, use bonding jumpers to provide electrical continuity of the raceway system. Make raceway terminations tight. Where terminations are subject to vibration, use bonding bushings or wedges to assure electrical continuity. Where subject to vibration or dampness, use insulating bushings to protect conductors. Use expansion fittings at building expansion joints.
- V. Tighten set screws of threadless fittings with suitable tool.
- W. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely and install the locknuts with dished part against the box. Where terminations cannot be made secure with one locknut, use two

locknuts, one inside and one outside of the box. All conduit connections to junction boxes shall have insulated bushings.

- X. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.
- Y. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200-lb tensile strength. Leave no less than 12 inches of slack at each end of the pull wire.
- Z. Install raceway sealing fittings in accordance with the manufacturer's written instructions. Fitting should come complete with O-ring gasket. Locate fittings at suitable, approved, accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points and elsewhere as indicated:
  - 1. Where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces, air-conditioned spaces and walk-in coolers.
  - 2. Where required by the NEC.
- AA. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs and set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; flexible metal conduit may be used 6 inches above the floor. Where equipment connections are not made under this contract, install screwdriver-operated threaded flush plugs flush with floor.
- BB. Flexible connection: Use length (maximum of 6 ft.) of flexible conduit for recessed and semi-recessed lighting fixtures, for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquid-tight flexible conduit in wet locations. Install separate equipment grounding conductor across flexible connections.
- CC. Install nonferrous conduit or tubing for circuits operating above 60 Hz.
- DD. PVC externally coated rigid steel conduit: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduit.
- EE. All underground conduits shall be installed a minimum of 48 inches below finish grade for medium-voltage feeders and 30 inches for 480-Volt feeders. All other conduits shall be installed in accordance with the NEC and coordinated depth with other trades.
- FF. All medium-voltage ductbanks shall be encased in concrete.
- GG. Grounding: Install a separate green equipment grounding conductor in all raceways from the panelboard/junction box supplying the raceway to the receptacle or equipment ground terminals. Conduits will not be permitted as a ground conductor.
- HH. Emergency and standby feeder raceways that are not concealed in the electrical room or in sprinkled spaces shall be wrapped in a 2-hour protected fire wrap (MFR:

3M interam wrap or approved equal) or wiring shall be 2-hour protected and UL listed for that purpose.

- II. Furnish and install all raceways from elevator machine room to fire command center for elevator status.
  
- JJ. Clearances: All electrical raceways shall be routed to maintain appropriate clearances from low-voltage raceways per NEC, ANSI/EIA/TIA, and BICSI requirements. Provided below are minimum requirements of key components that shall be maintained. For any instances where field conditions do not allow for the minimum clearances, the Contractor shall notify the Architect and Engineer so that an acceptable solution can be coordinated.
  - 1. 120V Power Conduits: 6 inches (150mm)
  - 2. 208V and Higher Power: 24 inches (600mm)
  - 3. Lighting System: 12 inches (300mm)
  - 4. Transformers: 48 inches (1200mm)
  - 5. Motors and Fans: 48 inches (1200mm)
  - 6. Other Interfering Sources to be field verified and coordinated by Contractor with Architect and Engineer.
  
- KK. Support: All electrical raceways shall be independently supported. Support from suspended ceiling elements is not permitted.

### 3.3 INSTALLATION OF ELECTRICAL BOXES AND FITTINGS

- A. General: Install electrical boxes and fittings in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation," and in accordance with recognized industry practices to fulfill project requirements.
  
- B. Dimensions unless shown on drawings are given below and are from finished floor to center line of outlets unless noted otherwise. Adjust heights of outlets in masonry walls to correspond with consistent brick or block course. Outlets in block walls shall be installed in core of block.

Wall Switches	4' - 0" (to top of box)
Convenience outlets	1' - 4" (to bottom of box) - gyp or 8" block 1' - 6" (to bottom of box) - 6" block
Above counter wall outlet	0' - 8" (above counter to top of box, maximum 44" AFF, field verify height of backsplash)
Panelboards wall mounted	6' - 6" (to top of back box)
Wall phone outlet	4' - 0" (to top of box)
Tele/Data outlets	1' - 4" (to bottom of box) - gyp or 8" block 1' - 6" (to bottom of box) - 6" block
Fire alarm horns, speakers	ceiling or wall
Fire alarm pull stations	4' - 0" (to top of device)
Fire alarm strobes	6' - 8" or 6" below ceiling (whichever is lower)
Television outlets	Refer to A/V or architectural drawing.

Confirm final location and heights of all outlets, wall switches, and television outlets with architectural drawings and furniture plans prior to installation.

- C. Exact location of outlets and equipment shall be governed by structural conditions and obstructions or other equipment items. When necessary, relocate outlets so that when fixtures or equipment are installed, they will be symmetrically located according to room layout and will not interfere with other work or equipment. Verify final location of all outlets, panels, equipment, etc., with the Architect/Engineer.
- D. Coordinate installation of electrical boxes and fittings with wire/cable, wiring devices, and raceway installation work.
- E. Provide zinc-coated or cadmium-plated sheet steel outlet boxes not less than 4" octagonal or square, unless otherwise noted. Equip fixture outlet boxes with 3/8" no-bolt fixture studs. Where fixtures are mounted on or in an accessible type ceiling, provide a junction box and extend flexible conduit to each fixture. Outlet boxes in finished ceilings or walls shall be fitted with appropriate covers, set to come flush with the finished surface. Where more than one switch or device is located on one point, use gang boxes and covers unless otherwise indicated. Sectional switch boxes or utility boxes will not be permitted.
- F. Provide tile box or a 4" square box with tile ring in masonry walls which will not be plastered or furred, or where "dry-wall" type materials are applied. Through the wall type boxes are not permitted. Install minimum 12" lateral separation for back to back boxes.
- G. Provide outlets in rain tight box with metallic "in use" covers for interior and exterior locations exposed to weather or moisture.
- H. Provide rain tight box for all interior, exterior and non-conditioned locations exposed to weather or moisture. This includes boxes located under overhangs not directly exposed to moisture.
- I. Surface-mounted devices are to be mounted in cast type boxes with gasketed covers: (Crouse-Hinds FS/FD or equal).
- J. Provide knockout closures to cap unused knockout holes where blanks have been removed.
- K. Install electrical boxes in those locations which ensure ready accessibility to enclosed electrical wiring.
- L. Electrical Contractor to provide access panels for electrical boxes which are code required to have accessibility.
- M. Installing boxes back-to-back in walls shall not be permitted. Provide no less than 12 inches (150 mm) of separation.
- N. Position recessed outlet boxes accurately to allow for surface finish thickness.
- O. Avoid using round boxes where conduit must enter box through side of box, which would result in difficult and insecure connections when fastened with locknut or bushing on rounded surfaces.
- P. Fasten electrical boxes firmly and rigidly to substrates, or structural surfaces to which attached, or solidly embedded electrical boxes in concrete or masonry.

- Q. Provide electrical connections for installed boxes.
- R. Exterior junction or pull boxes shall be mounted flush with grade, unless noted otherwise or indicated to be above ground on the drawings. Boxes shall be surrounded on all sides with 6 inches minimum of concrete. Top of concrete shall flush with grade. Seal all conduit entries into box with duct seal to prevent entrance of moisture, after conductors are installed.
- S. Tap and splices, where permitted by these specifications within exterior junction boxes, shall be performed with an encapsulating watertight splice or tap kit which insulates and moisture seals the connection. Kit shall consist of the appropriate size and type mold, encapsulating resin and end sealing tape.
- T. Subsequent to installation of boxes, protect boxes from construction debris and damage.
- U. Provide a standard access panel having a hinged metal door neatly fitted into a flush metal trim, where a junction box or equipment is located above non-accessible ceilings or behind finished walls. Coordinate location and type with the Architect.
- V. Outlets except over counters, benches, special equipment, baseboards, fin tube radiators, etc., or at wainscoting, shall be at a height to prevent interference to service equipment, or as noted on drawings.

### 3.4 GROUNDING

- A. Upon completion of installation work, properly ground electrical boxes and demonstrate compliance with requirements.

### 3.5 ADJUSTING AND CLEANING

- A. Upon completion of installation of raceways, inspect interiors of raceways; clear all blockages and remove burrs, dirt, and construction debris.

**END OF SECTION**

## **SECTION 26 05 48**

### **VIBRATION AND SEISMIC CONTROLS**

#### **PART 1 - GENERAL**

##### 1.1 DESCRIPTION

- A. Furnish and install vibration control devices, materials, and related items. Perform all work as shown on the drawings and as specified herein to provide complete vibration isolation systems in proper working order.

##### 1.2 MATERIAL AND EQUIPMENT

- A. All vibration isolation mounts shall be supplied by one of the approved manufacturers stated in the PRODUCTS Section of this specification. Substitutions of equal equipment beyond the alternatives listed will be permitted only with the written permission of the Architect. Accompany each request for acceptance of substitute equipment with manufacturer's certified data proving the equivalence of the proposed substitute in quality and performance. The Architect shall be the final judge of the validity of the data submitted.
- B. Unless otherwise specified, supply only new equipment, parts, and materials.

##### 1.3 SUBMITTALS

- A. Refer to related sections elsewhere for procedural instructions for submittals.
- B. The shop drawing submittal for isolated electrical equipment shall include submittal information for the isolation mounts. Information supplied shall be as follows:
  - 1. A complete description of products to be supplied including product data, dimensions, specifications, and installation instructions.
  - 2. Detailed selection data for each vibration isolator supporting equipment, including:
    - a. The equipment identification mark.
    - b. The isolator type.
    - c. The actual load.
  - 3. Detailed selection data for seismic restraints including:
    - a. Submit manufacturer's data for all manufactured restraints.
    - b. All submittals shall be stamped and certified by a Structural Engineer registered in the State of Georgia with a minimum of 5 years experience in the design of seismic restraints.
    - c. Submit shop drawings for all fabricated restraints.

- d. Show restraint type and location on the installation shop drawings.  
Drawings to include:
    - 1) All seismic brace locations.
    - 2) All seismic restraint connections to structure and vertical support anchorage at seismic locations and all other vertical support anchorage connections. Including but not limited to Quantity, Size, and Embedment.
    - 3) Brace reaction at all connection points to the structure for Structural Engineer of Record use in checking suitability of the building structure.
    - 4) Type and size of brace member.
    - 5) Suspended utility maximum lbs. per linear foot or maximum conduit size at all seismic locations.
    - 6) Minimum all thread rod size at all seismic locations.
    - 7) Size all horizontal support members taking into account, but not limited to, deflection and load.
    - 8) Registered Georgia Engineer stamp and signature.
  - e. Submit calculations for all seismic restraint systems that are not preapproved.
  - f. Job site conditions not covered by the manufacturer's seismic bracing guidelines shall be engineered by the manufacturer.
- C. Submission of samples may be requested for each type of vibration isolation device. After approval, samples will be returned for installation at the job. All costs associated with submission of samples shall be borne by the Contractor.

#### 1.4 QUALITY ASSURANCE

- A. Coordinate the size, location, and special requirements of vibration isolation equipment and systems with other trades. Coordinate plan dimensions with size of housekeeping pads.
- B. Provide vibration isolators of the appropriate sizes and proper loading to meet the specified requirements.
- C. Supply and install any incidental materials needed to meet the requirements stated herein, even if not expressly specified or shown on the drawings, without claim for additional payment.
- D. Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.
- E. Should any electrical equipment cause excessive noise or vibration, the Contractor shall be responsible for remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for the unit in question.
- F. Upon completion of the work, the Architect or Architect's representative shall inspect the installation and shall inform the installing contractor of any further work that must be completed. Make all adjustments as directed by the Architect that

result from the final inspection. This work shall be done before vibration isolation systems are accepted.

## **PART 2 - PRODUCTS**

### 2.1 VIBRATION ISOLATION MOUNT TYPES

#### A. Type DNP (Double Neoprene Pad):

1. Neoprene pad isolators shall be formed by two layers of 1/4" to 5/16" thick ribbed or waffled neoprene, separated by a stainless-steel or aluminum plate. These layers shall be permanently adhered together. The pads shall be sized so that they will be loaded within the manufacturer's recommended range.
2. Type DNP isolators shall be formed from one of the following products or approved equal:

Type NR	Amber/Booth
Type Korpad	Korfund Dynamics
Type WSW	Mason Industries
Type NPS	Kinetics Noise Control
Series Shear Flex	Vibration Mountings & Control

#### B. Type HN (Hanger Neoprene):

1. Vibration isolation hangers shall consist of a neoprene-in-shear or glass fiber element contained in a steel housing. A neoprene neck bushing (or other element) shall be provided where the hanger rod passes through the hanger housing to prevent the rod from contacting the hanger housing. The diameter of the hole in the housing shall be sufficient to permit the hanger rod to swing through a 30° arc before contacting the hanger housing.
2. Type HN isolators shall be one of the following products or approved equal:

Type BRDA	Amber/Booth
Type H	Korfund Dynamics
Type HD	Mason Industries
Type RH or FH	Kinetics Noise Control
Type RHD or RFD	Vibration Mountings & Control

### 2.2 FLEXIBLE ELECTRICAL CONNECTIONS

#### A. Type A:

1. Flexible Electrical Connection Type A shall be a prefabricated unit incorporating a flexible and watertight outer jacket, grounding strap, plastic inner sleeve to maintain smooth wireway, and end hubs with tapered electrical threads to fit standard threaded rigid metal conduit.
2. Flexible Electrical Connection Type A shall be Crouse-Hinds (Syracuse, NY) "XD Expansion/Deflection Coupling," Spring City Electrical Mfg. Co. (Spring City, PA) "Type DF Expansion and Deflection Fitting," or approved equal.

#### B. Type B:



1. Flexible Electrical Connection Type B shall be field fabricated using a minimum 2 (two) foot length of flexible conduit or cable.

C. Type C:

1. Flexible Electrical Connection Type C shall be field fabricated using a minimum 4 (four) foot length of flexible conduit or cable.

### **PART 3 - EXECUTION**

#### 3.1 APPLICATION

A. Transformers, Unit Substations, and Uninterruptible Power Supplies (UPS):

1. Transformers, Unit Substations, and UPS devices within the building construction shall follow the following table:

<b>Transformers</b>	<b>Base Type</b>	<b>Isolator Type</b>	<b>Static Defl (in.)</b>	<b>Mason Industries Type</b>
Floor Mounted – Greater than 350 kVA	Rigid Steel	Spring	2	SLR or PC30N
Floor Mounted – 45 to 350 kVA	Trapeze	Neoprene	0.25	HD or ND
Suspended – 45 to 350 kVA	Trapeze	Spring	1	30N
Suspended – Less than 45 kVA		Neoprene	0.05	W

2. Electrical connections to isolated transformers and UPS devices shall be made using flexible electrical connections Type A or Type B.

B. Dimmers:

1. Dimmer cabinets shall be mounted on Type DNP isolators.
2. Electrical connections to dimmers shall be made using flexible electrical connections Type A or Type B.

C. Mechanical Equipment:

1. Electrical connections to vibration isolated mechanical equipment shall be made using flexible electrical connections Type A or Type C.

#### 3.2 INSTALLATION

A. General:

1. In all cases, isolated electrical equipment shall be positioned so that it is free standing and does not come in rigid contact with the building structure or other systems.

B. Isolation Mounts:

1. All mounts shall be aligned squarely above or below mounting points for the supported equipment.
2. If a housekeeping pad is provided, the isolators shall bear on the housekeeping pad and the isolator base plate shall rest entirely on the pad.
3. Hanger rods for vibration isolated supports shall be connected to structural beams or joists, not to the floor slab between beams and joists. Provide suitable intermediate support members as necessary.
4. Vibration isolation hanger elements shall be positioned as high as possible in the hanger rod assembly, but not in contact with the building structure, and so that the hanger housing may rotate a full 360° about the rod axis without contacting any object.

C. Flexible Electrical Connections:

1. Type C connections shall be installed in a grossly slack "U" shape or a 360 loop.
2. Rigid conduit on the isolated-equipment side of the flexible connection, and the flexible connection itself, shall not be tied to the building construction or other rigid structures.

### 3.3 SEISMIC REQUIREMENTS

- A. Brace all electrical systems and items of equipment to withstand lateral and vertical forces that result from earthquakes. Refer to Part 1 of this section.
- B. Provide slack cable restraints and bracing for conduit and cable trays as follows:
  1. Conduit 2-1/2" in Diameter and Larger: Shall be braced per IBC.
  2. Conduit Smaller than 2-1/2" in Diameter: Comply with IBC requirements, including flexible connections between component and the conduit.
  3. Cable Trays with Weights Greater than 10 lbs/ft: Shall be braced per IBC.
- C. All electrical equipment and systems shall be provided with restraints and anchors adequate to withstand the applicable force factors per the International Building Code.
- D. Anchors and Equipment:
  1. Calculations: Calculations shall be certified by a Structural Engineer registered in the State of Georgia with experience in the design of seismic restraints.
- E. For conduits crossing seismic separations, provide approved fittings that permit horizontal expansion and vertical and angular deflection. Selection of fitting to be based on the dimension of the separation and conduit size.

### 3.4 SEISMIC REQUIREMENTS FOR LIGHTING FIXTURES

- A. Pendant Light Fixtures: Provide approved seismic fixture suspension allowing for 45° swing in all directions without impacting adjacent obstruction or structure. For stem-mounted fixtures, provide approved seismic ball aligners at fixture and outlet box, and 9-gauge steel wire in each stem and with the circuit conductors, continuous from the fixture housing, through the outlet box, and attach directly to the structure above. Do not use ceiling construction to directly support the fixture. Within the fixture housing, provide a mechanically crimped cable loop and secure to the housing with a closed eyebolt nut and lockwasher. At the structure above, provide a cable loop and closed eye threaded lag screws and steel wedge drilled anchors. Level and adjust fixtures and remove cable slack before attaching to the fixture housing.
1. Where pendant fixtures are indicated to be cable supported, provide 3/32" (minimum) stainless-steel aircraft cables, cable to rod swivel adapters, 1/4–20 rod extensions above the ceiling to the structure. Brace the rod seismically with a rod fitting and (3) 12-gauge steel wires extended from the rod to the structure at 120° angles.
  2. If a 45° swing cannot be achieved, brace fixtures to prevent contact with the adjacent obstruction or structure. All fixture suspension assemblies to be State of Georgia approved.
  3. Submit a sample of the seismic ball aligner and details of the cable attachments and assemblies with the fixture shop drawing submittal.
- B. Fixtures Installed In or On a Suspended Acoustical Ceiling System:
1. As a minimum, all lighting fixtures shall be positively attached to the suspended ceiling system. The attachment device shall have a capacity of 100% of the lighting fixture weight acting in all directions.
  2. In addition to the ceiling system support methods required by code, because the ceiling system is supporting light fixtures, provide (2) 12-gauge steel hanger wires from diagonal corners of the fixture housing to the structure above for fixtures weighing less than 56 pounds.
  3. Lighting fixtures weighing 56 pounds or more shall be supported directly from the structure above by approved hangers. Do not use the ceiling suspension system to directly support the fixture.
  4. Pendant hung lighting fixtures shall be supported directly from the structure above with 9-gauge steel wire, or an approved equivalent. Do not use the ceiling suspension system to directly support the fixture.
  5. Attach surface-mounted fixtures to main runners with a minimum of two approved clamping devices, 14-gauge minimum, and support each clamp from the ceiling structure with 10-gauge wire.

**END OF SECTION**

## **SECTION 26 05 53**

### **IDENTIFICATION**

#### **PART 1 - GENERAL**

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Requirements of the following Division 26 Sections apply to this Section:
  - 1. "Electrical Requirements."

##### 1.2 SUMMARY

- A. This Section includes identification of electrical materials, equipment, and installations. It includes requirements for electrical identification components including but not limited to the following:
  - 1. Buried electrical line warnings.
  - 2. Identification labeling for raceways, cables, and conductors.
  - 3. Operational instruction signs.
  - 4. Warning and caution signs.
  - 5. Equipment labels and signs.
- B. Related Sections: The following Sections contain requirements that relate to this Section;
  - 1. Division 9 Section "Painting" for related identification requirements.
  - 2. Division 26 Section "Electrical Power Conductors Cables" for requirements for color coding of conductors for phase identification.
- C. Refer to other Division 26 Sections for additional specific electrical identification associated with specific items.

##### 1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product Data for each type of product specified.
- C. Schedule of identification nomenclature to be used for identification signs and labels.

- D. Samples of engraved, plastic laminate to be used on switchgear, switchboards, disconnect switches and panelboards.

#### 1.4 QUALITY ASSURANCE

- A. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."
- B. ANSI Compliance: Comply with requirements of ANSI Standard A13.1, "Scheme for the identification of Piping Systems," with regard to type and size of lettering for raceway and cable labels.

### **PART 2 - PRODUCTS**

#### 2.1 ELECTRICAL IDENTIFICATION PRODUCTS

- A. Colored Adhesive Marking Tape for Raceways, Wires, and Cables: Self-adhesive vinyl tape not less than 3 mil thick by 1 inch to 2 inches in width.
- B. Underground Line Marking Tape: Permanent, bright-colored, continuous-printed, plastic tape with magnetic tracer strip not less than 6-inches wide by 4-mil thick. Printed legend indicative of general type of underground line below.
- C. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wrap around, cable/conductor markers with preprinted numbers and letters.
- D. Engraved, Plastic-Laminated Labels, Signs, and Instruction Plates: Engraving stock melamine plastic laminate, 1/16-inch minimum thick for sign up to 20 square inches, or 8 inches in length; 1/8-inch thick for larger sizes. Engraved legend in black letters on white face for normal power and white letters on red face for emergency and standby power. Plastic laminate shall be punched for mechanical fasteners. Refer to details on drawings for exact information requirements.
- E. Baked-Enamel Warning and Caution Signs for Interior Use: Preprinted aluminum signs, punched for fasteners, with colors, legend, and size appropriate to the location.
- F. Exterior Metal-Backed Butyrate Warning and Caution Signs: Weather-resistant, non-fading, preprinted cellulose acetate butyrate signs with 20-gage, galvanized steel backing, with colors, legend, and size appropriate to the location. Provide 1/4-inch grommets in corners for mounting.
- G. Fasteners for Plastic-Laminated and Metal Signs: Self-tapping stainless-steel screws or number 10/32 stainless-steel machine screws with nuts and flat and lock washers.
- H. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18-inch minimum width, 50-lb minimum tensile strength, and suitable for a temperature range from minus 50°F to 350°F. Provide ties in specified colors when used for color coding.

- I. Electronic Labels: Self-adhesive, 3/16-inch-industrial label, black on clear for normal circuits and red on clear for emergency/standby circuits. Acceptable manufacturers include the following:
  1. Brother
  2. Kroy

## **PART 3 - EXECUTION**

### 3.1 INSTALLATION

- A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and as required by code.
- B. Install identification devices in accordance with manufacturer's written instructions and requirements of NEC.
- C. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.

### 3.2 IDENTIFICATION

- A. Identify Junction, Pull, and Connection Boxes: Code-required caution sign for boxes shall be pressure-sensitive, self-adhesive label indicating system voltage in black, preprinted on orange background. Install on outside of box cover. Also, label box covers with identity of contained circuits. Use pressure-sensitive plastic labels at exposed locations and similar labels at concealed boxes.
- B. Underground Electrical Line Identification: During trench backfilling, for underground power, signal, and communications lines, install continuous underground plastic line marker, located directly above line at 6 to 8 inches below finished grade. Where multiple lines installed in a common trench or concrete envelope do not exceed an overall width of 16 inches; install a single line marker.
- C. Install line marker for underground wiring, both direct-buried and in raceway.
- D. Identify Raceways of Certain Systems with Color Banding: Band exposed or accessible raceways of the following systems for identification. Bands shall be painted with colors indicated below. Make each color band 2 inches-wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side. Install bands at changes in direction, at penetrations of walls and floors, and at 40-foot maximum intervals in straight runs. Apply the following colors:
  1. Fire Alarm Systems: Red.
  2. Fire Suppression Supervisory and Control System: Red and Yellow.
  3. Mechanical and Electrical Supervisory System: Green and Blue.
  4. Telephone System: Green and Yellow.
  5. Tag or label conductors as follows:

- a. Future Connections: Conductors indicated to be for future connection or connection under another contract with identification indicating source and intent.
  - b. Multiple Circuits: Where multiple branch circuits or control wiring or communications/signal conductors are present in the same box or enclosure label each conductor or cable. Provide label on each box indicating source, voltage, circuit number, and phase for branch circuit wiring. Phase and voltage of branch circuit wiring may be indicated by mean of coded color of conductor insulation. For control and communications/signal wiring, use color coding or wire/cable marking tape at terminations and at intermediate locations where conductors appear in wiring boxes, troughs, and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tapes.
  - c. Match identification markings with designations used in panelboards shop drawings, Contract Documents, and similar previously established identification schemes for the facilities' electrical installations.
- E. Install labels at locations indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.
- F. Conductor Color Coding: Provide color coding for secondary service, feeder, and branch circuit conductors throughout the project secondary electrical system as follows:

<u>208/120-Volts</u>	<u>Phase</u>	<u>480/277-Volts</u>
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray
Green	Ground	Green

- G. Use conductors with color factory-applied the entire length of the conductors except as follows:
- 1. The following field-applied color-coding methods may be used in lieu of factory-coded wire for sizes larger than No. 10 AWG:
    - a. Apply colored, pressure-sensitive plastic tap in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply the last two laps of tape with no tension to prevent possible unwinding. Use 1-inch-wide tape in colors as specified. Do not obliterate cable identification markings by taping. Tape locations may be adjusted slightly to prevent such obliteration.
    - b. In lieu of pressure-sensitive tape, colored cable ties may be used for color identification. Apply three ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal and spaced 3 inches apart. Apply with a special tool or pliers, tighten for snug fit, and cut off excess length.
  - 2. All grounded conductors No. 6 AWG and smaller shall be a factory applied color across the entire length of conductors.

- H. Power Circuit Identification:

1. Securely fasten wrap-around marker bands to cables, feeders, and power circuits in pull boxes, junction boxes, and switchgear rooms.
- I. Apply warning, caution, and instruction signs and stencils as follows:
1. Install warning, caution, or instruction signs where required by NEC where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.
  2. Emergency Operating Signs: Install engraved laminate signs with white legend on red background with minimum 3/8-inch-high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.
  3. Arc Flash Labels: All electrical equipment shall be marked with a label consisting of the following information:
    - a. Nominal voltage.
    - b. Available fault current at the equipment.
    - c. Clearing time.
    - d. Arc flash hazard boundary.
    - e. Flash hazard at 18".
    - f. PPE (Personnel protective equipment) level.
    - g. Distance of limited approach.
    - h. Distance of restricted approach.
    - i. Distance of prohibited approach.
    - j. Date label is applied or calculations were performed.
- J. Install equipment/system circuit/device identification as follows:
1. Apply equipment identification labels of engraved plastic-laminate on each major unit for electrical equipment in the arena including central or master unit of each electrical system. This includes communication/signal/alarm system, unless unit is specified with its own self-explanatory identification. Except as otherwise indicated, provide single line of text, with 3/8-inch-high lettering on 1-1/2-inch-high label (2-inch-high where two lines are required), black lettering in white field for normal power and red lettering on white field for emergency and standby power. Text shall match terminology and numbering of the Contract Documents and shop drawings. Apply labels for each unit of the following categories of electrical equipment:
    - a. Panelboards, electrical cabinets, and enclosures.
      - 1) Labels shall include at a minimum: voltage, phase, ampacity, AIC rating, available fault current (and when it was calculated) and where the equipment is fed from. **Refer to detail on drawings for additional information.**
    - b. Access doors and panels for concealed electrical items.
    - c. Electrical switchgear and switchboards.



- 1) Labels shall include at a minimum: voltage, phase, ampacity, AIC rating, available fault current and where the equipment is fed from. **Refer to detail on drawings for additional information.**
  - d. Motor starters, motor control centers.
  - e. Pushbutton stations.
  - f. Power transfer equipment.
  - g. Contactors.
  - h. Remote-controlled switches.
  - i. Dimmers.
  - j. Control devices.
  - k. Transformers.
- 1) Include on label, location of primary overcurrent protection device.
  - l. Power generating units.
  - m. Telephone switching equipment.
  - n. Fire alarm master station or control panel.
  - o. Lighting control panel.
  - p. Static uninterruptable power supply
2. Apply electronic label on the outside of all receptacle and switch plates. The labels shall identify circuit and panelboard.
3. All emergency circuits shall be permanently marked as emergency as indicated below:
  - a. Junction Boxes – with permanently fastened labels.
  - b. Raceways – with permanently fastened labels at intervals of not more than 25ft.
- K. Apply circuit/control/item designation labels of engraved plastic laminate for disconnect switches, breakers, pushbuttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm/signal components, where labeling is specified elsewhere. For panelboards, provide framed, typed circuit schedules with explicit description and identification (including room numbers) of items controlled by each individual breaker.
- L. Fire Pump Service Identification: A placard shall be externally installed on the Fire Pump primary disconnecting means stating, "Fire Pump Disconnecting Mean." The lettering shall be at least one inch in height. In addition, a placard shall be placed adjacent to the Fire Pump controller stating the location of this disconnecting means and the location of the key (if the disconnecting means is locked).
- M. Electrical Service Room Distribution Placard: In each of the main electrical rooms, provide a single line riser diagram placard of the entire electrical distribution fed from that room. The placard shall also identify where other services are located per NEC 230.2(e). The riser diagram shall be framed under glass and mounted on the wall in the electrical room. The print shall be of diffusion transfer process to eliminate fading.

**END OF SECTION**

## **SECTION 26 24 16**

### **PANELBOARDS**

#### **PART 1 - GENERAL**

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Division 26 Basic Electrical Material and Methods sections apply to work specified in this section.

##### 1.2 SUMMARY

- A. Provide all panelboards and enclosure work, including cabinets and cutout boxes, as indicated by drawings and schedules, and as specified herein.
- B. Types of panelboards, and enclosures required for the project include the following:
  - 1. Power-distribution panelboards.
  - 2. Lighting and appliance panelboards.
- C. All switchboards, panelboards, switchgears, transformers, disconnect switches, starters, etc., shall be fabricated by same manufacturer throughout the entire project unless specifically noted otherwise.
- D. Wires/cables, bus-way, electrical boxes and fittings, and raceways required in conjunction with the installation of panelboards, and enclosures are specified in other Division 26 sections.

##### 1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's data on panelboards, and enclosures.
- B. Wiring Diagrams: Submit wiring diagrams for panelboards showing connections to electrical power feeders and distribution branches.
- C. Submit electrical room plan view drawings at 1/4" scale showing all equipment, panelboards, disconnects and ratings, buss work, conduit areas, dimensions and mounting of equipment supplied.
- D. Shop drawings showing dimensions, voltage, phasing, continuous current capacity, and short circuit rating.
- E. The equipment product data, electrical room layouts and short-circuit study shall be submitted together in order to provide proper evaluation.

- F. Submittals shall be in accordance with specification section 26 05 00.

#### 1.4 QUALITY ASSURANCE

- A. **Manufacturer's Qualifications:** The manufacturer of this equipment shall be regularly engaged in manufacture of panelboards and enclosures, of types, sizes, and ratings required and have produced similar electrical equipment, for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- B. **Codes and Standards**
  - 1. **Electrical Code Compliance:** Comply with applicable local code requirements of the authority having jurisdiction and NEC Article 384 as applicable to installation, and construction of electrical panelboards and enclosures.
  - 2. **UL Compliance:** Comply with applicable requirements of UL 67, "Electric Panelboards", and UL's 50, 869, 486A, 486B, 891, and 1053 pertaining to panelboards, accessories and enclosures. Provide panelboard units which are UL-listed and labeled.
  - 3. **Special-Use Markings:** Provide panelboards, constructed for special-use, with appropriate UL markings which indicated that they are suitable for special type of use/application.
  - 4. **NEMA Compliance:** Comply with NEMA Standards Pub/No. 250, "Enclosure for Electrical Equipment (1000-Volts Maximum)", Pub/No. PB 1, "Panelboards", and Pub/No. PB 1.1, "Instructions for Safe Installation, Operation, and Maintenance of Panelboards Rated 600-Volts or Less".

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store panelboards in clean dry space. Protect units from dirt, fumes, water, construction debris and traffic; where necessary to store outdoors, store electrical components above grade and enclose with watertight wrapping.
- B. Handle panelboards carefully to prevent internal components damage, breakage, denting, and scoring enclosure finish. Do not install damaged components; replace and return damaged units to equipment manufacturer.

#### 1.6 SEQUENCING AND SCHEDULING

- A. Coordinate installation of panelboards and enclosures with installation of wires/cables, electrical boxes and fittings, and raceway work.

### **PART 2 - PRODUCTS**

#### 2.1 PANELBOARDS (800 AMPS OR LESS)

- A. **General:** Except as otherwise indicated, provide panelboards, enclosures and ancillary components, of types, sizes, and ratings indicated on drawings, which

comply with manufacturer's standard materials; with the design and construction in accordance with published product information; equip with proper numbers of unit panelboard devices as required for complete installation.

1. Prefabricated or pre-wired panelboards are not acceptable.
- B. Power Distribution Panelboards: Provide dead-front safety type power distribution panelboards as indicated, with panelboards switching and protective devices in quantities, ratings, types, and with arrangement shown; with anti-turn solderless pressure type main lug connectors approved for use with copper conductors. Select unit with feeders connecting at top of panel. Equip with copper buss bars with not less than 98% conductivity, and with full-sized neutral buss; provide suitable lugs on neutral bus for outgoing feeders requiring neutral connection. Provide molded-case main and branch circuit-breaker types for each circuit, with toggle handles that indicated when tripped. Where multiple-pole breakers are indicated, provide with common trip so overload on one pole will trip all poles simultaneously. Where multiple single pole breakers share a common neutral conductor, provide breaker tie bars as required so overload on one pole will trip all poles simultaneously. Provide panelboards with bare un-insulated grounding bars suitable for bolting to enclosures. Select enclosures fabricated by same manufacturers as panelboards, which mate and match properly with panelboards. Employ bolt on breakers that are fully rated for the available short-circuit condition but of not less than 22,000 sym AIC.
- C. Lighting and Appliance Panelboards: Provide dead-front safety type lighting and appliance panelboards as indicated, with switching and protective devices in quantities, ratings, types and arrangements shown. Equipped with anti-turn solderless pressure type lug connectors approved for use with copper conductors; construct unit for connecting feeders at top of panel; equip with copper buss bars, full-sized neutral bar, with bolt-in type heavy-duty, quick-make, quick-break, single-pole circuit breakers, with toggle handles that indicate when tripped. Provide suitable lugs on neutral buss for each outgoing feeder required; and provide bare uninsulated grounding bars suitable for bolting to enclosures. Select enclosures fabricated by same manufacturers as panelboards, which mate and match properly with panelboards.
1. Employ breakers that are fully rated for the available short-circuit condition but not less than 10,000 sym AIC at 120/208-Volts; and 14,000 sym AIC at 277/480-Volts.
  2. Where multiple single pole breakers share a common neutral conductor, provide breaker tie bars as required so overload on one pole will trip all poles simultaneously.
  3. All circuit breakers feeding food service loads or vending machines shall be GFCI type.
- D. Panelboard Enclosures: Provide galvanized sheet steel cabinet type enclosures, in sizes and NEMA types as indicated, code-gage, minimum 16-gage thickness. Construct with multiple knockouts and wiring gutters. Provide fronts with adjustable trim clamps, and doors with flush locks and keys, all panelboard enclosures keyed alike, with concealed piano door hinges with door in door swings as indicated. Equip with interior circuit-directory frame, and card with clear plastic covering. Provide baked gray enamel finish over a rust inhibitor coating. Design enclosures for surface mounting. Provide enclosures which are fabricated by same manufacturer as panelboards, which mate and match properly with panelboards to be enclosed.

- E. Molded-Case Circuit Breakers: Provide factory-assembled, molded-case circuit breakers of frame sizes, characteristics, and ratings including RMS symmetrical interrupting ratings indicated. Select breakers with permanent thermal and instantaneous magnetic trip, and ampere ratings as indicated on the drawings. Construct with overcenter, trip-free, toggle-type operating mechanisms with quick-make, quick-break action and positive handle trip indication. Construct breakers for mounting and operating in any physical position, and operating in ambient temperature of 40°C. Provide breakers with mechanical screw or compression type removable connector lugs, AL/CU rated. The breakers for 277/480V panelboards shall be industrial grade; breakers that allow or direct particles of combustion resulting from fault conditions out of the breaker are not acceptable, they shall be contained within its casing. For example; GE AE series panelboards with TEY circuit breakers are not acceptable, TED breakers are acceptable.
1. Breakers feeding the primary side of a transformer shall have provisions for locking the breaker on or off.
- F. Emergency and Standby Fused Lighting and Appliance Coordination Type Panelboard
1. Provide dead front safety type fused coordination panelboard(s) with overcurrent and switching devices consisting of series connected branch circuit breakers, lockable in the OFF position and Class CC or Class J fuses in rejection dead-front fuse holders. Provide with copper bussing throughout.
  2. Panelboard shall have voltage and current ratings as specified on the drawings including:
    - a. 120/208V, 3PH, 4W
    - b. 120/240V, 1PH, 3W
    - c. 277/480V, 3PH, 4W
  3. Panelboard shall have been successfully tested for a short-circuit-current-rating of at least 100,000 amps AC RMS symmetrical at the specified voltage on the drawing.
  4. Panelboard shall be selectively coordinated with all upstream overcurrent protective devices in accordance with NEC 700.27, 701.18, 517.26 and 708.54.
  5. Refer to project panel schedules for the panelboard circuit configuration, bus capacity, voltage, branch device sizes, enclosure type, mounting, rating, type of mains, etc.
  6. Panelboard may require main circuit breaker or provide with Class T Main Fuse Switch ampere ratings is specified on the drawing.
  7. Bus bars shall be tin-plated copper with sufficient cross sectional area to meet UL 67 temperature rise requirements. Provide fully rated neutral bar. Lugs on neutral and ground bars shall be sized to accommodate required feeders.
  8. All panels fed from the emergency distribution shall accommodate an external Surge Protective Device (SPD). Refer to section 26 43 14.
  9. Refer to 26 05 03 for acceptable manufacturers.

### **PART 3 - EXECUTION**

#### 3.1 EXAMINATION

- A. Examine area and conditions under which panelboards and enclosures are to be installed, and notify Engineer in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

- A. Install panelboards and enclosures as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC standards and NECA's "Standards of Installation" and in compliance with recognized industry practices to ensure that products fulfill requirements.
- B. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturers' published torque tightening values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals to comply with torque tightening requirements specified in UL Standards 486A and B.
- C. Fasten enclosures firmly to walls and structural surfaces, ensuring that they are permanently and mechanically anchored.
- D. Provide properly wired electrical connections for panelboards within the enclosures.
  - 1. Prefabricated or pre-wired panelboards are not acceptable.
- E. Provide engraved, plastic laminate labels for all panelboards indicating name, voltage, phase, wire and short circuit rating. Refer to Section 26 05 53 for more information.
- F. At all recessed panel locations, provide three 3/4" spare conduits stubbed to the accessible ceiling space for future use.
- G. Provide typed panelboards circuit directory card upon completion of installation work to match as-built conditions and nomenclature indicated on engineering drawings and submit directories to the Engineer for review prior to mounting in panelboard.

#### 3.3 GROUNDING

- A. Provide equipment grounding connections as indicated herein. Tighten connection to comply with torque tightening requirements specified in UL Standard 486A to assure permanent and effective grounds.
- B. Refer to Section 26 05 26 for additional grounding requirements.

### 3.4 FIELD QUALITY CONTROL

Tests shall conform to International Electrical Testing Association (INETA) Standard ATS, "Acceptance Testing Specifications for Electrical Power Distribution Equipment".

#### A. Infrared Inspection (After Energized)

1. The scan is to include all electrical panelboards or bussed distribution equipment.
2. All equipment should be energized at normal load levels during an event for at least 1 to 2 hours prior to being scanned.
3. Access covers are to be removed and reinstalled by the electrical Contractor for the testing agency to inspect and scan all electrical junctions, buss, and cable.
4. The IR Scan will be made using a Flir Thermal Imaging Camera. The camera shall provide infrared photos clearly indicating problem areas.
5. All problem areas will be noted as to location, description, and recommended solution by providing a typed report including infrared and digital pictures of all problem areas.

#### B. Panelboards:

1. Visual and Mechanical Inspection:
  - a. Inspect for physical damage and code violations.
  - b. Inspect for proper alignment, anchorage and grounding.
  - c. Inspect for proper identification of protective devices and switches.
  - d. Check tightness of accessible bolted buss joints.
  - e. Physically test all electrical or mechanical interlocks to assure proper function.
  - f. Clean interior and insulator surfaces once a month prior to job completion.
  - g. Inspect for proper operation of space heaters and thermostat settings (if they exist).
2. Electrical Tests:
  - a. Measure insulation resistance of each buss section phase-to-phase and phase-to-ground.
  - b. Check panelboards for electrical continuity of circuits and for short circuits.

### 3.5 ADJUSTING AND CLEANING

- A. Adjust operating mechanisms for free mechanical movement.
- B. Touch-up scratched or marred surfaces to match original finishes.

3.6 DEMONSTRATION

- A. Subsequent to wire and cable hook-ups, energize and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

**END OF SECTION**



## **SECTION 26 27 26**

### **WIRING DEVICES**

#### **PART 1 - GENERAL**

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Requirements of the following Division 26 Sections apply to this section.

##### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Receptacles
  - 2. Ground-Fault Circuit-Interrupter Receptacles
  - 3. Plugs
  - 4. Plug Connectors
  - 5. Snap Switches
  - 6. Incandescent Lamp Load Specific Dimmers
  - 7. Wall Plates
  - 8. Occupancy Sensors
  - 9. Floor Boxes
- B. Related Sections: The following sections contain requirements that relate to this section:
  - 1. Division 26 Section "Motor Disconnects and Fuses" for devices other than snap switches and plug/receptacle sets used as disconnects for motors.

##### 1.3 SUBMITTALS

- A. Product data for each type of product specified.
- B. Shop Drawings / Architectural Coordination Requirements:
  - 1. Floor box locations and types indicated on drawings are schematic in nature and are not dimensioned locations. Contractor shall submit shop drawings and product data for final review and comment by the Architect, Owner, and Engineer, to ensure desired aesthetics are achieved.
  - 2. Shop drawings shall include the following detailed information:
    - a. Placement: Dimensioned floor box placement shown on floor plan with current furniture layer shown.

- b. Conduit: Show all conduit size and routing with labels for power, data, AV, etc.
    - c. Covers: Specific labels or notes to indicate where different cover types and finish are to be used, if applicable.
  - C. Occupancy Sensors Wired
    - 1. Submit a lighting plan clearly marked by manufacturer identifying product type, locations, orientation and coverage for each sensor.
    - 2. Submit any interconnection diagrams per major subsystems showing proper wiring.
  - D. Occupancy Sensor Wireless
    - 1. Submit a lighting plan clearly marked by manufacturer identifying product type, locations, orientation and coverage for each sensor.
- 1.4 QUALITY ASSURANCE
  - A. Regulatory Requirements: Comply with provisions of the following codes.
    - 1. NFPA 70 "National Electrical Code."
  - B. UL and NEMA Compliance: Provide wiring devices which are listed and labeled by UL, Federal Specification and comply with applicable UL and NEMA standards.
    - 1. UL 943
- 1.5 SEQUENCE AND SCHEDULING
  - A. Schedule installation of finish plates after the surface upon which they are installed has received final finish.

## **PART 2 - PRODUCTS**

- 2.1 WIRING DEVICES
  - A. General: Provide wiring devices, in types, characteristics, grades, colors, and electrical ratings for applications indicated which are UL listed and which comply with NEMA WD 1 and other applicable UL and NEMA standards.
  - B. Color of Devices: Color of all devices shall be coordinated with the Architect, except special purpose devices shall be black, emergency power system devices which shall be red, corrosion-resistant devices which shall be yellow, or isolated ground devices which shall be orange.
  - C. Receptacles: As scheduled in Table 1 in Part 3 indicated herein. Comply with UL 498 and NEMA WD 1 and WD 6. Damp and wet location receptacles to be listed as weather resistant. Plug tail devices are not acceptable.

- D. Receptacles, Industrial Heavy Duty: Provide pin and sleeve design receptacles conforming to UL 498. Comply with UL 1010 where installed in hazardous locations. Provide features indicated.
  - E. Receptacles, USB charging type: 2 port, 5 Amp minimum, 5-Volt D.C, WR rated as required.
  - F. Receptacles, Automatic Receptacle Control required by energy code. Provide receptacles which are marked according to NEC 406.3.
  - G. Ground-Fault Circuit-Interrupter (GFCI) Receptacles: As scheduled in Table 1 in Part 3 indicated herein: Provide "terminal" or feed-through type ground fault circuit interrupter, as indicated on drawings, with integral heavy-duty NEMA 5-20R duplex receptacles. Provide unit designed for installation in a 2-3/4-inch-deep outlet box without adapter, grounding type, Class A, Group 1 per UL Standard 943 including self-testing.
  - H. Snap Switches: As scheduled in Table 2 in Part 3 indicated herein.
  - I. Wall Dimmer: As scheduled in Table 2 in Part 3 indicated herein.
    - 1. Incandescent wall dimmers shall be 120-Volt, solid state type with slide control handle, preset button and semi-flush mounting. Dimmers shall be sized to continuously carry the load they are connected to, the minimum size shall be 1000 watts, and shall be rated larger if indicated on the drawings or required to serve the load.
    - 2. Dimmers indicated on the drawings to serve low-voltage incandescent lamps shall be the same as specified for incandescent lamps and in addition shall be specifically rated for the low-voltage transformer load. Dimmer shall be UL listed for use with low-voltage fixtures.
    - 3. Dimmers indicated to serve fluorescent lamps shall be 120v or 277v, as required for circuit served, solid state type for use with fluorescent dimming ballasts. Control shall be slide handle and dimmer shall be for semi-flush mounting.
    - 4. Dimmers indicated to serve 0-10V loads shall be 120V or 277V, as required for circuit served, solid state type for use with 0-10V ballasts/drivers. Control shall be slide handle and dimmer shall be for semi-flush mounting.
    - 5. All dimmers shall be of the same manufacturer. Faceplate shall be the same color as device plates specified.
  - J. All exterior weatherproof receptacles located on the roof, receptacles located in elevator pits and machine rooms shall be GFCI type or GFCI protected and have cast metallic "in use" covers.
  - K. All devices shall be premium specification grade.
- 2.2 WIRING DEVICE ACCESSORIES
- A. Wall Plates: Single and combination, of types, sizes, and with ganging and cutouts as indicated. Provide metal screws for securing plates to devices with screw heads colored to match finish of plates. Provide plates possessing the following additional construction features:

1. Material and Finish: 0.03-inch-thick, type 302 satin finished stainless steel. Plate shall be Hubbell "S" Series or approved equal.
2. Emergency receptacles shall have red cover plates.

- B. For all devices installed which are exposed to the weather, moisture or where indicated on the drawings, device plates shall be weatherproof. Device cover plates shall be cast metallic in-use type with gasketing to prevent entrance of moisture when closed.

### 2.3 OCCUPANCY SENSORS

- A. General: Layouts shown on plan drawings are intended to show general control concepts (i.e. wall sensors, ceiling sensors, or switch sensor) for an area. The contractor shall provide sensor coverage of the entire space based on the concept shown, as well as all other devices required (power packs, control wiring, switching, etc.) for a complete and working system. Low-voltage switching to allow local override of the sensors shall be provided at all entries to areas shown as controlled by ceiling or wall-mounted sensors. In areas that require two or more sensors for full coverage, the sensors shall be interconnected together to provide a single switching zone for the entire space, regardless of the number of circuits.
- B. Wall switch sensor shall be capable of detection of occupancy up to 300 square feet and gross motion up to 1000 square feet. Wall switch sensors shall accommodate loads from 0 to 800 watts at 120-Volts, 0 to 1200 watts at 277-Volts and shall have 180° coverage capability. All wall switches shall utilize zero crossing circuitry, field deselectable option (automatic – on to manual on).
- C. Wall dimmer sensor shall be capable of detection of occupancy up to 300 square feet and gross motion up to 1000 square feet. Wall dimmer sensor shall accommodate loads from incandescent, halogen, MLV, ELV and 0-10V.
- D. Ceiling-mounted sensors shall be dual technology (passive infrared and ultrasonic). The sensor shall offer day lighting foot candle adjustment control and be able to accommodate dual level lighting. Sensors shall be immune to false triggering from RFI and EMI.
- E. All sensors shall utilize automatically adjustable time delay and sensitivity settings. Settings shall be located on sensor.
- F. In the event of failure, a bypass override shall be provided on each sensor. When bypass is utilized, lighting shall remain on constantly or control shall diver to a wall switch until sensor is replaced. This control shall be recessed to prevent tampering.
- G. All sensors shall provide an LED as a visual means of indication at all times to verify that motion is being detected during both test and normal operation.
- H. Sensors shall have an internal additional isolated relay with normally open, normally closed and common outputs for use with HVAC control, data logging and other control options.

## 2.4 FLOOR BOXES

### A. General Information:

1. Poke Thrus and Cast-in-place floor boxes shall be manufactured with all metal die-cast aluminum construction or steel with die-cast aluminum covers. Devices shall be designed to fit in core hole opening or be cast in place.
2. Covers shall be manufactured with all metal die-cast aluminum or solid metal finish construction. At a minimum, device cover shall be available in the following options; *Black, Gray, Nickel, Brass, Bronze and Brushed Aluminum*.
3. Miscellaneous: Specific device mounting plates and bottom housing assemblies shall be provided for various applications. Contractor shall be load rated for 1000 pounds and provide all components per drawings and/or manufacturer recommendations for a complete solution. Refer to Power and/or Technology drawing details for additional information.

### B. Poke-Thru Device (Power / Low Voltage)

1. Application: Elevated slab floor mounted device locations and Modular Furniture Feed floor mounted device locations, as applicable. 6-inch poke-thru shall be used for power only or power/data locations. 8-inch poke-thru shall be used (as applicable) for any locations with AV connectivity.
2. Fire Rating: Poke Through shall be UL listed for use in 2 hour fire rated floors (minimum).
3. Conduit Openings: Poke Thru shall have through floor fitting with a minimum of (1) 3/4-inch conduit for power and pass through channels for low-voltage cabling.
4. Flexible Conduit Feed: Black 2-inch Polytuff flexible conduit shall be provided to extend low-voltage device cabling from floor box knock-out to modular furniture, as applicable.

Products: Refer to Appendix 1 Floor Box Equipment Schedules for a list of benchmark manufacturer's part numbers.

### C. Cast-in-place Furniture Feed Floor Box (Power / Low Voltage)

1. Application: Cast-in-place or slab on grade furniture feed device locations.
2. Compartments: 2-compartment floor box to support power and low-voltage systems such as voice/data.
3. Fire Rating: No Rating.
4. Conduit Openings: Each compartment of floor box shall have knock-outs ranging from 3/4 inch (for power) up to 2 inch (for low-voltage cabling).
5. Flexible Conduit Feed: Black 2-inch Polytuff flexible conduit shall be provided to extend low-voltage device cabling from floor box knock-out to modular furniture, as applicable.

Products: Refer to Appendix 1 Floor Box Equipment Schedules for a list of benchmark manufacturer's part numbers.

### D. Cast-in-place Floor Box (Power / Low Voltage)

1. Application: Cast-in-place or slab on grade floor box locations.
2. Compartments: 4-compartment floor box to support power and low-voltage systems such as voice/data.
3. Fire Rating: No Rating.

4. Conduit Openings: Each compartment of floor box shall have knock-outs ranging from 3/4 inch (for power) up to 1-1/4 inch (for low-voltage cabling).

Products: Refer to Appendix 1 Floor Box Equipment Schedules for a list of benchmark manufacturer's part numbers.

E. AV Cast-in-place Floor Box (Power / Low Voltage)

1. Application: Cast-in-place or slab on grade floor box locations with AV components.
2. Compartments: 6-compartment floor box to support power and low-voltage systems such as voice/data and audio/visual.
3. Fire Rating: No Rating.
4. Conduit Openings: Each compartment of floor box shall have knock-outs ranging from 3/4 inch (for power) up to 2 inch (for low-voltage cabling).

Products: Refer to Appendix 1 Floor Box Equipment Schedules for a list of benchmark manufacturer's part numbers.

F. Recessed Floor Box for Raised Floors (Power / Low Voltage)

1. Application: Floor box device location within a raised floor.
2. Fire Rating: No Rating.
3. Conduit Openings: Floor box shall have fitting with a minimum of (1) 3/4-inch conduit for power and a minimum of (1) 1" conduit for low-voltage cabling.

Products: Refer to Appendix 1 Floor Box Equipment Schedules for a list of benchmark manufacturer's part numbers.

## 2.5 FURNITURE FEED SERVICE POLES

A. Aluminum Service Poles

1. Service Pole: Service Poles shall be manufactured with durable extruded aluminum and shall have multiple Style Line openings.
2. Device Channels: Service Poles shall be dual channel to accommodate power and low-voltage cabling. The low-voltage (back) channel shall incorporate an access panel that provides a passageway to two Style Line low-voltage knockouts located on the front of the pole.
3. Finish Material: Exact material finish for each specific location shall be coordinated with the Owner, Architect and Engineer during the submittal process, prior to purchase and installation, to ensure the desired aesthetics are achieved. Service poles shall be available in the following finish options as a minimum:
  - a. Gray
  - b. Ivory
  - c. Satin Finish
  - d. White
  - e. Black
4. T-bar Assembly: Provide adjustable T-bar assembly (as required) for mounting poles in the middle of a ceiling tile.

5. Low-Voltage Style Line Outlet Frames: Refer to Technology "Horizontal Cabling" specifications for requirement on voice/data outlet types and mounting plate to be installed within Style Line opening for the service poles.
6. Products:
  - a. Service Pole: Hubbell #HBLPPxxx (xxx = length and finish) or approved equal.
  - b. T-Bar Assembly: Hubbell #ATB

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION OF WIRING DEVICES AND ACCESSORIES**

- A. Install wiring devices and accessories as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and in accordance with recognized industry practices to fulfill project requirements.
- B. Coordinate with other work, including painting, electrical boxes and wiring installations, as necessary to interface installation of wiring devices with other work.
- C. The mounting height of devices is indicated in the legend on the drawings. Where finished walls are exposed concrete block, brick or tile, the height shall be adjusted to allow outlet box for device to be mounted at a joint.
- D. Receptacles above countertops shall be installed with major axis horizontal above the backsplash.
- E. Install GFCI receptacles or GFCI breakers in all areas as required per NEC 210.8, including but not limited to bathrooms, kitchens, rooftops, outdoors, within 6 feet of a sink, locker rooms, garages, crawl spaces and unfished occupied areas of basements.
- F. Install tamper resistance on 15& 20A 120V receptacles in all areas as required per NEC 406.12, including but not limited:
  1. Business offices, corridors, waiting rooms and the like in clinics.
  2. Public areas of assembly occupancies.
- G. Mount all devices within outlet boxes to allow device plates to be in contact with wall on all sides. Align devices with major axis of device parallel to adjacent predominant building feature, i.e., door frames or countertops.
- H. Install wall switches on the strike side of doors.
- I. Install wiring devices only in electrical boxes which are clean; free from building materials, dirt, and debris.
- J. Provide a current carrying conductor, neutral, equipment grounding conductor and an insulated grounding conductor to each isolated ground "IG" receptacle.
- K. Install galvanized steel wall plates in unfinished spaces.

- L. Install wiring devices after wiring work is completed.
- M. Install wall plates after painting work is completed.
- N. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for wiring devices. Where manufacturer's torque requirements are not indicated, tighten connectors and terminal to comply with tightening torque requirements specified in UL Standard 486A. Use properly scaled torque indicating hand tool.
- O. Provide hardwire connection to all modular furniture system power entry cables.

3.2 PROTECTION

- A. Protect installed components from damage. Replace damaged items prior to final acceptance.

3.3 FIELD QUALITY CONTROL

- A. Testing: Prior to energizing circuits, test wiring for electrical continuity, and for short-circuits. Ensure proper polarity of connections is maintained. Subsequent to energizing test wiring devices and demonstrating compliance with requirements, operate each operable device at least six times.
- B. Test ground-fault interrupter operation with both local and remote fault simulations in accordance with manufacturer recommendations.

C. TABLE 1

RECEPTACLES

<b>Designation (1)</b>	<b>Current Rating Amps</b>	<b>Voltage Rating</b>	<b>Single/Duplex</b>	<b>NEMA Config.</b>	<b>Hubbell Catalog #(3)</b>	<b>Notes</b>
-	20	125	Duplex	5-20R	HBL5362	-
-	20	125	Single	5-20R	HBL5361	-
-	20	125	Duplex	5-20R	HBL5362C2	(7)
U (USB)	20	125	Duplex	5-20R	USB20AC5	(6)
IG	20	125	Duplex	5-20R	IG5362	Isolated Ground
WP	20	125	Duplex	5-20R	GFR5362SG/ WP826 (4)	In Use Weather-proof
GFCI	20	125	Duplex	5-20R	GF5362SG	Integral GFCI (2)
-	20	125	Duplex	5-20R	HBL5362SA	Surge Suppression
-	20	125	Duplex	5-20R	HBL8300SGA	Tamperproof

NOTES



1. Letter designations are used where symbols alone do not clearly designate on plans locations where specific receptacle types are used.
2. Protecting downstream receptacles on same circuit is not acceptable.
3. Refer to Section 26 05 03 for additional acceptable manufacturers. Color of device shall be verified with Architect (ivory, gray, white, etc.). All emergency receptacles shall be red.
4. Where required per NEC or local code, provide Hubbell 'WP26E' in-use water-proof cover for two-gang devices.
5. Where receptacles are located in damp or wet locations per article 406 in the National Electric Code, provide receptacles that are listed weather resistant. Use Hubbell HBL5362WR or approved equal receptacles where GFCI is not required at the receptacle location. Use Hubbell GFR5362 or approved equal where GFCI is required at the receptacle location.
6. Provide USB20AC5WR as required where weather resistance is needed.
7. Controlled receptacles shall be marked with power symbol and labeled as "Controlled" as required by the NEC 406.3E.

D. TABLE 2

SNAP SWITCHES

<b>Designation (1)</b>	<b>Typical Application</b>	<b>Load Rating</b>	<b>Voltage Rating (AC)</b>	<b>Poles</b>	<b>Hubbell Catalog # (3)</b>	<b>Notes</b>
S	Control Lights	20A	120/277	1	HBL1221	-
S3	Control Lights	20A	120/277	3-way	HBL1223	-
S4	Control Lights	20A	120/277	4-way	HBL1224	
Sp	Switch and Pilot Light	20A	120/277	1	HBL1221PL	(2)
Sk	Key Switch	20A	120/277	1	HBL1221L	
Swp	Wp Switch and Cover Plate	20A	120/277	1	HBL1281/HBL 1750	

NOTES

1. For snap switches, designation is the same as the symbol used on plans for the device. Type of switch is determined from plan context including type of device or circuit being controlled.
2. Pilot light "on" when switch is "on."
3. Hubbell basis of design. Refer to Section 26 05 03 for additional acceptable manufacturers. Color of device shall be verified with Architect (black, gray, white, etc.).

E. TABLE 3

WALL BOX SENSORS/DIMMER SWITCHES

<b>Load Type (1)</b>	<b>Load Rating</b>	<b>Voltage Rating (AC)</b>	<b>Lutron Part # (2)</b>	<b>Notes</b>
Occ/Vac Sensing 0-10v Dimmer	8A	120/277	MRF2S-8SD010-XX	

<b>Load Type (1)</b>	<b>Load Rating</b>	<b>Voltage Rating (AC)</b>	<b>Lutron Part # (2)</b>	<b>Notes</b>
Occ/Vac Sensing Switch	8A	120/277	MRF2S-8SS-XX	
Switch	8A	120/277	MRF2S-8S-DV-XX	
CFL/LED Incandescent/ML V Dimmer	150W CFL/LED 600W Inc/MLV	120	MRF2S-6CL-XX	
Incandescent/ML V Dimmer	600W	120	MRF2S-6ND-120-XX	
ELV Dimmer	150W LED 600W ELV	120	MRF2S-6ELV120-XX	

**NOTES**

1. Provide dimmer wattage size to handle load served. Derate dimmer switch per manufacturer's recommendations where dimmers are ganged together. Provide dimmer model as required based on application, i.e., voltage rating, load, and load type.
2. Lutron basis of design. Refer to Section 26 05 03 for additional acceptable manufacturers. Color of device shall be verified with Architect (black, gray, white, etc.).

**END OF SECTION**

**APPENDIX 1 - FLOOR BOX EQUIPMENT SCHEDULE**

NOTES:

1. This specification is intended to be performance based, thus all products listed in the table below are benchmark products. Hubbell's equivalent products are acceptable. Contractor may propose other alternate manufacturers and/or models, but alternates are subject to approval by the Owner, Engineer, and/or Architect.
2. Contractor shall provide complete solution including all necessary components for installation of power and low-voltage systems. Refer to power and low-voltage drawings and/or drawing details and manufacturer recommendations for additional information.

<b>Table 3.1 - Poke-Thru Floor Boxes</b>			
<b>Item</b>	<b>Part Name/Description</b>	<b>Manufacturer</b>	<b>Part Numbers</b>
1	6-inch Poke-Thru Device	Legrand / Wiremold	6ATCFFxx, 6ATC2Pxx, 6AT2Pxx, 6PPS
2	6-inch Poke-Thru Center Mount Device Plates	Legrand / Wiremold	6B (blank), 6ACT8A (data)
3	8-inch Poke-Thru Device	Legrand / Wiremold	8ATC2Pxx, 8AT2Pxx, 8PPS
4	8-inch Poke-Thru Center Mount Device Plates	Legrand / Wiremold	8B (blank), 8ACT8A (data)

<b>Table 3.2 - Cast-in-Place Furniture Feed Floor Boxes</b>			
<b>Item</b>	<b>Part Name/Description</b>	<b>Manufacturer</b>	<b>Part Numbers</b>
1	Cast-in-place Furniture Feed (Power / Low Voltage)	Legrand / Wiremold	EFBFF-OG
2	Furniture Feed Floor Box Cover	Legrand / Wiremold	FPFFTCxx
3	Furniture Feed Floor Box Accessories (Divider, etc.)	Legrand / Wiremold	EFBFF-DIV

<b>Table 3.3 - Cast-in-Place Floor Boxes</b>			
<b>Item</b>	<b>Part Name/Description</b>	<b>Manufacturer</b>	<b>Part Numbers</b>
1	Cast-in-place Floor Box (Power / Low Voltage)	Legrand / Wiremold	RFB Series-OG (RFB4E-OG)
2	Floor Box Cover	Legrand / Wiremold	6CTC2xx, 6CT2Cxx
3	Floor Box Accessories (Low-Voltage mounting plates, Divider, etc.)	Legrand / Wiremold	Submit for approval (Refer to drawing details)

<b>Table 3.4 - AV Cast-in-Place Floor Boxes</b>			
<b>Item</b>	<b>Part Name/Description</b>	<b>Manufacturer</b>	<b>Part Numbers</b>
1	AV Cast-in-place Floor Box (Power / Low Voltage)	Legrand / Wiremold	EFB8S-OG
2	AV Floor Box Cover	Legrand / Wiremold	EFB610BTxx, EFB610CTCxx
3	AV Floor Box Accessories (Low-Voltage mounting plates, Divider, etc.)	Legrand / Wiremold	Submit for approval (Refer to drawing details)

<b>Table 3.5 - Floor Boxes for Raised Floors</b>			
<b>Item</b>	<b>Part Name/Description</b>	<b>Manufacturer</b>	<b>Part Numbers</b>
1	Recessed Floor Box for Raised Floors (Power / Low Voltage)	Legrand / Wiremold	CRFB Series
2	Floor Box Cover (Raised Floors)	Legrand / Wiremold	8CTCxx, 8CTxx

<b>Table 3.5 - Floor Boxes for Raised Floors</b>			
<b>Item</b>	<b>Part Name/Description</b>	<b>Manufacturer</b>	<b>Part Numbers</b>
3	Floor Box Accessories (Low-Voltage mounting plates, Divider, etc.)	Legrand / Wiremold	Submit for approval (Refer to drawing details)

## **SECTION 26 28 16**

### **ENCLOSED SWITCHES, FUSES AND CIRCUIT BREAKERS**

#### **PART 1 - GENERAL**

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Section 26 05 02, "Basic Material and Methods", applies to work of this section.

##### 1.2 SUMMARY

- A. Provide all circuit and motor disconnect switch work including fusing, electrical connections to motors, appliance and mechanical equipment as indicated on the drawings and schedules.
- B. Types of circuit and motor disconnect switches in this section include the following:
  - 1. Equipment disconnects.
  - 2. Appliance disconnects.
  - 3. Motor-circuit disconnects.
- C. Applications of electrical power connections specified in this section include the following:
  - 1. To resistive heaters.
  - 2. From electrical source to motor starters.
  - 3. From motor starters to motors.
  - 4. To lighting fixtures.
  - 5. To converters, rectifiers, transformers, inverters, rheostats, and similar current adjustment features of equipment.
  - 6. To grounds including earthing connections.
  - 7. To panelboards, contactors, time clocks and similar equipment.
  - 8. Enclosed busway plug-in assemblies.
- D. All switchboards, panelboards, transformers, disconnect switches, starters, etc., shall be fabricated by same manufacturer throughout the entire project.

##### 1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's data on circuit and motor disconnect switches, and equipment connectors.

- B. Fuse Product Data: For each type of fuse 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. Fuse sizes for elevator feeders and elevator disconnect switches.

#### 1.4 QUALITY ASSURANCE

- A. All equipment shall be in compliance with codes and standards referenced in Section 26 05 00 titled "Electrical Requirements".
- B. UL Compliance: Comply with requirements of UL 98, "Enclosed and Dead-Front Switches." Provide circuit and motor disconnect switches which have been UL listed and labeled.
- C. Comply with UL Standard 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors," including, but not limited to, tightening of electrical connectors to torque values indicated.
- D. NEMA Compliance: Comply with applicable requirements for NEMA Standards Pub/No. KS 1, "Enclosed Switches," and No. 250, "Enclosures for Electrical Equipment (1000-Volts Maximum)."
- E. ANSI Compliance: Comply with applicable requirements of ANSI C97.1, "Low-Voltage Cartridge Fuses 600-Volts or Less."
- F. NEMA Compliance: Comply with NEMA FU1 for cartridge fuses.

#### 1.5 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

## **PART 2 - PRODUCTS**

### 2.1 CIRCUIT AND MOTOR DISCONNECT SWITCHES

- A. Furnish and install safety switches as required for motor outlets or other equipment. Switches shall be of size, number of poles, and fused or non-fused, as required for job conditions and the National Electrical Code.
- B. Switches shall be equipped with fuse contacts and jaws which ensure positive fuse and jaw contact by means of reinforcing spring clips or other approved means. All current carrying parts shall be silver-plated. Hinges shall be non-current carrying. Switches shall be so designed that they can be locked in either open or closed position.
- C. All safety switches shall be NEMA 1 enclosed Type "HD" (heavy duty) quick-make, quick-break, and have interlocking cover with handle that may either be front or side operating with padlocking provisions. Provide NEMA 3R weatherproof enclosures where indicated on the drawings or exposed to exterior or damp locations. Incorporate rejection clips where used with Class "R" fuses.
- D. Fusible Switches: Heavy duty switches, with fuses of classes and current ratings indicated on drawings. See Section "2.3" for Fuse specifications. Where current limiting fuses are indicated, provide switches with non-interchangeable feature suitable only for current limiting type fuses.
- E. Non-fusible Disconnects: Heavy duty switches of classes and current ratings as indicated on drawings.
- F. Double-Throw Switches: Heavy duty switches of classes and current rating as indicated on drawings.
- G. Bolted Pressure Switches: Bolted pressure switches conforming to and listed under UL Standard 977; single or double-throw arrangement as indicated. For fusible units provide fuses as indicated on drawings.
- H. Accessories:
  - 1. Electrical Interlocks: Provide number and arrangement of interlock contacts in switches as indicated on drawings or specified elsewhere in specifications.
  - 2. Special Enclosure Material: Provide special enclosure material as follows for switches indicated on drawings to be NEMA 4X:
    - a. Stainless Steel Type 316.
    - b. Heavy case aluminum.
  - 3. Captive Fuse Pullers: Provide built-in pullers arranged to facilitate fuse removal.

### 2.2 CONNECTIONS FOR EQUIPMENT

- A. General: For each electrical connection indicated provide complete assembly of materials, including but not necessarily limited to, pressure connectors, terminals

(lugs), electrical insulating tape, electrical solder, electrical soldering flux, heat-shrinkable insulating tubing, cable ties and solderless wirenuts. All other items and accessories as needed to complete splices and terminations of types indicated.

B. Metal Conduit, Tubing and Fittings:

1. General: Provide metal conduit, tubing and fitting of types, grades, sizes and weights (wall thicknesses) indicated for each type service. Where types and grades are not indicated, provide proper selection as determined by Installer to fulfill wiring requirements and comply with NEC requirements for raceways. Provide products complying with Section 26 05 02 titled "Basic Materials and Methods" and Section 26 05 33 titled "Raceways and Boxes" and in accordance with the following listing of metal conduit, tubing and fittings:
  - a. Rigid steel conduit.
  - b. Rigid metal conduit fittings.
  - c. Electrical metallic tubing.
  - d. EMT fittings.
  - e. Flexible metal conduit.
  - f. Flexible metal conduit fittings.
  - g. Liquid-tight flexible metal conduit.
  - h. Liquid tight flexible metal conduit fittings.

C. Wires, Cables, and Connectors:

1. General: Provide wires, cables and connectors complying with Division 26 05 02 titled "Basic Materials and Methods" and "Section 26 05 19" titled "Electrical Power Conductors and Cables."
2. Wires/Cables: Unless otherwise indicated, provide wires/cables (conductors) for electrical connections which match, including sizes and rating, of wires/cables which are supplying electrical power. Provide copper conductors with conductivity of not less than 98% at 20°C (68°F).
3. Connectors and Terminals: Provide electrical connectors and terminals which mate and match, including sizes and ratings, with equipment terminals and are recommended for use by equipment manufacturer for intended applications.
4. Electrical Connection Accessories: Provide electrical insulating tape, heat shrinkable insulating tubing and boots, electrical solder, electrical soldering flux, wirenuts and cable ties as recommended for use by accessories manufacturers for type services indicated.

2.3 FUSES

- A. General: Except as otherwise indicated, provide fuses of types, sizes, ratings, and average time-current and peak let-through current characteristics, which comply with manufacturer's standard design, materials, and constructed in accordance with published product information, and with industry standards and configurations.
- B. Class RK1 dual element time-delay fuses: Provide UL Class RK1 current limiting time-delay fuses rated 600-Volts, (250-Volts where specified), 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting circuit breakers, motors and panelboards.



- C. Class RK5 dual element time-delay fuses: Provide UL Class RK5 current limiting time-delay fuses rated 600-Volts, (250-Volts where specified), 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting circuit breakers, motors, and transformers.
- D. Class L time-delay fuses: Provide UL Class L time-delay fuses rated 600-Volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating.
- E. Class J dual element time-delay fuses: Provide UL Class J time-delay fuses rated 600-Volts, 60 Hz, with 300,000 RMS symmetrical interrupting current rating.

#### 2.4 SPARE-FUSE CABINET

- A. Characteristics: Wall-mounted NEMA-1 steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
  - 1. Size: Adequate for storage of spare fuses specified in Section 3.3 with 15 percent spare capacity minimum.
  - 2. Finish: Gray, baked enamel.
  - 3. Provide engraved, plastic laminate label "Spare Fuses" for cabinet. Refer to Section 26 05 53 for more information.
  - 4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

### **PART 3 - EXECUTION**

#### 3.1 INSTALLATION OF CIRCUIT AND MOTOR DISCONNECT SWITCHES

- A. Install circuit and motor disconnect switches as indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's "Standard of Installation," and in accordance with recognized industry practices.
- B. Coordinate circuit and motor disconnect switch installation work with electrical raceway and cable work, as necessary for proper interface.
- C. Install disconnect switches for use with motor-driven appliances, and motors and controllers within sight of controller position unless otherwise indicated. For all disconnecting means located remote from the motor controller (starter or variable frequency drive), contractor to provide disconnect with auxiliary contacts, contacts and control wiring back to motor controller.
- D. Provide NEMA 3R disconnect switches for all exterior locations and any location subject to moisture.

#### 3.2 INSTALLATION OF EQUIPMENT CONNECTIONS

- A. Install electrical connections in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable

requirements of UL, NEC and NECA's "Standard of installation" to ensure that products fulfill requirements.

- B. Coordinate with other work, including wires/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.
- C. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.
- D. Cover splices with electrical insulating material equivalent to, or of greater insulation resistivity rating, than electrical insulation rating of those conductors being spliced.
- E. Prepare cables and wires, by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid "nicking" copper conductors while skinning wire.
- F. Trim cables and wires as short as practicable and arrange routing to facilitate inspection, testing and maintenance.
- G. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturers published torque tightening values for equipment connectors. Accomplish tightening by utilizing proper torque tools, including torque screwdriver, beam-type torque wrench, and ratchet wrench with adjustable torque settings. Where manufacturer's torque requirements are not available, tighten connectors and terminals to comply with torque values contained in UL 486A.
- H. Provide PVC-coated conduit and fittings for highly-corrosive atmospheres.
- I. Provide flexible conduit for motor connections, and other electrical equipment connections, where subject to movement and vibration.
- J. Provide liquid-tight flexible conduit for connection of motors and other electrical equipment where subject to movement and vibration, and also where connections are subjected to one or more of the following conditions:
  - 1. Exterior location.
  - 2. Moist or humid atmosphere where condensation can be expected to accumulate.
  - 3. Corrosive atmosphere.
  - 4. Water spray.
  - 5. Dripping oil, grease, or water.
- K. Fasten identification markers to each electrical power supply wire/cable conductor which indicates their voltage, phase and feeder number in accordance with Division 26 section titled "Electrical Identification." Affix markers on each terminal conductor, as close as possible to the point of connection.
- L. Provide flexible metal conduit or Type "S" rubber cords, pigtailed, caps, etc., as required to constitute an operating system. All flexible cords shall have grounding

conductors. Ground all equipment. See Section 26 05 26 titled "Grounding and Bonding" for additional requirements.

- M. Prior to roughing-in, refer to all equipment manufacturer's shop drawings for details of equipment connections. Provide receptacles as required to match the cord caps on the equipment furnished. Provide either direct wiring or receptacles for final connection to equipment as required for the particular equipment furnished regardless of the type of outlet shown on the plans.

### 3.3 INSTALLATION OF FUSES

- A. Install fuses as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to ensure that protective devices comply with requirements. Comply with NEC and NEMA standards for installation of fuses.
- B. Coordinate work including electrical wiring, as necessary, to interface installation of fuses with other trades.
- C. Install fuses in fused switches.
- D. Provide spare fuse cabinet located in each main switchgear room. Provide spare fuse of size and type for every five (5) fuses installed. A minimum of three (3) spare fuses shall be provided for each size installed.

### 3.4 GROUNDING

- A. Provide equipment grounding connections, sufficiently tight to assure a permanent and effective ground for electrical disconnect switches.

### 3.5 FIELD QUALITY CONTROL

- A. Testing: Subsequent to completion of installation of electrical disconnect switches, energize circuits and demonstrate capability and compliance with requirements. Except as otherwise indicated, do not test switches by operating them under load. However, demonstrate switch operation through six opening/closing cycles with circuit unloaded. Open each switch enclosure for inspection of interior, mechanical and electrical connections, fuse installation, and for verification of type and rating of fuses installed. Correct deficiencies then retest to demonstrate compliance. Remove and replace defective units with new units and retest.

**END OF SECTION**

## SECTION 26 43 14

### **SURGE PROTECTIVE DEVICE (SPD)**

#### **PART 1 - GENERAL**

##### 1.1 SUMMARY

- A. This specification includes requirements for a high energy, field-mounted, Surge Protective Device (SPD) Type 1 (formerly known as Secondary Surge Arrestor/TVSS) and SPD Type 2 (formerly known as Transient Voltage Surge Suppressor) electronic filtering system used to protect low-voltage AC electrical distribution from the effects of lightning, utility switching events, temporary over voltages (TOV), and impulses generated internally within a facility.

##### 1.2 RELATED DOCUMENTS

- A. The specified unit shall be designed, manufactured, tested and installed in compliance with the following standards:
  - 1. ANSI/IEEE C62.41.1-2002, C62.41.2-2002 and C62.45-2002
  - 2. Canadian Standards (CUL)
  - 3. Federal Information Processing Standards Publication 94 (FIPS PUB 94)
  - 4. National Fire Protection Association (NFPA 70 (NEC), 75 and 78)
  - 5. Underwriters Laboratories Listed (UL 96A, 198, 248-1, 489, 1283 and 1449-Third Edition)

##### 1.3 SUBMITTALS

- A. Product Data: Provide complete product data detailing manufacturer's model number, specifications, features and options.
- B. Test Data: Manufacturers shall submit certified independent 3<sup>rd</sup> party test data verifying the following: life cycle testing, overcurrent protection, UL1449 Third edition as tested by Underwriters Laboratories (UL), noise attenuation and surge current capacity. Data shall include type classification (Type 1, Type 2), voltage protective rating (VPR), actual MCOV test value, nominal discharge current test ( $I_n$ ) rating.
- C. Shop Drawings: Provide electrical and mechanical drawings that include detail on unit dimensions, weights, field connections and mounting provisions.
- D. Installation, Operation and Maintenance Manuals: Provide one copy of the installation, start-up, operation and maintenance data for each unit supplied.

1.4 ACCEPTABLE MANUFACTURER

- A. These specifications detail performance requirements for a surge suppression system manufactured by Current Technology, Citel (Panelboards only), Emerson/Liebert, Square D/Schneider, Eaton/Bussmann, General Electric, Mersen, Siemens or Thor. Substitute, value-engineered or alternate products shall meet all performance and reliability aspects of this specification, including the substitute/alternate products submittal requirements.

1.5 SUBSTITUTION PRE-APPROVAL PROCEDURES

- A. Manufacturers requesting approval of their products shall identify the full model number and submit product data and specifications.

1.6 WARRANTY

- A. The manufacturer shall provide a ten (10) year limited warranty for service entrance and switchboard units, and a ten (10) year limited warranty for panelboard units from the date of shipment against failure when installed in compliance with applicable national/local electrical codes and the manufacturer's installation, operation and maintenance instructions.

1.7 LOCAL SERVICE SUPPORT

- A. A dedicated support organization shall be located within 150 miles of the project location, and shall have experience supporting at least twenty other projects of similar complexity within the last three years.

**PART 2 - PRODUCTS**

2.1 HIGH PERFORMANCE SUPPRESSION SYSTEM

- A. The suppression system shall incorporate metal oxide varistor (MOV) arrays and filtering capacitors. These components shall optimally share surge currents to ensure maximum performance and long-term reliability. The system shall not utilize gas tubes, spark gaps, silicon avalanche diodes, or other components that might short or crowbar the line, thus leading to power interruption.

2.2 UL 1449 THIRD EDITION UL TYPE 1 AND TYPE 2 DEVICE

- A. The unit shall be certified as a Type 1 or Type 2 device suitable for use in these applications. The nominal discharge current shall be 20 KA, and the applied MCOV value shall be the actual MCOV of the unit's suppression components (i.e. between 115% and 130% of nominal installed voltage, according to Section 2.4).

2.3 UNIT OPERATING VOLTAGE

- A. The operating voltage and configuration shall be 277/480-Volt or 120/208-Volt grounded wye as indicated on the drawings.

2.4 MAXIMUM CONTINUOUS OPERATING VOLTAGE (MCOV)

- A. The MCOV shall be greater than 115 percent (%) of nominal voltage, but no greater than 130 percent (%).

2.5 PROTECTION MODES

- A. All modes on all phases shall be protected (e.g., line-to-line, line-to-neutral, line-to-ground and neutral-to-ground).

2.6 RATED SINGLE PULSE SURGE CURRENT CAPACITY

- A. The proposed product shall be single pulsed surge current tested in all modes at the rated surge currents by an industry recognized independent test laboratory. The test shall include a surge impulse (6kV (1.2x50  $\mu$ s), 500 amp (8x20  $\mu$ s) waveform) to benchmark the unit's suppression voltage. The applied impulse is followed by a single pulse surge of the maximum rated surge current magnitude, followed by a second 6kV (1.2x50  $\mu$ s), 500 amp (8x20  $\mu$ s) impulse as a means of measuring clamping deviation (component degradation). Compliance is achieved if the two measured suppression voltage do not vary by more than 5%.

<b>Rated Single Pulse Surge Current Capacity</b>				
Location	L-N	L-G	N-G	L-L
Service Entrance & Switchboards	120,000 A	120,000 A	120,000 A	120,000 A
Panelboards	50,000 A	50,000 A	50,000 A	50,000 A

2.7 MINIMUM REPETITIVE SURGE CURRENT CAPACITY

- A. Per ANSI/IEEE C62.41 and ANSI/IEEE C62.45-2002, every mode of the suppression filter system shall be designed to survive multiple Category C 20 KV, 10 KA impulses. Test documentation shall detail the unit's ability to survive the following number of events (at one minute intervals) without any performance degradation.

<b>Repetitive Surge Current Capacity - Number of Impulses</b>				
Locations	L-L	L-N	L-G	N-G
Service Entrance & Switchboards	>12,000	>12,000	>12,000	>12,000
Panelboards	>4500	>4500	>4500	>4500

2.8 HIGH FREQUENCY EXTENDED RANGE FILTER

- A. Noise Attenuation: The filter shall provide an attenuation of 63 db max from 10 kHz to 100MHz, per 50 Ohm Insertion Loss Methodology from MIL 220A. The system shall provide up to 120-dB insertion loss from 100 kHz to 100 MHz when used in a coordinated facility system
- B. For installations that install multiple downstream filters, the filters shall be coordinated to provide minimum noise rejection/attenuation as follows:
  - 1. NOTE: Insertion loss data shall be based on a minimum of 100 feet of #4 AWG conductor between filters.

2.9 UL 1449 THIRD EDITION VOLTAGE PROTECTIVE RATING

- A. The voltage protective rating (VPR) for grounded wye circuits at applicable voltage shall not exceed the following:

<b>System Voltage</b>	<b>Mode</b>	<b>UL 1449 Third Edition VPR</b>
120/208	Line to Line (L-L)	1200
	Line to Neutral (L-N)	700
	Line to Ground (L-G)	700
	Neutral to Ground (N-G)	700
277/480	Line to Line (L-L)	2000
	Line to Neutral (L-N)	1200
	Line to Ground (L-G)	1200
	Neutral to Ground (N-G)	1200

2.10 REDUNDANT OVERCURRENT PROTECTION

- A. Each suppression element shall utilize individual tested fuses to ensure that the failure of a single suppression component, or operation of any single fuse does not render the entire mode, phase or product deficient by more than twenty percent (20%). All fuses shall be capable of withstanding the rated single pulse surge current capacity of the individual components they protect without failure.

2.11 INTERNAL CONNECTIONS

- A. Internal surge current paths shall utilize low-impedance copper bus bar. No plug-in modules or quick-disconnect terminals shall be used in the surge current-carrying paths.

2.12 ENCLOSURE

- A. The service entrance unit shall utilize a NEMA 1 metallic enclosure for interior locations.

2.13 ADDITIONAL FEATURES/EQUIPMENT

- A. Advanced Monitoring Feature. A battery-powered audible alarm with event counter display and two sets of form C dry contacts (N.O. or N.C.) shall be provided. The alarm shall indicate single or multiple phase failure of the filter.

**PART 3 - EXECUTION**

3.1 INSTALLATION

- A. The service entrance, switchboards, and panelboard filters shall be installed external to the switchgear/panelboard as close as possible to the connection point following the manufacturer's recommendations for conductor size and minimal bends.
- B. All insulation resistance tests shall be performed without being connected to the distribution equipment.

3.2 START UP SERVICES

- A. Complete start up checks according to manufacturer's written instructions.

3.3 EQUIPMENT MANUAL

- A. An equipment manual shall be provided that details installation, operation, and maintenance instructions for the filter. Information shall include unit dimensions, weights, mounting provisions, connection details and a layout diagram.

**END OF SECTION**



## **SECTION 26 51 13**

### **ARCHITECTURAL LUMINAIRES, SOURCES AND COMPONENTS**

#### **PART 1 - GENERAL**

##### 1.1 RELATED DOCUMENTS

- A. Contract Drawings, conditions of Contract (including General Conditions, Addendum to the General Conditions, Special Conditions, Division 01 Specification Sections and all other Contract Documents) apply to the work of this Section.
- B. Related Appendices Luminaire Schedule and Catalogue Extracts are attached as appendices to this Section.

##### 1.2 SUMMARY

- A. Included in the Work of this Section are labor, materials, and appurtenances required to complete the Work of this Section, as specified herein, as required by job conditions, or as indicated on drawings. The scope of this section includes general requirements for luminaires and their components, coordination, definitions, quality assurances, submittals, mockups, samples and general responsibility for a complete job.

##### 1.3 DEFINITIONS

- A. In this specification, the term "Architect" includes the Architect, Interior Designer, Landscape Architect, Construction Manager, Owner's representative and/or the Lighting Specifier, together or individually as they shall decide.
- B. The term "luminaires" refers to lighting fixtures with their integrated light sources and all other components.
- C. The use of the word "Approved" shall not extend the Architect's responsibilities beyond that as defined in the General Conditions.

##### 1.4 GENERAL REQUIREMENTS

- A. Provide labor, materials, and equipment for the installation of indoor luminaires, lighting equipment, control wiring, and sources as shown on the drawings and specified herein and in Related Sections. Luminaires shall be securely attached to supports.
- B. Refer to architectural drawings for locations, dimensions and details, and electrical documents for quantities. Check and verify dimensions and details on drawings before proceeding with the Work. Report any inconsistencies or discrepancies. Should

it appear that the Work intended is not sufficiently detailed or explained on the drawings or in the specifications, apply for further drawings or explanations, as may be necessary. Conform to these explanations in the work. If any question arises about the true meaning of the drawings or specifications, provide timely and written questions before proceeding. Under no circumstances shall any request for extra compensation be honored where the basis of claim is such a clarification. In no case submit a bid or proceed on any Work with uncertainty. The intention of this specification and the accompanying or applicable drawings is to provide a job complete in every respect. Contractor is responsible for this result.

## 1.5 COORDINATION

- A. Luminaire locations and mounting heights as indicated on the electrical drawings are generalized and approximate. Carefully verify locations and mounting heights with Architect's drawings, reflected ceiling plans, interior elevations and other reference data prior to installation. Check for adequacy of headroom and non-interference with other equipment, such as ducts, pipes or openings. Provide timely and written notification of such conflicts before proceeding with the Work. Although the location of equipment included in the Work of this Section may be shown on the Contract Drawings in a certain place, actual construction may disclose that the location for the Work does not make its position easily and quickly accessible. In such cases, provide timely and written notification of this situation before installing this Work, and comply with installation directions.
- B. Clearly indicate the Work to be performed by other trades' contractors, and the materials that are adjacent to or abutting the Work of this Section. Coordinate as required. Give ample notice of special openings required for placing equipment in the building, in order to avoid cutting of completed Work. Provide the materials and labor for Work included under this Section in ample time, and in sufficient quantities so that all of the Work may be installed in proper sequence to avoid unnecessary cutting of the floors and walls. Schedule the Work to prevent Work of this Section being damaged by other construction operations. Remove and replace Work so damaged at no cost to the project. Coordinate and schedule the Work of this Section with the Work of other Sections and Utility Companies so that there shall be no delay in the proper installation and completion of any part of each respective Work. Construction Work shall proceed in its natural sequence without unnecessary delay caused by the Work of this Section.
- C. Coordinate with other contractors regarding attachment to or openings in the materials of other trades such as pre-cast concrete, ornamental metals, or wood panels for recessed junction boxes, and other equipment.
- D. Arrange the installation in proper relation to other Work and with architectural finishes so that it shall harmonize in service and appearance and so that there shall be no interference with the Work of others, including interference in location or level.
- E. Where a catalog number and a narrative or pictorial description are provided, the written description shall take precedence and prevail.

- F. Where Work of this Section is to be flush or concealed, install it to assure that it does not project visually or physically beyond the finished lines of floors, ceilings or walls.
- G. Verify ceiling conditions and provide appropriate mounting details for each luminaire. Submit mounting details for approval.
- H. Become familiarized with all equipment listed in the luminaire schedule and take responsibility for the successful completion of the entire lighting installation.
- I. Verify compatibility of supply voltage indicated on electrical drawings with voltage specified for each luminaire prior to release. Provide timely and written notification of any and all discrepancies.

#### 1.6 QUALITY ASSURANCES

- A. Contractor shall comply with the General Requirements related to Quality Control, in addition to the provisions herein
- B. Manufacturers: Manufacturers listed in the APPENDIX – LUMINAIRE SCHEDULE (lighting fixture schedule) herein, shall be assumed capable of supplying the listed luminaires unless exceptions are set forth in their quotations. Provide timely and written notification of any such exceptions. Acceptable manufacturers are listed in the luminaire schedule. Acceptable manufacturers shall be capable of providing proof of satisfactory production of luminaires of the type and quality shown for a period of at least five years.
- C. Statement of Application:
  - 1. By commencing the Work of this Section, the Contractor assumes overall responsibility, as a part of the warranty of the Work, to ensure that assemblies, components and parts shown or required within the Work of this Section, comply with the Contract Documents.
  - 2. Warranty: In addition to any warranties required by the General Requirements, the Contractor of the Work of this section shall:
    - a. For a period of one year after Owner's initial acceptance and establishment of the beginning date of the warranty period, and at no additional cost, promptly provide and install replacements for luminaires or components thereof which are defective in materials or workmanship under normal operating conditions, except for sources; or successfully repair installed equipment at the job site. For any time during the warranty period that luminaires are not fully functional due to defects in materials or workmanship, provide or pay for and install and remove suitable and adequate temporary luminaires. Warrant replacement luminaires or components to be free of defects in workmanship or materials for a period of one year following replacement and replace any defective replacements.
    - b. Contractor shall not be held responsible for acts of vandalism or for abnormal or accidental abuse of the luminaires or their components occurring after the beginning of the warranty period, nor shall Contractor be held responsible for deleterious effects caused by maintenance procedures performed without the concurrence of Contractor.

D. Equipment Compatibility:

1. For all similar luminaire type, provide luminaires, power supplies, LED drivers, ballasts and other components fabricated or supplied by a single manufacturer, to simplify maintenance and replacement of equipment. Under no circumstances shall sources of the same type, even if different wattages, be supplied by more than one manufacturer unless operable samples are submitted, reviewed and approved in writing.
2. Luminaire details shown may be modified by the manufacturer provided all of the following conditions have been met:
  - a. Luminaire performance is equal or improved.
  - b. Structural, mechanical, electrical, safety, and maintenance characteristics are equal or improved.
  - c. Cost to the Owner is reduced or equal.
  - d. No conformance to codes has been compromised.
  - e. No performance criteria for, LEED, or WELL Building ratings has been compromised.
  - f. Modifications have been reviewed and approved in writing.

E. Regulatory Agencies:

1. Provide luminaires constructed, wired and installed in compliance with the current edition of applicable city, state and national codes. Provide luminaires conforming to or exceeding Underwriters Laboratories (UL) standards, and to provisions of applicable codes which exceed those standards.
2. For any category of luminaire tested by any of the following labs, provide luminaires listed and labeled by an independent Nationally Recognized Testing Laboratory (NRTL) such as UL, ETL, CSA, MET
3. In addition, provide luminaires which conform to additional regulations necessary to obtain approval for use of specified luminaires in locations shown. Use only electrical components listed by the above NRTLs.

F. Recognized Standards: In addition to standards that may be referenced in Division 01 Specification Sections, luminaires shall comply with the applicable standards of the following organizations.

1. Underwriters Laboratories (UL)
2. National Electrical Code (NEC)
3. Certified Ballast Manufacturers Association (CBM)
4. Illuminating Engineering Society (IES)
5. American Society for Testing and Materials (ASTM)
6. American National Standards Institute (ANSI)
7. National Electrical Manufacturers Association (NEMA)
8. International Electrotechnical Commission (IEC)
9. National Electrical Safety Code (IEEE C2)
10. Americans with Disabilities Act (ADA)
11. United States Institute for Theater Technology (USITT)

1.7 BIDDING

- A. Follow bidding procedures as described in Division 01 of this specification.

- B. Provide specified and alternate unit prices separated from installation costs as required in APPENDIX - LUMINAIRE SCHEDULE (the lighting fixture schedule).

#### 1.8 SUBSTITUTIONS:

- A. Luminaires included under this Section are specified by approved manufacturer and type. Provide equipment exactly as specified, unless substitutions are mutually agreed upon, as follows:
  1. Any proposed substitutions must be accompanied by full point-by-point calculations and auxiliary documentation demonstrating that the proposed luminaires fully meet the criteria in each specific application.
  2. Substitutions will only be considered for luminaire descriptions where the words "or approved equal" are explicitly stated.
  3. Submit a written request for luminaires proposed for substitution, at least two weeks before the end of bid period – the "substitution period". Make the request for substitution an alternate, separate proposal, accompanied by complete descriptive and technical data. Indicate if there is any addition or deduction from the base bid. Substitutions proposed after this time, or not including proper documentation shall not be considered. Submissions of substitutions may be accepted or rejected without explanation.
  4. Exceptions: During the construction period, no substitutions shall be considered unless compelling reasons are given - such as a specified product no longer being available. If Contractor has failed to follow the schedule presented under the Paragraph titled "Submittals" below, no substitutions will be allowed based on inability of specified manufacturer to meet delivery schedule, and the Contractor shall provide luminaires exactly as specified without delay to the project and without additional cost to Owner.
  5. Substitutions shall be indicated as such in the bid documents, and operable (plug-in) samples, catalogue cuts and complete photometric reports by independent testing laboratories submitted. A complete comparison of the performance of the proposed substitution in relation to the performance of at least the first named specified product shall be included. In addition, for any luminaire type of which six (6) or more of the luminaires are to be used, submit computer generated point-by-point calculations for illumination on vertical and horizontal planes. Such calculations shall include either the typical mounting condition for the subject luminaire or a specialized mounting condition deemed critical for the success of the design.
  6. Written documentation shall clearly show that the proposed manufacturer complies with each and every aspect of the specification and/or indicate any exceptions or variations. Where proposed substitutions alter the functional or visual design or change the space requirements or mounting details indicated herein or on the drawings, such changes shall be detailed in the proposal and costs indicated for revised design and construction for trades involved. Cost data shall be provided as called for in the General Requirements. Submittal shall include names and addresses of at least three (3) similar projects on which the product was used, including names and phone numbers of specifiers and owners of each project, and dates of installation.
- B. Value Engineering:

1. To the extent that Value Engineering is allowed in the General Requirements, the procedure for value engineering is the same as outlined above regarding the substitution process, with the words "value engineering proposed substitution(s)" replacing the word "substitution(s)". Value engineering submittals shall be clearly separated from substitutions, and line-item cost savings for each proposed luminaire type clearly documented.

## 1.9 SUBMITTALS

### A. General:

1. For standard catalog items with no modifications, submit catalog cut sheets prepared by the manufacturer which clearly show all elements to be supplied and all corresponding product data (including sources, manufacturer and model number of power supply, LED driver, ballast, and other components, as well as voltage; accessories, options and any miscellaneous items detailed in the written description of the specification.) If cut sheet shows more than one (1) luminaire type, all non-applicable information shall be crossed out.
2. For custom luminaires, modified luminaires or linear luminaires mounted in continuous rows, submit a layout drawing prepared by the manufacturer showing all details of construction, lengths of runs, source layout, if applicable, suspension installation hardware or components, power locations, remote power supplies, remote LED drivers, remote ballasts, remote transformers, finishes and list of materials. Drawings must be to scale. Provide manufacturer with field dimensions where required. If scallop shields, wallwash reflectors or baffles are required, drawings shall indicate relative position to wall or adjacent vertical surface.
3. When components are indicated as contractor supplied or specified (i.e. remote power supplies, remote LED drivers, ballast housings, NEMA enclosures, etc., provide submittals for components in conjunction with the luminaire submittal.
4. Provide submittals with luminaire installation instruction sheets.

### B. Submittal Schedule (Note: All days, week or months listed are "calendar" days, weeks or months, and not working days, weeks or months):

1. List of Intended Manufacturers: Within fifteen (15) calendar days of the Notice to Proceed, submit a List of Intended Manufacturers, with estimated fabrication lead times. "Lead times" shall be measured in weeks, beginning from the manufacturer's receipt of approved shop drawings and release, and ending at shipment. The response to this list will indicate if any manufacturers are unacceptable.
2. Acknowledgments and standard shop drawings: Within twenty (20) days after receipt of the response to the list of Intended Manufacturers, submit copies of purchase orders and manufacturers' acknowledgments for all luminaires specified, conforming to responses. The purchase orders and the manufacturer's acknowledgments need not list prices, but shall contain a guaranteed fabrication lead time, in weeks, as defined above. These fabrication times shall be adequate for the timely completion of the job. At the same time, but not less than twenty-four (24) weeks before standard manufactured luminaires are required on the site, submit shop drawings for all standard luminaires or those with minor modifications.

3. Custom Shop Drawings: In order to allow for mockups and independent testing for all custom luminaires or those with major modifications, submit complete shop drawings within sixty (60) days after the Notice to Proceed, but not less than eleven (11) months prior to the time they are required on the site.
  4. Release for fabrication: Within twenty (20) days after receipt of shop drawings marked "No Exceptions Taken" or "Make Corrections Noted", release luminaires for fabrication and forward verification that the luminaires have been released for fabrication, with a guaranteed shipment date for each specified luminaire. At the same time, forward finish or component samples, tests, or any outstanding data required for approval.
  5. Operable luminaire samples and mockups as indicated in APPENDIX - LUMINAIRE SCHEDULE (the lighting fixture schedule) shall be received by the designated parties, or installed on the site, within forty-five (45) days after Contractor's receipt of shop drawings marked "No Exceptions Taken" or "Make Corrections Noted".
  6. Re-submissions: Within fourteen (14) days after receipt of shop drawings marked "Revise and Resubmit" or "Rejected", resubmit revised shop drawings in accordance with the General Requirements regarding re-submissions.
  7. Provide written notification of any potential scheduling problems, or of any submittals that have not been returned which are required to maintain the installation schedule. Such notification shall be in a timely manner and well in advance of the time such delay might affect the fabrication schedule or appropriate delivery of luminaires.
  8. Request for Final Layout: At the same time that shop drawings are submitted, request verification of final layouts and control zones for all luminaires. Submit templates for labeling of all controls. Layout adjustments shall be considered no-cost clarification as long as the quantity or value of luminaires does not increase. Provide blank control station faceplates until labels are available. Custom engraved or labeled faceplates shall be ordered from the manufacturer so that they arrive prior to the final release of the space and subsequent beginning of the warranty period. Blank faceplates shall be replaced with custom labeled faceplates at no additional cost to the project.
- C. Shop Drawings:
1. Submit shop drawings for each type of luminaire, arranged in order of lighting type designation except where specified luminaires are standard, unmodified, "off-the-shelf" units, fully described by catalogue cuts. If comprehensive, such catalogue cuts may be substituted for shop drawings, however full shop drawing shall be submitted upon request. Submit catalogue cuts of individual lamps or replaceable source modules to be provided for each luminaire. Submit shop drawings in the quantity and format called for in the General Requirements.
  2. Shop drawings shall show all luminaire components, including but not limited to lampholders, reflectors, louvers, lenses, fuses, junction boxes, power supplies, ballasts and sources. Shop drawings shall show materials, finishes, metal gauges, overall and detailed dimensions, sizes, electrical and mechanical connections, fasteners, welds, joints, any exposed hardware, and conditions, or provisions for the work of others, and similar information. Indicate complete details of the luminaire, including manufacturer's name and catalogue numbers for sockets, power supplies, LED drivers, ballasts, light shields, switches and type of wiring, and targeting and locking devices for adjustable luminaires.

Indicate that source type specified is appropriate for luminaire design. Indicate maximum allowed distance between light luminaire and remote power supply. Indicate type and extent of approved inert insulating materials to prevent electrolytic corrosion at junctions of dissimilar metals. Include pertinent mounting details including hung ceiling construction. Standard catalogue cuts shall be supplemented by additional drawings if information or descriptions listed above are not included in the cuts. Photometric documentation and finish samples shall be provided upon request. Samples shall be provided if indicated in APPENDIX - LUMINAIRE SCHEDULE (the lighting fixture schedule). No luminaires will be approved without the previous described submission of data. Submissions may be modified during the submission review process. Luminaires or other materials shall not be fabricated, shipped, stored or installed unless prior written approval has been received.

3. Submit layouts for continuous luminaires or coves, indicating overall field measurements and proposed lengths, and condition of joints, corners, ends and any unlighted lengths.
  4. Submit catalogue cuts for all lamps, power supplies, LED drivers, ballasts and emergency battery backup power supplies and ballasts.
- D. Data: Submit independent laboratory photometric data in the directed number of copies and in format as directed. Photometric data shall be submitted for standard, "off-the-shelf" units at the time the manufacturer's cuts are submitted. Photometric testing and reporting shall conform to IESNA procedures. Submit additional photometric testing as required by Luminaire Schedule or upon request.
- E. Manufacturer's Catalogue Sheets shall indicate input watts and electrical characteristics, ambient temperature rating, noise level rating, mounting methods and UL or ETL listing for use with required source, power supply, LED driver, transformer, lamp and/or ballast (if any).
- F. For Guaranteed Maximum Pricing (G.M.P.) Submit a detailed breakdown of bid by material cost, labor, and wiring and quantities for each luminaire, when requested.

#### 1.10 SAMPLES

- A. After shop drawings, data and any other required submissions have been approved, submit samples of each of the following components upon request:
1. Samples demonstrating the finishes of any custom metal, paint color or finish. Sample size to be a minimum of 4in (100mm) square. Place labels on the back side of finish samples only.
  2. Material samples of any transmitting media, such as plastic, glass, perforated metal and the like. Sample size to be a minimum of 12in (305mm) square, to allow adequate space for label.
  3. Each downlight reflector cone that differs in size or finish.
  4. Any other luminaires or components requested in the luminaire descriptions, schedule, or in the contract documents.
- B. Submit two (2) samples unless otherwise indicated. If luminaire samples are requested, supply a completely operable luminaire as specified in the Luminaire Schedule and/or incorporating responses to shop drawing, with the specified source



and a 10ft (3m) cord and plug for standard 120-volt service. For 277-volt luminaires, also supply a completely wired or plug-wired step-up transformer to convert from 120 to 277 volts, with a 120-volt cord and plug. Provide component parts as specifically requested.

- C. Where a sample is submitted or requested, do not fabricate that luminaire type until the sample is approved. Submit and resubmit a sample as required, until samples are approved.
- D. The purpose of the sample is to review manufacturing techniques, detailing, light source, and scale. Minor modifications, if any, shall be considered part of these Specifications and shall be accomplished at no additional cost.
- E. Submit complete and operable sample luminaires for any proposed substitution or value engineering proposal as indicated above. There shall be no expectation that substitution products or samples received after the substitution period will be accepted or reviewed.
- F. Provide samples as called for in the General Requirements. Tag samples with the name of the project, referenced specification, paragraph or drawing number, the luminaire type number and any other identifying data. Ship the samples to two separate addresses as requested. After review, the samples shall be shipped to the project site for use as standards. All transportation charges for samples shall be paid by Contractor. Make luminaires supplied under the Work of this Section identical with approved samples. Do not install any sample luminaires in the project.
- G. If sample submissions are not approved, samples shall be returned to Contractor, at Contractor's expense. Upon receipt of sample disapproval, immediately make a new submission of samples meeting the comments and contract requirements, as called for in the General Requirements.

#### 1.11 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Luminaires and their component elements shall be delivered to the job site factory-assembled and wired to the greatest extent practical, in strict accordance with the approved shop drawings, samples, certificates and catalogue cuts, and shall be handled in a careful manner to avoid damage.
- B. Exposed finishes shall be protected during fabrication, transport, storage and handling. Delivered materials shall be identical to the approved samples. Materials which become damaged shall be repaired and/or replaced as directed.
- C. Luminaires shall be stored under cover, above the ground, in clean, dry areas, and shall be tagged and/or marked as to type and location.
- D. Delivered luminaires shall include wiring, sockets, power supplies, LED drivers, ballasts, shielding, channels, lenses and other parts and appurtenances necessary for luminaire installation of each luminaire type.

## 1.12 MOCK-UP

- A. As a part of the Work of this Section, when specifically called for in the Luminaire Schedule, and at no additional cost to project, temporarily install, connect and adjust a reasonable number of luminaires, three (3) unless otherwise stated. Install completely operable luminaires with all sources, power supplies, LED drivers, ballasts, etc., of each type listed in the Luminaire Schedule where a mock-up is specified, to verify the specified catalogue number and requirements. Place the mock-up luminaires where and when directed. Remove and store mock-up luminaires, when approved, as necessary to complete the work, at Contractor's expense.
1. The mock-up installation shall closely conform to the conditions of the actual installation as to height, distance from ceiling, light source type, output and performance, number and type of sources, material, color, and space finishes, etc. Submit a written description of each proposed mock-up with drawings to obtain approval prior to commencement of each mock-up.
  2. Where mounting of mockup may negatively impact existing conditions or constructed scope of Work, temporary mounting methods shall be implemented to avoid any damage.
  3. The purpose of the mock-up will be to study the general appearance and performance of the intended lighting systems unless otherwise indicated. At that time, certain minimal test variations may be requested as to lamp location, source type, reflector shape, color, etc. Final modifications, if any, shall be considered as part of these Specifications and shall be accomplished with no additional cost to the project.

## **PART 2 - PRODUCTS**

### 2.1 GENERAL

- A. Provide materials, equipment, appurtenances and workmanship for the Work of this Section conforming to the highest commercial standards, as specified and indicated on the drawings. Make luminaire parts and components not specifically identified or indicated on the drawings, of materials most appropriate to their use or function, and resistant to corrosion and to thermal and mechanical stresses encountered in the normal application and function of the luminaires.
- B. Provide recessed luminaires that are constructed to be suitable for and compatible with the ceiling, wall, pavement or other materials and construction in which they will be installed.
- C. Named manufacturers, when listed in the luminaire schedule, are representative of an adequate level of quality and reputation, and are allowed to submit a product, provided that they are capable of satisfying the provisions of the specifications in every respect. This does not mean that any standard product provided by that manufacturer is automatically qualified. Manufacturers not on this list may be proposed during the substitution period if they can substantiate that their product meets every particular of the relevant specification, and are of comparable quality,

experience and reputation. See the paragraph titled "Substitutions", above. Any submitted product may be rejected without explanation.

## 2.2 DEFINITIONS:

- A. CCT: Correlated Color Temperature
- B. CRI: Color Rendering Index
- C. Fixture: See "Luminaire"
- D. IP: International Protection or Ingress Protection Rating
- E. LED: Light Emitting Diode
- F. Lumen: Measured output of source and luminaire or both
- G. Luminaire: Complete lighting unit, including source, gear, reflector and housing

## 2.3 MARKING OF LUMINAIRES

- A. Luminaires shall be equipped with markings showing safety specifications, construction safeguards, and minimum resistance to hazard sources operation under fault conditions. Marking shall include manufacturer/distributor's name, related voltage or voltage range, rated wattage, light output, optical distribution and rated frequency. LED luminaires not suitable for dimming control are required to indicate this clearly in installation instructions or package labelling. Mark luminaires with replaceable sources according to proper source type. Provide markings that are clear and that are located to be readily visible to service personnel, but invisible from normal viewing angles when sources are in place.

## 2.4 MATERIALS AND FABRICATION

- A. Provide luminaires completely factory-assembled and wired and equipped with necessary sockets, power supplies, LED drivers, ballasts, wiring, shielding, reflectors, channels, lenses, integral emergency battery packs (if required) and other parts and appurtenances necessary. Deliver to project site ready for installation and to complete the luminaire installation.
- B. Use only completely concealed hardware, unless otherwise noted. Latching of luminaire door frames shall be unobtrusive. Make luminaire free from light leaks by the inherent design of the luminaire body and frame. Bond gaskets, when used, to the luminaire metal. Weld power supply support studs, socket saddle studs and reflector support studs to luminaire body. Flexible leads shall enter luminaires at sides, unless otherwise noted.
- C. Minimum gauges sheet steel: 22-gauge for recessed LED, unless thicker gauge required by regulating agency; unless otherwise specified.

- D. Construct luminaires with the minimum number of joints. Make unexposed joints by approved method such as welding, brazing, screwing or bolting. Soldered joints are not acceptable.
- E. Provide metallic cast or extruded parts of luminaires that are close grained, sound, and free from imperfections or discoloration. Provide cast or extruded parts that are rigid, true to pattern, and of ample weight and thickness. Provide cast or extruded parts that are properly fitted, filed, ground, and buffed finished surfaces and joints free of imperfections. Make thickness on cast parts not less than 1/8in (3mm).
- F. Provide housings that make electrical components easily accessible and replaceable, without removing the luminaire body from its mounting.
- G. Provide luminaires indicated as "continuous" on drawings or specifications with finished end-to-end or wall-to-wall appearance. Verify run lengths per field conditions prior to ordering. Maximize lighted length to nearest six inches (152mm), with equally spaced unlighted portions at each end, not to exceed 3 inches (76mm) each. Provide continuous louvers and/or lenses into unlighted ends and at corners.
- H. Wiring:
  - 1. Provide luminaire wiring between sources, lampholders and associated operating and starting equipment in compliance with UL 1570 and NEC, UL 8750 for LED's.
  - 2. Make connections of wires to terminals of sources, lampholders and other accessories in a neat and workmanlike manner and which are electrically and mechanically secure, with no loose strands protruding. Provide of the appropriate amount of wires extending to or from the terminals of a source, lampholder or other accessory. These wires shall not be in excess of the number which the accessory is designed to accommodate.
  - 3. Provide wiring channels and wireways free from projections and rough or sharp edges throughout. At points or edges over which conductors shall pass and may be subject to injury or wear, grind to make a smooth contact surface with the conductors. Install insulated bushings at points of entrances and exit of flexible wiring.
- I. All interior luminaires shall be UL/ETL listed, "Damp Location" rated at a minimum, with greater protection (UL/ETL "Damp Location" or "Wet Location") as appropriate or required by code for the application.
- J. All exterior luminaires shall be UL/ETL listed, "Wet Location" rated at a minimum (unless otherwise specified). All hardware, including bolts imbedded in lighting pole foundations, shall be stainless steel or equivalent marine grade resistant.

## 2.5 FINISHES

- A. The paint finish/color may affect the heat dissipation from luminaires. Apply luminaire finishes after fabrication in a manner that assures a durable wear-resistant surfacing. Prior to finishing, hot clean the surfaces by accepted chemical means, and treat them with corrosion inhibiting (phosphating) treatment to assure positive paint-adhesion. Give exposed metal surfaces (brass, bronze, aluminum and others) and finished

castings except chromium-plated or stainless-steel parts an even coat of high-grade methacrylate lacquer, or transparent epoxy. Anodize exposed aluminum surfaces for corrosion resistance. Make sheet steel luminaire housing, and iron and steel parts which have not received phosphating treatment, or which are to be utilized in exterior applications corrosion resistant by zinc or cadmium plating or hot-dip zinc galvanizing after completion of all forming, welding, or drilling operations.

- B. Electroplate parts operated under temperatures injurious to hot-dipped galvanizing.
- C. Cadmium plate screws, bolts, nuts and other fastening or latching hardware.
- D. Except where otherwise indicated provide luminaires with a final synthetic, high-temperature baked enamel coating of color and finish as specified or directed. Unless otherwise specified, provide white baked enamel "reflective" surfaces, with a minimum reflectance of 86 percent. Unless otherwise specified, provide potentially visible non-reflective surfaces with a matte-black baked enamel finish. Prior to painting give all parts proper etched surface preparation to assure paint adherence and durability.

## 2.6 COMPONENTS

### A. General:

1. Provide identical power supply and gear within each luminaire type. Provide power supplies and gear that are suitable and UL-listed for the electrical characteristics of the supply circuits to which they are to be connected and which are suitable for operating LED or relevant light sources, including future LED replacement lamps.
2. Unless otherwise specified, provide power supplies and control gear of same type and same manufacturer for ease of stocking and replacement.
3. Components shall be configured and installed in luminaire by the luminaire manufacturer.
4. Components shall not contain Polychlorinated biphenyls (PCBs) and shall be labeled "No PCBs".
5. Gear housing shall be constructed of painted metal with no sharp edges.
6. Provide only luminaires whose design, fabrication and assembly prevent overheating or cycling of light engines or power supplies under any condition of use.
7. Electronic ballasts shall meet the requirements of the Federal Communications Commission Rules and Regulations, Part 18, Part C (RF Lighting Devices) Non-consumer equipment, regarding radio frequency interference (RFI) (radiated) and electromagnetic interference (EMI) (power line conducted).
8. Submit gear details with luminaire shop drawings.

## 2.7 TRANSFORMERS FOR LOW-VOLTAGE LUMINAIRES

### A. General:

1. Each transformer controlled by a dimmer shall have a suitable choke to eliminate noise during dimming.

2. Secondary wiring shall meet all requirements of this Division and of all applicable local codes. Additionally, secondary wiring shall be sized so that the total average voltage drop on the transformer secondary side does not exceed 3 percent.
3. Source operating voltage, as measured at the socket, shall be between 11.5-12.1 volt for nominal 12-volt sources, and between 23.0-24.2 volt for nominal 24-volt sources. Contractor shall demonstrate that voltage is within this range if requested.

- B. Where a remote transformer is required for interior installations, provide a UL listed remote low voltage power supply which meets or exceeds the following requirements, in addition to those of Paragraph A above.
1. Power supply shall contain a toroidal transformer, primary circuit breaker, and thermal protection.
  2. Power supply shall be UL listed, suitable for surface or recessed mounting in both walls and ceilings and require zero clearance to combustible materials.

## 2.8 SOURCES

A. General:

1. Provide electric sources as required, during construction, including sources for luminaires provided by others.
2. Provide a complete set of new lamps (excluding LED lamps and light engines), as described in this Section and specified the Luminaire Schedule below, in each luminaire, at the completion of the Work, leaving luminaires and lighting equipment completely lamped and/or in normal operating condition. Provide spare sources in accordance with the paragraph titled "Spares", below.
3. Submit catalogue cuts of all sources to be used in the Work, along with the shop drawing submittal.

B. Solid State Lighting / Light Emitting Diode (LED) Light Sources and Luminaires:

1. General:

- a. Luminaire manufacturer shall have a minimum of five (5) years' experience in the manufacture and design of LED products and systems and no less than one hundred (100) North American installations.
- b. Unless otherwise specified, luminaire fabrication shall integrate all LED light sources and power/data supplies fabricated by a single manufacturer to ensure compatibility.
- c. All components peripheral devices, integrated photosensors, occupancy/vacancy sensors, controllers, even if manufactured or provided by others, shall be the responsibility of a single entity, the luminaire manufacturer. All components shall perform successfully as a complete system. Integrated controls shall be programmed onsite to operate as described in Lighting Control Intent Narrative documents or Appendix - Luminaire Schedule.
- d. Provide submittals as described in Part 1 above.
- e. Provide two (2) samples of each separate manufacturer and type of LED luminaire if requested in Appendix - Luminaire Schedule. Follow procedure for submitting samples as described in Part 1 above.

- f. Include all components necessary for a complete installation. Provide all power supplies, synchronizers, data cables, and data terminators for a complete working system.
  - g. All white light LED sources within the same luminaire type shall be within two (2) MacAdam ellipses/steps of each other.
  - h. All LED sources used in the LED luminaire shall be of proven quality from established and reputable LED manufacturers and shall have been fabricated within 12 months before installation per the date code on the module. Acceptable LED component or module manufacturers unless otherwise noted are:
    - 1) Cree, Inc.
    - 2) Lumileds
    - 3) Nichia Corporation
    - 4) Norlux
    - 5) Lextar
    - 6) Osram Optronics Semiconductors
    - 7) Xicato
    - 8) Bridgelux
    - 9) Epistar
    - 10) San'an
    - 11) Citizen Electronics
    - 12) General Electric Company
    - 13) Sora
    - 14) Samsung
    - 15) Seoul Semiconductor
    - 16) Lumenetix
    - 17) Ledengin
2. Replacement and Spares:
- a. Manufacturer shall provide written guarantee of the following:
    - 1) Manufacturer's LED system or equivalent system will be available for ten (10) years: Manufacturer will provide exact replacement parts, complete replacement luminaires, or provide upgraded parts that are designed to fit into the original luminaire and provide equivalent distribution and lumen output to the original, without any negative consequences.
    - 2) Manufacturer will keep record of original chromaticity coordinates for each LED module and have replacement modules or luminaires from within two (2) MacAdam Ellipses/ steps of the same coordinates available.
    - 3) Manufacturer will keep an inventory or ability to supply replacement parts or complete fixtures within two (2) weeks for component parts or the standard lead time of the original fixture for a complete fixture for duration of warranty period.
  - b. All parts of system shall be replaceable in the field as specified in Appendix - Luminaire Schedule.
  - c. System shall carry a full warranty for a minimum of three (3) years from the date of shipment (or longer if required by the project, also refer to Division 1 - General Requirements for further warranty requirements). Manufacturer shall be responsible for a cost of labor and shipping as agreed between parties, to replace any component of the system that fails within the warranty period.

3. Products and Components – Performance
  - a. LED luminaires and components shall be approved by an NRTL facility such as UL, ETL or CSA/US.
  - b. For applicable fixtures: all products included in system shall use Mil-Std 810F, Random Vibration 7.698g as a minimum standard. In installations subject to vibration, luminaire shall be installed with vibration isolation hardware to sufficiently dampen vibrations.
  - c. All LED components shall be mercury and lead-free.
  - d. All manufacturing processes and electronic materials shall conform to the requirements of the European Union's Restriction on the Use of Hazardous Substances in Electrical and Electronics Equipment (RoHS) Directive, 2002/95/EC.
  - e. LEDs shall comply with ANSI/NEMA/ANSLG C78.377-2008 – Specifications for the Chromaticity of Solid-State Lighting Products. Color shall remain stable throughout the life of the source. The chromaticity of the installed product shall match IES LM-80 data showing that the LED's do not shift more than .005 DuV from an approved sample or submitted documentation.
  - f. LEDs testing shall be performed in accordance with IES LM-80 - Approved Method for Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules.
  - g. LEDs shall have a minimum rated source life of 50,000 hours or as specified in Appendix: Luminaire Schedule. LED "rated source life" shall be determined per IES TM-21 - Projecting Long Term Lumen Maintenance of LED Light Sources based on LM-80 test data. Calculated lifetimes not exceeding testing hours per TM-21 are not accepted.
  - h. Luminaire assembly shall include a method of dissipating heat to prevent degradation of source life, electronic equipment, or lenses. LED luminaire housing shall be designed to transfer heat from the LED board to the outside environment. Luminaire housing shall have no negative impact on life of components. High power LED luminaires shall be thermally protected using one or more of the following thermal management techniques: metal core board, gap pad, and/or internal monitoring firmware
  - i. Luminaire shall be tested and suitable to operate under a minimum of two (2) case temperatures: 55°C (131°F) and 85°C (185°F) and a relative humidity under 65%.
  - j. Manufacturer shall supply in writing a range of permissible operating temperatures and relative humidity levels in which system will perform optimally. LEDs shall be adequately protected from moisture or dust in interior applications.
  - k. All hardwired power connections to LED luminaires shall be reverse polarity protected and provide high voltage protection in the event connections are reversed, shorted or otherwise mis-wired during the installation process.
  - l. For data wiring/cabling, provide CAT5 and CAT6 pinout information.
  - m. LEDs shall not be overdriven beyond their specified nominal voltage and current.
  - n. Color-changing luminaires utilizing discrete LED chips shall use an equal combination of each color of LED and shall be capable of a minimum of 8-bit control.



- o. Manufacturer shall be able to provide supporting documentation of the product meeting third party regulatory compliance.
  - p. Manufacturer shall ensure that products undergo and successfully meet appropriate design and manufacturability testing including Design Failure Mode & Effects Analysis, Process Failure Mode & Effects Analysis, Environmental Engineering Considerations and Laboratory Tests, IEC standards and UL/CE testing.
  - q. Manufacturer shall provide Luminaire Efficacy (lm/W), total luminous flux (lumens), luminous intensity (candelas), chromaticity coordinates, CCT and CRI. optical performance, polar diagrams, and relevant luminance and illuminance photometric data. Provide data in IES file format in accordance with testing standards IES LM-79-08 and IES LM-82-12, based on test results from an independent Nationally Recognized Testing Laboratory or National Voluntary Laboratory Accreditation Program (NVLAP) accredited laboratory.
4. LED Control and Communication – Performance
- a. LED luminaires shall be network controllable via digital control.
  - b. The LED system shall use integral and differential non-linear control.
  - c. Constant data transmission rates shall be employed, resulting in the output being independent of distance of cable between power supply and light source within the specified length.
  - d. LED system shall have a selectable means of external control via a data network.
  - e. Each LED luminaire and/or node shall have the capability to be set to a unique and individual address. Address shall be selectable through on-board switches or by an external hardware or software method.
  - f. The LED system shall be scalable, with every LED luminaire/address in the system capable of being controlled by a single, centralized controller.
5. All color characteristics, CCT, CRI, Color Fidelity, CIE Chromaticity Coordinates shall be consistent across the entire dimming range.
6. Luminaires shall have less than 30% flicker at frequencies of 200Hz or below at 100% and 20% light output and/or meet IEEE standard PAR 1789.
- C. LED Power Supplies/ Drivers:
- 1. LED driver shall have a minimum 50,000 hour published life while operating at maximum case temperature and 65 percent non-condensing relative humidity.
  - 2. Driver shall be Sound Rated A+.
  - 3. Driver shall be > 80% efficient at full load across all input voltages.
  - 4. Driver shall include ability to turn off at low control input rather than holding at a minimum dimming level and shall consume 0.5 Watts or less in standby/off mode. Control deadband at low control input shall be included to allow for voltage variation of incoming signal without causing noticeable variation in luminaire to luminaire output.
  - 5. Drivers shall track evenly across multiple luminaires at all light levels and shall have an input signal to output light level that allows smooth adjustment over the entire dimming range.
  - 6. Control Input:
    - a. 4-Wire (0-10V DC Voltage Controlled) Dimming Drivers
      - 1) Must meet IEC 60929 Annex E for General White Lighting LED drivers.

- 2) Connect to devices compatible with 0 to 10V Analog Control Protocol, Class 2, capable of sinking 0.6 ma per driver at a low end of 0.3V.
  - 3) Must meet ESTA E1.3 for RGBW LED drivers.
  - b. Digital (DALI Low Voltage Controlled) Dimming Drivers
    - 1) Must meet IEC 62386.
  - c. Digital Multiplex 512 (DMX Low Voltage Controlled) Dimming Drivers
    - 1) Must meet DMX / RDM: USITT DMX512A and ANSI E1.20 (Explore & Address).
    - 2) Must be capable of signal interpolation and smoothing of color and intensity transitions.
- D. Other:
1. For other luminaires, provide sources as specified. If specification is not complete, request clarification before ordering equipment.

## 2.9 REFLECTORS

### A. Reflectors:

1. Provide reflectors and reflecting cones or baffles fabricated from aluminum/plastic reflector sheet no less than minimum thickness listed below for each application, Reflector shall be absolutely free of tooling marks including spinning lines, and free of marks or indentation caused by riveting or other assembly techniques. No rivets, springs, or other hardware shall be visible after installation.
  - a. Cones: 0.0500in (1.27mm)
  - b. Wall wash kicker panels in cones: 0.0400in (1.01mm)
  - c. Reflectors (non-structural): 0.0235in (0.59mm)
  - d. Louvers/Baffles: 0.0200in (0.50mm)
2. Provide reflectors and baffles of first-quality polished, buffed and anodized finish, "Alzak" or approved equal, and with specular or semi-specular finish color to be clear, unless specified otherwise. Provide reflector and baffles which produce no apparent brightness nor a source image, nor shall any part of the source be visible from 50° above nadir to 90° above nadir (vertical). That is, the reflector shall have a maximum 50° cutoff angle and a minimum 40° shielding angle.
3. Provide other aluminum reflectors where required and formed and finished as noted on drawings and elsewhere in the specifications. Provide only reflectors free from blemishes, scratches, or indentations which would distort their reflective function and finished by means of the "Alzak" process, or approved equal, unless otherwise noted. No rivets, springs, or other hardware shall be visible after installation.
4. For luminaires employing multi-color sources or sources emitting more than one distinct frequency of color, provide reflectors, cones, or baffles with low iridescent coating on all surfaces seen from normal viewing angles.
5. Anodized aluminum reflectors shall have the following characteristics:
  - a. Specular:
    - 1) 2 mg/in<sup>2</sup> (0.31 mg/cm<sup>2</sup>) minimum Weight of Coating (Anodizing process. Coating of aluminum oxide: Reference ASTM Test Method B-137)

- 2) 86 minimum Total Hemispherical Reflectance and 70 minimum Specular Component (Reference ASTM Test Method E-903-82 (testing utilizing a TR1 or TR2 Total Reflectometer is also acceptable pending issuance of ASTM standard))
- 3) 90 minimum Visual Clarity and 0.03 minimum Diffuseness at 15° (c) (Reference ASTM Test Method E-430-78 (1983))

B. Painted Reflectors:

1. Reflectors shall be completely formed before application of primer and enamel color coat or coats.
2. When requested, submit a sufficient quantity of flat steel panels having the identical primer and color coat or coats applied in the same manner as proposed for the contract items.
3. Tests will be required only in case of dispute about reflector characteristics. Tests may be required at any time before or during Contractor's warranty period. Contractor will pay the cost of tests, if required. Reflectors which do not meet the criteria expressed here will be replaced at Contractor's expense, with reflectors meeting specified requirements.
4. Tests:
  - a. Painted reflectors shall have an initial reflection factor not less than 86 percent in the visible range of 400-700 nanometers as per ASTM Method E-424-71 as determined by independent laboratory test of fading, tested in the following manner: One half of sample shall be covered and remaining half shall be exposed to a 150 watt sunlamp placed 1/2in (12.7mm) above reflective surface for 72 hours. Comparison of exposed and unexposed sides shall show no visible fading or deterioration in appearance or reflectance.
  - b. The percentage of Specular Gloss shall be a minimum of 80 percent as determined by ASTM Method D-532-T, Procedure A.

2.10 LENSES / FACEPLATES / TRIM

- A. Where plastic lens is indicated, provide lens of 100 percent virgin acrylic (polymethyl methacrylate), nominal 0.125in (3mm) thick, unless otherwise indicated. Lens is to be strain-free, uniform in appearance, and destaticized.
- B. Where clear acrylic lens is indicated, provide lens with a minimum visible light transmittance of 92 percent, unless otherwise indicated.
- C. Where prismatic acrylic lens is indicated, lens shall be composed of 3/16in (4.7mm) square non-convex prismatic cones of maximum 0.080in (2mm) depth and aligned 45° to the length and width of the lens panel, unless otherwise specified. Lens shall be a minimum of 7.5 oz. per square foot (2289g/m<sup>2</sup>). Lens shall have minimum 80 percent visible light transmittance.
- D. Where diffuse acrylic lens is indicated, lens shall be diffuse frosted white, high transmission acrylic with a minimum 73 percent visible light transmittance unless otherwise indicated. Provide nominal 0.125in (3mm) thick lens unless otherwise specified.

- E. Where acrylic "overlay" is indicated, lens shall be supported by other rigid luminaire members, such as louvers or shelves. Lens shall be white or clear, as specified, with a minimum 79 percent visible light transmission for white lenses, and a minimum 83 percent transmission for clear lenses. Provide 0.040in (1mm) thick lens unless otherwise indicated.
- F. Make lenses, louvers, or other light diffusing elements contained in frames removable, but positively held within the frames so that hinging or other motion of the frame will not cause the diffusing element to drop out.
- G. For recessed luminaires with trim that is removable or open for access to the interior of the luminaire, and serves as a ceiling trim, provide trim that is positively held to the luminaire body by adjustable means that permit the trim to be drawn up to the ceiling as tight as necessary to insure complete contact of faceplate with ceiling surrounding the luminaire.

## 2.11 RATED LOCATION LUMINAIRES

- A. General:
  - 1. Provide luminaires designed and manufactured specifically for "rated" (e.g., damp, wet, shower, hazardous) location service. Components, including nuts, bolts, rivets, springs, and similar parts shall be made of materials of effective corrosion resistance, or of materials which have been subjected to finishing treatment which will assure such resistance.
  - 2. Provide anodized aluminum for aluminum parts of exterior luminaires that are not specified as requiring a painted finish.
  - 3. All luminaires shall be constructed according to UL procedures, and listed by UL ETL or CSA-US for the appropriate category.
- B. Damp Location:
  - 1. In addition to the requirements of paragraph, above, damp location luminaires shall meet or exceed the following criteria:
    - a. Provide metal parts of luminaires, which are specified as requiring painting, for use in indoor, outdoor or damp locations, which are painted with suitable weather and/or moisture resisting qualities.
    - b. Provide luminaires for use outdoors, or in areas designated as damp locations, which are suitably and effectively gasketed to prevent access of moisture into electrical components or enclosing diffusers, lenses or globes.
    - c. Luminaires shall be UL, ETL or CSA-US listed for damp locations.
- C. Wet Location:
  - 1. In addition to the requirements of Paragraphs above, wet location luminaires shall meet or exceed the following criteria:
    - a. Any exposed luminaires shall be UL, ETL or CSA/US rated for wet locations.
    - b. Provide luminaires for use outdoors, or in areas designated as wet locations, which are suitably and effectively gasketed to prevent access of moisture into electrical components or enclosing diffusers, lenses or globes.

- c. Provide wet location luminaires with a suitable IP rating for their planned environment, unless otherwise specified in Appendix – Luminaire Schedule.
  - 1) Recessed luminaires suitable for wet location shall have a minimum IP54 rating.
  - 2) Surface mounted luminaires exposed to direct rain, shall have a minimum IP65 rating.
  - 3) Luminaires intended to be cleaned by high pressure waterjet cleaning, shall have a minimum IP66 rating.
  - 4) Ground-mounted luminaires located in floodplains, shall have a minimum IP68 rating.

D. Bathtub and Shower Locations:

- 1. In addition to the relevant requirements of paragraphs above, "Bathtub and Shower" location luminaires shall meet all applicable local codes and standards.
  - a. Luminaire shall be damp location rated.
  - b. Luminaire shall be recessed or surface-mounted at or above 8'-0" (2.43m) above and at least 3'-0" (0.91m) horizontally from the highest point in the shower (threshold) or the tub (tub rim).
  - c. Luminaires used in or near showers, or in similar locations, shall be UL or ETL listed specifically for such use.
  - d. Provide damp/wet location luminaires with a suitable IP rating for their planned environment, unless otherwise specified in Appendix – Luminaire Schedule.
    - 1) Luminaires located in bathtub and showers shall have a minimum IP65 rating.

## 2.12 LUMINAIRE DESCRIPTIONS

A. General:

- 1. Provide luminaires which conform to the above standards and criteria, as indicated on the drawings, and as indicated below and in APPENDIX - Luminaire Schedule.
- 2. Verify mounting conditions and trim for all luminaire types.
- 3. Verify all voltages, and verify which luminaires require ducted or plenum air supply or return capability or are to be static.
- 4. Catalogue or series numbers, when shown herein, are intended to assist in establishing general type or category of luminaires. Provide a luminaire that meets the complete performance descriptions, as well as information provided by detail drawings. Standard catalogue cuts, when included, are for general assistance. Written luminaire descriptions are the primary basis for luminaire specification. The Luminaire Schedule in the Appendix supersedes any legend or schedule on the Electrical Drawings.
- 5. The terminology "Or Approved Equal" if and only if used on the Luminaire Schedule, means the following: Products fabricated by alternative manufacturers to those listed may be submitted under the terms of the substitution clauses outlined in this Section. The products must meet the specifications in every way. Any substitutions or alternatives may be accepted or rejected without a detailed explanation.

6. Provide timely and written notification of any discrepancies between drawing and specifications before submitting bids. If such discrepancies are not resolved prior to the end of the bid period, the more costly alternative will be considered as included in the bid price. See paragraph above regarding definition of Acceptable Manufacturers.
7. All finishes are to be factory applied, including colored flanges and trims.

B. Spare Parts / Extra Stock:

1. Provide spare parts and extra stock to the Owner upon completion of the work. Extra stock quantities shall be included in main order to prevent additional cost to the Owner. All boxes shall be clearly labeled regarding contents, relevant luminaire type, and description. All spare parts shall be turned over to the Owner's authorized representative, and a receipt in duplicate, signed by the site representative shall be delivered to the Owner's authorized representative.
2. The following spare parts shall be provided as a minimum unless otherwise directed by Owner. Additional spare parts shall be provided as required by mention elsewhere in this specification, other sections of these Specifications, or the Contract Drawings:
  - a. Sources/Lamps: Ten (10) percent (but not less than six (6) of each type)
  - b. Ballasts/Transformers/ Power Supplies/LED Drivers: Five (5) percent (but not less than one (1) of each type)
  - c. Lenses, Baffles, Snoots, Barndoors: Ten (10) percent (but not less than one (1) of each type)

C. LUMINAIRE SCHEDULE: SEE SECTION 26 51 13 APPENDIX LUMINAIRE SCHEDULE AT THE END OF THIS SECTION.

1. Complete specifications for the components (sources, power supplies, LED drivers, ballasts, reflectors, lenses, etc.) of luminaires described below are found above in Part 2. The Luminaire Schedule below supersedes any similar legend or schedule issued previously or issued concurrently on the Drawings. Provide timely and written notification of any discrepancies before preparing any bids or proceeding with any work.
2. Descriptions for additional luminaire types, specified by the Electrical Engineer, may be located on the Electrical Drawings.

2.13 POLE/LUMINAIRE ASSEMBLIES

- A. Supply luminaires, davit arms, brackets, poles, handhole covers, base components, and all other accessories complete by specified manufacturer who will be responsible for proper fitting of all elements.
- B. Manufacturer will supply assembly to withstand 100 mph winds with a 1.3 gust factor without permanent deflection.
- C. Manufacturer shall be responsible for design of and structural integrity of pole and complete base (i.e., concrete dimensions, rebar requirements, grounding and conduit requirements, drainage and ground compaction requirements under the specific installation conditions for the project).

### **PART 3 - EXECUTION**

#### **3.1 GENERAL**

- A. Install luminaires complete with light sources, as indicated, and with equipment, materials, parts, attachments, devices, aligner and filler clips, hardware, hangers, cables, supports, channels, frames and brackets necessary to make a safe, complete, and fully operative installation.
- B. Verify and provide luminaires that are appropriate for the ceiling and mounting conditions of the project.
- C. Coordinate with other trades as appropriate to properly interface installation of luminaires with other work.
- D. Reject and do not install blemished, damaged, or unsatisfactory luminaires. Replace imperfect or unsatisfactory luminaires, if installed, as directed.
- E. Set luminaires, when installed, to be true, and free of light leaks, warps, dents, or other irregularities. No light leaks are permitted at the ceiling line or from any visible part or joint of the luminaires. Install luminaires plumb, square, and level with ceiling and walls, in alignment with adjacent luminaires, and secure in accordance with manufacturers' directions and approved shop drawings. Install all adjacent and continuous luminaires straight and trued, aligned in both plan and elevation. Supply and install alignment rods or joint straps as required to achieve this effect.
- F. Provide finish for exposed parts or trims as specified. If not indicated, provide a finish as directed.
- G. Do not install reflector cones, aperture plates, lenses, diffusers, louvers, and decorative elements of luminaires until completion of wet work, plastering, painting and general clean-up in the area of the luminaires.
- H. Mount luminaires at heights and locations indicated on the Contract Drawings, or as required by Architect. Mounting heights specified or indicated are to be to the bottom of each luminaire for suspended and ceiling-mounted luminaires, and to the center of each luminaire for wall-mounted luminaires, unless otherwise noted. Obtain approval of the exact mounting for luminaires on the job before installation is commenced and, where applicable, after coordinating with the type, style, and pattern of the surface being installed.
- I. Conform to the requirements of NFPA 70, and all other relevant codes. Supports shall be suitable for local seismic zone.
- J. In Mechanical Equipment Rooms, luminaires shall be hung from ceilings after piping and equipment therein has been installed. Exact locations for such luminaires shall be determined at the job site during the course of the Work, in coordination with the mechanical work.

- K. Adequately protect the housing of recessed luminaires during installation by internal blocking or framing to prevent distortion of sides, or dislocation of threaded lugs, which, upon completion, shall be in perfect alignment and match the corresponding holes in frames or rims. Holding screws shall be inserted freely without forcing and shall remain easily removable for servicing.
- L. Ground non-current-carrying parts of electrical equipment in accordance with UL and NEC provisions.
- M. Upon completion of installation of luminaires, and after building circuits have been energized, apply electrical energy to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at the site, then re-test to demonstrate compliance. Otherwise, remove and replace with new units, and proceed with re-testing. Coordinate all test times and requirements with the Architect or Construction Manager.
  - 1. For normal and emergency building lighting, upon completion of the installation, conduct an operating test to show that the equipment operates in accordance with the requirements of this and other relevant sections.
  - 2. Test all wiring with an insulation testing instrument, both before and after connection of luminaires and equipment. The minimum resistance shall be 250,000 ohms.
- N. Upon completion of the installation, the luminaires and lighting equipment shall be in first class operating order and free from defects in condition and finish. At time of final inspection, all luminaires and equipment shall be clean, fully lamped, and be complete with required lenses or diffusers, reflectors, side panels, louvers, or other components necessary for the function of the luminaires. Any reflectors, lenses, diffusers, side panels or other parts damaged prior to the final inspection shall be replaced prior to inspection.
- O. At the time of substantial completion and prior to field tests, replace lamps (excluding LED lamps and light engines) in interior luminaires which have been operating more than six months, or as work lights, or which are observed to be noticeably dimmed after use and testing during the construction period.
- P. Luminaires and sources that are part of the Work of this section shall not be used for work lights during construction, except in Mechanical Equipment rooms. Provide adequate portable or temporary lighting for construction.
- Q. Vibration Isolation: Mount and support all luminaires in such a manner to isolate the luminaire from structure-borne vibration, including but not limited to vibration caused by fans, motors, moveable tracks, moveable partitions, portable carts, vehicles, etc.

### 3.2 ACCESSIBILITY

- A. Install equipment such as junction and pull boxes, luminaire housings, transformers, power supplies, ballasts, switches and controls, and other apparatus that shall be reached from time to time for operation and maintenance, to be easily accessible and appropriate for mounting and ceiling conditions.



### 3.3 SUPPORTS

- A. Luminaires shall be securely fastened as per manufacturer's instructions. Provide plaster frames or mounting frames for luminaires that require them. Such frames shall be appropriate for the ceiling construction in which they are installed.
- B. Provide necessary hardware with luminaires, such as stems, plates, plaster frames, hangers and similar items, for safe support of the luminaire. Provide plaster frames made of non-ferrous metal, or of steel that has been suitably rustproofed after fabrication, as described above.
- C. Provide supports for luminaires that are adequate to support the weight of the luminaires.
- D. Provide hanging devices which, if visible from normal viewing angles, exactly match luminaire finishes specified, unless otherwise noted.
- E. Where necessary to meet fire resistance requirements of Building Code authorities, provide enclosures housing recessed luminaires that are constructed to meet or exceed required fire resistance rating.
- F. Provide attachment devices including brackets and cast metal shapes with the requisite rigidity and strength to maintain continuous alignment of installed luminaires. Attach luminaires to ceiling support members, and do not depend upon lathing, plaster or ceiling tile for alignment or support.
- G. Provide luminaires mounted in suspended ceilings that are supported by saddle hangers or the bars attached to runners or between crossbars of ceiling systems. Provide mounting splines or other positive means of maintaining alignment and rigidity.
- H. Provide supporting members that are surface passivated, and which are primed or paint-dipped to resist corrosion.
- I. Provide fastening devices of a positive locking type, which do not require special tools to apply or remove them. Do not use tie wires in place of fastening devices.
- J. Contractor is responsible for the necessary suspension system. Contractor shall ascertain the structural reliability of supports provided under other Sections of the specification.
- K. Attach reflectors to housings by means of safety chains, which shall prevent reflectors from falling. No part of the chain may be visible after installation, when viewed from any angle up to 50 degrees from the vertical.
- L. Provide pendant or surface mounted luminaires with required mounting devices and accessories, including hickeys, stud-extensions, ball aligners, canopies, and stems. Uniformly maintain the luminaire heights shown on the Contract Drawings or established in the field. The allowable tolerances in individual luminaire mounting shall not exceed 1/4 inch (7mm) and may not vary more than 1/2 inch (14mm) from the mounting height shown on the drawings. Install luminaires hung in continuous

runs absolutely level, and in line with each other. Hanging devices shall comply with code requirements.

- M. Provide an approved ceiling canopy for each stem, exactly matching specified finishes.
- N. Place stems to be vertical and plumb.
- O. Provide at least two rigid supports for individually mounted suspended linear luminaires. Where luminaires are ganged, provide supports at 8'-0" (2438mm) intervals, unless otherwise indicated.
- P. Recessed and semi-recessed luminaires:
  - 1. Support rods or wires shall be provided with a minimum of four rods or wires per luminaire and located not more than 0'-6" (152mm) from each corner of each luminaire.
  - 2. Do not support luminaires by ceiling acoustical panels.
  - 3. Where luminaires of sizes less than the ceiling grid are indicated to be centered in the acoustical panel, support such luminaires independently or with at least 0'-2 3/4" (19mm) metal channels spanning and wired to the ceiling tees.
  - 4. Provide rods or wires for luminaire support under this section of the specifications.

#### 3.4 AIMING AND ADJUSTMENT:

- A. Provide labor and tools for final aiming, focusing and adjustment, under the Architect's and Lighting Consultant's supervision, of all adjustable luminaires after regular working hours, and after dark in daylighted areas, whenever necessary, at no additional cost to the project. All luminaires shall be locked into place so that the aiming is not disturbed during future replacement of light source or power supply.
- B. Request preliminary aiming diagrams during the shop drawing submittals. If aiming diagrams are provided, pre-aim those luminaires during installation or prior to final aiming.
- C. If colored or diffusing filters are specified, supply up to four (4) theatrical gels for each luminaire type, in colors to be selected by the Architect after installation. Place alternate gels over the luminaires as requested. When the final colors are selected, order the filters from the manufacturer, and install them. Note that the time between ordering and shipping may be approximately four weeks.
- D. When extra lenses, louvers or shields are specified, change accessories until a final selection is made.
- E. Note final aiming and locked positions and include that information in the O&M manual.

### 3.5 CLEANING

- A. Immediately prior to occupancy, clean reflector cones, reflectors, aperture plates, lenses, louvers, sources and decorative elements. As per manufacturer's instructions, de-staticize lenses after cleaning, installing them to leave no finger or dirt marks.
- B. Upon completion of the luminaire installation and at the time of final inspection, luminaires shall be clean, and free from marks, dust, spotting or other defects. Replace any broken or defective parts prior to final inspection. Replace or make good all defects revealed by final inspection.
- C. Protect installed luminaires from damage during the remainder of construction period.

### 3.6 COMMISSIONING

- A. For any luminaire, power supply, LED driver, ballast, or lighting control system, provide a complete and operational system which meets or exceeds the performance specified.
- B. The Owner shall provide for or engage an independent commissioning agent to verify that all components and system as a whole meets design intent and to evaluate the Contractor's work. This includes evaluation and verification of all adjustable features, such as aiming angles, time clock settings, sensitivity settings, high end trim, fine tuning, customized settings, etc. Provide labor and equipment after normal working hours to correct and adjust system, working with or without direct supervision of commissioning agent until reasonable satisfaction has been achieved.
- C. Provide Spares, as described in Part 2 above.
- D. Submit a maintenance manual and operational submittals, as called for in Part 1 above, and under the conditions of the relevant General Requirements. After submittal is reviewed, make changes and resubmit, if necessary. After review and approval, this manual will be kept on site for reference use by facility maintenance personnel.
- E. Assemble and submit in either a bound 8.5in x 11in (216mm x 279mm) format or electronic format, as confirmed by Owner, an Operation and Maintenance Manual that includes the following:
  - 1. A chart clearly documenting the luminaire, source, power supply, LED driver and/or ballast actually installed for each luminaire type, with product designations sufficient for reordering new product and components to match those installed.
    - a. For Digital Addressable Fixtures: A chart clearly documenting luminaire type, Make/Model, location, digital address, control address, for client operation and for future maintenance.
  - 2. A current list of lighting distributors, manufacturers and manufacturer's representatives, (for the purposes of replacement, reordering or troubleshooting). This list shall be keyed to the list of luminaires, sources, power

- supplies, LED drivers and ballasts, so that the Owner has a name, address and phone number of at least two (2) contacts for each product or component.
3. Shop drawings, technical data sheets, product technical documents, installation instructions, cut sheets, operating instructions, calibration instructions, and troubleshooting guides in the installation, including but not limited to sources, power supplies, LED drivers, ballasts and lighting control devices.
  4. Color-coded as-built drawings showing all source, power supply, LED drivers and ballast types, to facilitate replacement. O&M Walk-through: Transfer of the O&M document will include a thorough walk-through and demonstration of equipment by Contractor for facility personnel.
- F. Owner Training: At the Owner's convenience, provide a minimum of four (4) hours, not to exceed eight (8) hours, of expertise and training concerning the installation, characteristics, operations and maintenance of the Work of this Section. Such training shall take place after the Owner has been provided the final approved maintenance and operational submittals mentioned above.
- G. Video-tape the training session and provide two (2) copies on flash/thumb drives, or DVD. Alternative electronic formats may be provided if mutually agreed upon.
- H. Solid State Lighting / Light Emitting Diode LED luminaires:
1. Color Changing or Programming Support
    - a. Manufacturer shall provide installation and commissioning support to the electrical contractor as required to achieve a complete and operational system that meets the intent of the Control Intent Narrative.
    - b. The lighting controls Integrator shall assist the Contractor and ensure that the color changing system is installed, programmed and operating correctly, that all integral sensors are functioning properly and to verify luminaire performance. Integrator shall coordinate with contractors, other required disciplines and with luminaire manufacturers to ensure that the lighting color-changing and/or control system is coordinated between the various disciplines for a fully functioning system. Commissioning shall include intermittent testing of lighting system and other components during the process of construction, as well as up to \_\_\_ (X) full days of programming sessions with the owner's representatives and lighting designer. This shall be subsequent to the final completion of system start-up. Additional programming days may be added as required.
    - c. Two (2) full day follow up site visits shall be provided by the Commissioning Agent and Integrator to ensure lasting functionality update of the lighting control system. The first visit shall take place three (3) months after installation and the second shall take place one (1) year after the installation.

## **PART 4 - APPENDICES**

### 4.1 GENERAL

- A. The appendices listed below are integral parts of the specifications and contract documents. If either Appendix is missing or incomplete, provide timely and written notification. Do not submit a bid based on incomplete information.

### 4.2 APPENDIX A – LUMINAIRE SCHEDULE

- A. See Part 2 above for complete specifications for the components (sources, power supplies, LED drivers, ballasts, reflectors, lenses, etc.) of the luminaires described in the Schedule. The Luminaire Schedule below supersedes any similar legend or schedule issued previously or issued concurrently on the drawings. Provide timely and written notification of any discrepancies before preparing any bids or proceeding with any work.

**Luminaire Schedule**

**GENERAL NOTES:**

- Provide luminaire shop drawings for Lighting Consultant, Architect, and Owner approval prior to fabrication. For all continuous run luminaires, including track, manufacturer shall submit a layout drawing for run lengths specified on architectural drawings during submittal review for Lighting Designer and Architect approval prior to fabrication.
- Architect shall verify all luminaire body, trim, flange, pole, track and any other visible accessories/hardware finishes. All visible conduit, junction boxes, canopy plates, hardware, gear containers, etc. shall be painted to match adjacent surfaces (Architect to verify).
- Refer to electrical drawings for voltage information. Electrical contractor shall verify all voltages with Electrical Engineer before placing any orders or proceeding with any work.
- Electrical contractor shall verify emergency operation of all luminaires with Electrical Engineer before placing any orders or proceeding with any work. Refer to electrical drawings for all emergency or code-related requirements.
- Contractor shall verify and coordinate recessed luminaire installation and mounting with architectural details, housing type, field conditions, and ceiling system details including grid type and flange requirements such that there are no light leaks between luminaire and ceiling system and luminaire can accommodate ceiling thickness.
- Contractor to verify and coordinate all other luminaire installation and mounting with architectural details and field conditions.
- Contractor shall verify mounting details with architect and/or architectural drawings and order all mounting components necessary for installation of luminaire at no additional cost, even if such components are not specifically called for in the contract documents.
- Provide adequate and sturdy support for each luminaire. Contractor shall be responsible for verifying weight and mounting method of all luminaires and furnish and install suitable supports. Luminaire mounting assemblies shall comply with all local seismic codes and regulations.
- Provide all luminaires as shown complete with all light sources, completely wired, controlled and securely attached to supports.
- Where both narrative and/or pictorial luminaire descriptions are provided, the written description shall take precedence and prevail. Contractor to confirm via RFI process with lighting designer and architect.
- Locations of luminaires are shown diagrammatically. Verify exact location and spacing with architectural drawings and designer at the site during installation. Notify Owner about field conditions at variance with Contract Documents before commencing installation.
- At the completion of construction, clean lenses and reflectors of all luminaires so as to render them free of any material, substance or film foreign to the luminaire. Blemished, damaged, or unsatisfactory luminaires shall be replaced in a satisfactory manner.

- When applicable, contractor shall review existing circuiting, verify new loads and panel capacity. Contractor shall notify Owner if a conflict between design documents and field conditions occur.
- Contractor shall refer to electrical drawings for information on controls and dimming requirements, and coordinate luminaire and control accessories required for a fully functioning system.
- Contractor to provide line item pricing at bid phase or earlier as requested by lighting designer or architect per type with labor and installation shown as separate line items.
- All 0-10V dimming gear provided shall be isolated to avoid AC interface on the dimming line.
- All LED sources within the same luminaire Type shall be within two (2) MacAdam ellipses/steps of each other.
- For all adjustable luminaires provide labor and materials for final aiming and locking of all adjustable luminaires under the Architect's supervision. Aiming shall take place immediately before building is turned over to Owner, after regular working hours where required. Contractor shall coordinate necessary personnel and equipment
- All luminaires shall have a minimum 3-year warranty.
- All lighting systems shall be ordered with necessary gear, power feeds and mounting accessories as required for installation of a complete system.
- Locate remote gear in a secure, concealed, accessible and well-ventilated location in compliance with manufacturer's directions.
- All luminaires and workmanship shall be guaranteed free of defects and fully operational for a minimum of one year after the acceptance of the project by the Owner unless otherwise indicated in the specifications. Any luminaires or workmanship found to be defective during the warranty period shall either be fixed or replaced by the Contractor at no cost to the Owner.
- The luminaires and workmanship must be in accordance with and meet the standards and regulations of the following: Underwriters Laboratories, National Electric Code, & Local Building and Life Safety Code Agencies.
- Replace all burned-out or inoperative sources and gear in all luminaires before the building is accepted by the Owner so that all luminaires will be in first class operating condition.
- For pendant mounted luminaires provide adequate cord length to suspend luminaires at heights shown on architectural drawings or indicated in the lighting fixture schedule.
- Electrical contractor shall field-verify each run length of continuous fixtures prior to ordering.
- Provide luminaire samples per type as requested in the Fixture Schedule. Supply a completely operable luminaire with cord and plug for standard 120 Volt service.
- Code required accessories and controls such as but not limited to motion sensors, photocell controls, dimming controls, etc. to be specified and coordinated by Electrical Engineer.

TYPE	LOCATION	DESCRIPTION	FIXTURE FINISH	LAMPS/SOURCE	POWER SUPPLY/ DRIVER	INPUT WATTS	INPUT WATT UNITS	LISTING	MANUFACTURER	NOTES
<b>INTERIOR FIXTURES</b>										
FB1	Lobby	5.86" wide by 17.5" long LED pendant mounted multihead fixture with 3 adjustable fixture heads	PER ARCHITECT	LED 3500K 80+ CRI L90 @ 50,000 hrs 3,240 Delivered Lumens	INTEGRAL DIM (1% Dimming) 0-10V	31.0W	EA	Etl Listed to cUL Standards, suitable for dry and damp locations	3G Lighting  3G-PM3-10-S80-35K-20D-(VOLTAGE)- DIM-(FINISH)-(HOUSING)-(CABLE)- (OPTIONS)	1. Refer to architectural drawings for suspension height AFF, provide suspension length or sufficient length of field-adjustable suspension as required. Fixture to be centered between ceiling panels. Bottom of fixture housing to align with bottom of ceiling panel. 2. Electrical Engineer/Contractor to verify compatibility of light source, gear and dimming system. 3. Architect to verify fixture finish. 4. Fixture requires aiming on site with Lighting Designer and Electrical Contractor. See specification section 26 5113 for details.
FB2	Lobby Curtains	RGBIL LED theatrical style spotlight fixture with ellipsoidal reflector, 50deg lens tube, shutters and Soft Focus Diffuser and Top Hat Accessories	PER ARCHITECT	LED RGBL  L70 @ 54,000 hrs 9,498 Maximum Lumens	INTEGRAL DIM (1% Dimming) DMX512	197.0W	EA	cETLus Listed	ETC CSSPOTVMVS-7423A1011 / LED50LT- 7460A2008 / 400TH-PSF1021 / S4LED- SFD-7460A4019	1. Luminaires shall be controlled by a DMX controller with manual control of color. Supply, install and commission a complete working system that will provide DMX-controlled color-changing light as a complete system capable of unified color changes. The controls for this feature shall control the color-changing luminaires indicated on drawings. The system shall include all luminaires, control wire and control equipment as required to provide a functioning system. 2. Contractor shall verify and coordinate luminaire installation and mounting with architectural details, housing type, field conditions, and ceiling system details including ceiling thickness, grid type, flange and insulation clearance requirements. 3. Electrical Engineer/Contractor to verify compatibility of light source, gear and dimming system. 4. Architect to verify fixture finish. 5. Fixture requires aiming on site with Lighting Designer and Electrical Contractor. See specification section 26 5113 for details.

TYPE	LOCATION	DESCRIPTION	FIXTURE FINISH	LAMPS/SOURCE	POWER SUPPLY/ DRIVER	INPUT WATTS	INPUT WATT UNITS	LISTING	MANUFACTURER	NOTES
FB3	Restrooms	3" aperture recessed, beveled LED downlight with 40 degree optic	PER ARCHITECT	LED 3500K 90+ CRI L70 @ 50,000 hrs 1,124 Delivered Lumens	INTEGRAL DIM (1% Dimming) 0-10V	12.0W	EA	ETL Listed for Damp locations	Tech Lighting E3R-FF-LO-935-4-D-(HOUSING) / E3R- F-B-O-(FINISH)	1. Luminaire shall be U.L. (or equivalent approved agency) listed and labeled "Suitable for damp locations." 2. Contractor shall verify and coordinate luminaire installation and mounting with architectural details, housing type, field conditions, and ceiling system details including ceiling thickness, grid type, flange and insulation clearance requirements. 3. Electrical Engineer/Contractor to verify compatibility of light source, gear and dimming system. 4. Architect to verify fixture finish.
FB3A	Green Room, Dressing Rooms	3" aperture recessed, beveled LED downlight with 40 degree optic	PER ARCHITECT	LED 3500K 90+ CRI L70 @ 50,000 hrs 1,124 Delivered Lumens	INTEGRAL DIM (1% Dimming) 0-10V	12.0W	EA	ETL Listed for Damp locations	Tech Lighting E3R-FF-LO-935-4-D-(HOUSING) / E3R- F-B-O-(FINISH)	1. Luminaire shall be U.L. (or equivalent approved agency) listed and labeled "Suitable for damp locations." 2. Contractor shall verify and coordinate luminaire installation and mounting with architectural details, housing type, field conditions, and ceiling system details including ceiling thickness, grid type, flange and insulation clearance requirements. 3. Electrical Engineer/Contractor to verify compatibility of light source, gear and dimming system. 4. Architect to verify fixture finish.
FB3B	Dressing Rooms	3" aperture recessed, beveled, shower rated LED downlight with 40 degree optic	PER ARCHITECT	LED 3500K 90+ CRI L70 @ 50,000 hrs 1,124 Delivered Lumens	INTEGRAL DIM (1% Dimming) 0-10V	12.0W	EA	Shower Version - Wet Listed	Tech Lighting E3R-FF-LO-935-4-D-(HOUSING) / E3R- F-B-H-(FINISH)	1. Luminaire shall be U.L. (or equivalent approved agency) listed and labeled "Suitable for shower locations." 2. Contractor shall verify and coordinate luminaire installation and mounting with architectural details, housing type, field conditions, and ceiling system details including ceiling thickness, grid type, flange and insulation clearance requirements. 3. Electrical Engineer/Contractor to verify compatibility of light source, gear and dimming system. 4. Architect to verify fixture finish.
FB3C	Restrooms	3" aperture recessed, beveled LED downlight with 40 degree optic	PER ARCHITECT	LED 3000K 90+ CRI L70 @ 50,000 hrs 1,124 Delivered Lumens	INTEGRAL DIM (1% Dimming) 0-10V	12.0W	EA	ETL Listed for Damp locations	Tech Lighting E3R-FF-LO-930-4-D-(HOUSING) / E3R- F-B-O-(FINISH)	1. Luminaire shall be U.L. (or equivalent approved agency) listed and labeled "Suitable for damp locations." 2. Contractor shall verify and coordinate luminaire installation and mounting with architectural details, housing type, field conditions, and ceiling system details including ceiling thickness, grid type, flange and insulation clearance requirements. 3. Electrical Engineer/Contractor to verify compatibility of light source, gear and dimming system. 4. Architect to verify fixture finish.
FB3D	Restrooms	3" aperture recessed, beveled LED downlight with 25 degree optic	PER ARCHITECT	LED 3500K 90+ CRI L70 @ 50,000 hrs 1,124 Delivered Lumens	INTEGRAL DIM (1% Dimming) 0-10V	12.0W	EA	ETL Listed for Damp locations	Tech Lighting E3R-FF-LO-935-2-D-(HOUSING) / E3R- F-B-O-(FINISH)	1. Luminaire shall be U.L. (or equivalent approved agency) listed and labeled "Suitable for damp locations." 2. Contractor shall verify and coordinate luminaire installation and mounting with architectural details, housing type, field conditions, and ceiling system details including ceiling thickness, grid type, flange and insulation clearance requirements. 3. Electrical Engineer/Contractor to verify compatibility of light source, gear and dimming system. 4. Architect to verify fixture finish.

TYPE	LOCATION	DESCRIPTION	FIXTURE FINISH	LAMPS/SOURCE	POWER SUPPLY/ DRIVER	INPUT WATTS	INPUT WATT UNITS	LISTING	MANUFACTURER	NOTES
FB3E	Exterior Canopy	3" aperture recessed, beveled, wet rated, square LED downlight with 40 degree optic	PER ARCHITECT	LED 3500K 90+ CRI L70 @ 50,000 hrs 1,124 Delivered Lumens	INTEGRAL DIM (1% Dimming) 0-10V	12.0W	EA	Shower Version - Wet Listed	Tech Lighting E3S-FF-LO-935-4-D-(HOUSING) / E3S-F B-H-(FINISH)	<ol style="list-style-type: none"> <li>Luminaire shall be U.L. (or equivalent approved agency) listed and labeled "Suitable for wet locations."</li> <li>Contractor shall verify and coordinate luminaire installation and mounting with architectural details, housing type, field conditions, and ceiling system details including ceiling thickness, grid type, flange and insulation clearance requirements.</li> <li>Electrical Engineer/Contractor to verify compatibility of light source, gear and dimming system.</li> <li>Architect to verify fixture finish.</li> </ol>
FB4	Restrooms	1.6" tall LED linear cove fixture in an architectural cove	PER ARCHITECT	LED 3500K 90+ CRI 858 Lumens per Foot	INTEGRAL DIM (1% Dimming) 0-10V	6.7W	LFT	UL Listed for Wet Location	Vode Lighting 707-Z9-SL-(LENGTH)-(RAIL)-EW- (CORD)-IP-AE-(VOLTAGE)- (EMERGENCY)-Z-SO-359-C1- (SENSORS)-(AL)-(OPTIONS)	<ol style="list-style-type: none"> <li>Luminaire shall be concealed in architectural cove. Refer to architectural drawings for details. Contractor shall provide longer lengths where possible, provide shorter lengths only as required to complete runs. Install luminaires end-to-end with no gaps. Center luminaires in cove, allow no more than 6" of free space at either end.</li> <li>Electrical Engineer/Contractor to verify compatibility of light source, gear and dimming system.</li> <li>Luminaire shall be ordered with necessary gear, control interfaces, power feed cables/terminators and mounting accessories as required for a complete system.</li> <li>Architect to verify fixture finish.</li> </ol>
FB4A	Restrooms	1.6" tall LED linear cove fixture in an architectural cove	PER ARCHITECT	LED 3000K 90+ CRI 858 Lumens per Foot	INTEGRAL DIM (1% Dimming) 0-10V	6.7W	LFT	UL Listed for Wet Location	Vode Lighting 707-Z9-SL-(LENGTH)-(RAIL)-EW- (CORD)-IP-AE-(VOLTAGE)- (EMERGENCY)-Z-SO-309-C1- (SENSORS)-(AL)-(OPTIONS)	<ol style="list-style-type: none"> <li>Luminaire shall be concealed in architectural cove. Refer to architectural drawings for details. Contractor shall provide longer lengths where possible, provide shorter lengths only as required to complete runs. Install luminaires end-to-end with no gaps. Center luminaires in cove, allow no more than 6" of free space at either end.</li> <li>Electrical Engineer/Contractor to verify compatibility of light source, gear and dimming system.</li> <li>Luminaire shall be ordered with necessary gear, control interfaces, power feed cables/terminators and mounting accessories as required for a complete system.</li> <li>Architect to verify fixture finish.</li> </ol>
FB5	Restrooms, Dressing Room	Wet rated LED tape in a .75" wide x .813" tall extrusion integrated into restroom mirrors	PER ARCHITECT	LED 3500K 90+ CRI L70 @ 50,000 hrs 205 Lumens per Foot	REMOTE DIM (1% Dimming) 0-10V	2.6W	LFT	UL Listed for Outdoor Use	Kelvix DL35K-WR-24V CH502A-(LENGTH)-FR-(MOUNTING)- EC	<ol style="list-style-type: none"> <li>Luminaire shall be U.L. (or equivalent approved agency) listed and labeled "Suitable for wet locations."</li> <li>Modular units to be installed for a continuous run condition as shown on drawing. Refer to architectural drawings for length of continuous runs, contractor shall provide an optimal combination of luminaire lengths to provide a continuous run as shown on architectural drawings.</li> <li>Luminaire shall be ordered with necessary gear, control interfaces, power feed cables/terminators and mounting accessories as required for a complete system.</li> <li>Locate remote gear in a secure, concealed, accessible and well-ventilated location in compliance with manufacturer's directions. Contractor/Manufacturer to coordinate remote gear size, location and wire gauge for &lt;2% Voltage drop over entire length of run.</li> <li>Electrical Engineer/Contractor to verify compatibility of light source, gear and dimming system.</li> <li>Architect to verify fixture finish.</li> </ol>
FB5A	NOT USED									



TYPE	LOCATION	DESCRIPTION	FIXTURE FINISH	LAMPS/SOURCE	POWER SUPPLY/ DRIVER	INPUT WATTS	INPUT WATT UNITS	LISTING	MANUFACTURER	NOTES
FB5B	Club, Green Room	Wet rated LED tape in a .75" wide x .813" tall extrusion integrated into bar counter	PER ARCHITECT	LED 3000K 90+ CRI L70 @ 50,000 hrs 205 Lumens per Foot	REMOTE DIM (1% Dimming) 0-10V	2.6W	LFT	UL Listed for Outdoor Use	Kelvix DL30K-WR-24V CH502A-(LENGTH)-FR-(MOUNTING)-EC	<ol style="list-style-type: none"> <li>Luminaire shall be U.L. (or equivalent approved agency) listed and labeled "Suitable for wet locations."</li> <li>Modular units to be installed for a continuous run condition as shown on drawing. Refer to architectural drawings for length of continuous runs, contractor shall provide an optimal combination of luminaire lengths to provide a continuous run as shown on architectural drawings.</li> <li>Luminaire shall be ordered with necessary gear, control interfaces, power feed cables/terminators and mounting accessories as required for a complete system.</li> <li>Locate remote gear in a secure, concealed, accessible and well-ventilated location in compliance with manufacturer's directions. Contractor/Manufacturer to coordinate remote gear size, location and wire gauge for &lt;2% Voltage drop over entire length of run.</li> <li>Electrical Engineer/Contractor to verify compatibility of light source, gear and dimming system.</li> <li>Architect to verify fixture finish.</li> </ol>
FB5C	Single Restrooms	Wet rated LED tape in a .75" wide x .813" tall extrusion integrated into restroom mirrors	PER ARCHITECT	LED 3000K 90+ CRI L70 @ 50,000 hrs 205 Lumens per Foot	REMOTE DIM (1% Dimming) 0-10V	2.6W	LFT	UL Listed for Outdoor Use	Kelvix DL30K-WR-24V CH502A-(LENGTH)-FR-(MOUNTING)-EC	<ol style="list-style-type: none"> <li>Luminaire shall be U.L. (or equivalent approved agency) listed and labeled "Suitable for wet locations."</li> <li>Modular units to be installed for a continuous run condition as shown on drawing. Refer to architectural drawings for length of continuous runs, contractor shall provide an optimal combination of luminaire lengths to provide a continuous run as shown on architectural drawings.</li> <li>Luminaire shall be ordered with necessary gear, control interfaces, power feed cables/terminators and mounting accessories as required for a complete system.</li> <li>Locate remote gear in a secure, concealed, accessible and well-ventilated location in compliance with manufacturer's directions. Contractor/Manufacturer to coordinate remote gear size, location and wire gauge for &lt;2% Voltage drop over entire length of run.</li> <li>Electrical Engineer/Contractor to verify compatibility of light source, gear and dimming system.</li> <li>Architect to verify fixture finish.</li> </ol>
FB5D	Club	Wet rated LED tape in a .75" wide x .813" tall extrusion integrated into bar shelves	PER ARCHITECT	LED 3000K 90+ CRI L70 @ 50,000 hrs 205 Lumens per Foot	REMOTE DIM (1% Dimming) 0-10V	2.6W	LFT	UL Listed for Outdoor Use	Kelvix DL30K-WR-24V CH502A-(LENGTH)-FR-(MOUNTING)-EC	<ol style="list-style-type: none"> <li>Luminaire shall be U.L. (or equivalent approved agency) listed and labeled "Suitable for wet locations."</li> <li>Modular units to be installed for a continuous run condition as shown on drawing. Refer to architectural drawings for length of continuous runs, contractor shall provide an optimal combination of luminaire lengths to provide a continuous run as shown on architectural drawings.</li> <li>Luminaire shall be ordered with necessary gear, control interfaces, power feed cables/terminators and mounting accessories as required for a complete system.</li> <li>Locate remote gear in a secure, concealed, accessible and well-ventilated location in compliance with manufacturer's directions. Contractor/Manufacturer to coordinate remote gear size, location and wire gauge for &lt;2% Voltage drop over entire length of run.</li> <li>Electrical Engineer/Contractor to verify compatibility of light source, gear and dimming system.</li> <li>Architect to verify fixture finish.</li> <li>Provide manufacturer's dimensioned shop drawings showing all materials, finishes and components for Lighting Designer and Architect review prior to fabrication.</li> <li>Fixture to run the full length of each bar shelf. Fixtures to be located at the back of each bar shelf. Refer to Architectural drawings for mounting details.</li> </ol>

TYPE	LOCATION	DESCRIPTION	FIXTURE FINISH	LAMPS/SOURCE	POWER SUPPLY/ DRIVER	INPUT WATTS	INPUT WATT UNITS	LISTING	MANUFACTURER	NOTES
FB6	Club	3.5" aperture, 3.5" tall, surface mounted LED downlight with 40 degree optics	PER ARCHITECT	LED 3000K 90 CRI L80 @ 55,000 hrs 934 Delivered Lumens	REMOTE DIM (1% Dimming) 0-10V	7.3W	EA	UL Listed	ALW NRM3-10-90-30-R4-NN-(DRIVER)-V01-(SHELL)-(SUSPENSION)-(SENSORS)-(EMERGENCY)	<ol style="list-style-type: none"> <li>Luminaire shall be mounted over a junction box.</li> <li>Electrical Engineer/Contractor to verify compatibility of light source, gear and dimming system.</li> <li>Luminaire shall be ordered with necessary gear, control interfaces, power feed cables/terminators and mounting accessories as required for a complete system.</li> <li>Locate remote gear in a secure, concealed, accessible and well-ventilated location in compliance with manufacturer's directions. Contractor/Manufacturer to coordinate remote gear size, location and wire gauge for &lt;2% Voltage drop over entire length of run.</li> <li>Luminaire finish to be verified by Architect</li> </ol>
FB7	Club	6.25" wide x 5.5" tall decorative pendant	PER ARCHITECT	LED 2700K  350 Lumens	INTEGRAL DIM (1% Dimming) 0-10V	3.5W	EA	UL Listed	Hennepinmade PCR-(FINISH)	<ol style="list-style-type: none"> <li>Refer to architectural drawings for suspension height AFF, provide suspension length or sufficient length of field-adjustable suspension as required. Luminaire shall be mounted over a junction box (by electrician). Contractor shall verify all seismic requirements</li> <li>Electrical Engineer/Contractor to verify compatibility of light source, gear and dimming system.</li> <li>Luminaire finish to be verified by Architect.</li> </ol>
FB8	Club	Field cuttable LED tile, behind frosted acrylic behind bar.	PER ARCHITECT	LED 3000K 90+ CRI L80 @ 75,000 hrs 150 Lumens per Square Foot	REMOTE DIM (1% Dimming) 0-10V	1.3W	SQFT	UL Listed	Cooledge TILE-INT-150-30-R2 CTR-SCT-DALI-58V	<ol style="list-style-type: none"> <li>Luminaire shall be mounted vertically behind frosted acrylic. Refer to architectural drawings for mounting details.</li> <li>Luminaire shall be ordered with necessary gear, control interfaces, power feed cables/terminators and mounting accessories as required for a complete system.</li> <li>Locate remote gear in a secure, concealed, accessible and well-ventilated location in compliance with manufacturer's directions. Contractor/Manufacturer to coordinate remote gear size, location and wire gauge for &lt;2% Voltage drop over entire length of run.</li> <li>Electrical Engineer/Contractor to verify compatibility of light source, gear and dimming system.</li> <li>Luminaire finish to be verified by Architect.</li> </ol>
FB9	Lobby, Exterior Canopies	3.57" x 3.57" suspended, wet rated LED linear fixture	PER ARCHITECT	LED 3500K 80+ CRI L70 @ 50,000 hrs 1114 Nominal Lumens per foot	INTEGRAL DIM (1% Dimming) 0-10V	9.8W	LFT	UL Wet Location	Alight ALD3ST-(LENGTH)-LH-35-(VOLTAGE)-HE-P(X)-(FINISH)-D-(EMERGENCY)-(SENSORS)-Q	<ol style="list-style-type: none"> <li>Contractor shall verify and coordinate luminaire installation and mounting with architectural details, housing type, field conditions, and ceiling system details including ceiling thickness, grid type, flange and insulation clearance requirements.</li> <li>Modular units to be installed for a continuous run condition as shown on drawing. Refer to architectural drawings for length of continuous runs, contractor shall provide an optimal combination of luminaire lengths to provide a continuous run as shown on architectural drawings.</li> <li>Luminaire shall be U.L. (or equivalent approved agency) listed and labeled "Suitable for wet locations."</li> <li>Electrical Engineer/Contractor to verify compatibility of light source, gear and dimming system.</li> <li>Luminaire finish to be verified by Architect.</li> </ol>
FB10	NOT USED									
FB11	Speak Easy	3.5" aperture, 4" tall, surface mounted LED downlight with 33 degree optics	PER ARCHITECT	LED 3000K 90+ CRI L70 @ 50,000 hrs 883 Delivered Lumens	INTEGRAL DIM PHASE	12.0W	EA	IP53, ETL Listed	Delta Light BOXY R 93033 DIM8	<ol style="list-style-type: none"> <li>Luminaire shall be mounted over a junction box.</li> <li>Electrical Engineer/Contractor to verify compatibility of light source, gear and dimming system.</li> <li>Luminaire finish to be verified by Architect</li> </ol>

TYPE	LOCATION	DESCRIPTION	FIXTURE FINISH	LAMPS/SOURCE	POWER SUPPLY/ DRIVER	INPUT WATTS	INPUT WATT UNITS	LISTING	MANUFACTURER	NOTES
FB12	Speakeasy	24" x 24" custom pendants with 14 lamps drops in a staggered configuration with an assortment of LED Smoke Lamps:	PER ARCHITECT	LED 3000K 80+ CRI  3,850 Lumens	INTEGRAL DIM TRIAC	56.0W	EA	UL Listed for Dry Locations	MixMatch Lighting m5-12mp-1-r10n1041-54	<ol style="list-style-type: none"> <li>1. Refer to Architectural drawings for mounting details. Luminaire shall be mounted over a junction box (by electrician). Contractor shall verify all seismic requirements.</li> <li>2. Electrical Engineer/Contractor to verify compatibility of light source, gear and dimming system.</li> <li>3. Luminaire finish, lamps, socket style, and suspension length to be verified by Architect.</li> <li>4. Provide manufacturer's dimensioned shop drawings showing all materials, finishes and components for Lighting Designer and Architect review prior to fabrication.</li> <li>5. Provide fixture with the following lamp styles: LED Smoke Edison, LED Smoke 7" Tube, LED Smoke 3" Globe, LED Smoke 5" Globe</li> <li>6. Provide lamps with 3000K.</li> </ol>
FB13	Speakeasy	2.5" aperture, 3" regressed LED perimeter slot fixture	PER ARCHITECT	LED 3000K 80+ CRI L90 @ 100,000 hrs 400 Lumens per foot	INTEGRAL DIM (1% Dimming) 0-10V	4.0W	LFT	ETL Damp Listed	Prudential Lighting P23-PER-REG3-LED3-LO-(LENGTH)- (TRIM COLOR)-SAL-D1-LP-SC- (VOLTAGE)-(CEILING)-DM01- (OPTIONS)	<ol style="list-style-type: none"> <li>1. Luminaire is a perimeter luminaire to be installed before ceiling, Contractor shall coordinate installation sequence as required. Fixtures shall be installed in a continuous wall-to-wall installation for fixtures that end against walls. Fixtures that do not end against walls shall run the full length of the wall being illuminated. Provide corners, extensions/telescoping sleeves and end caps as required for installation of a complete system. Center illuminated portion of luminaire in wall.</li> <li>2. Electrical Engineer/Contractor to verify compatibility of light source, gear and dimming system.</li> <li>3. Luminaire shall be ordered with necessary gear, control interfaces, power feed cables/terminators and mounting accessories as required for a complete system.</li> <li>4. Architect to verify fixture finish.</li> </ol>
<b>EXTERIOR FIXTURES</b>										
FS3	SITE	Handrail Pucks with Symmetric distribution	PER ARCHITECT	LED 3000K 80+ CRI L70 @ 90,000 hrs 170 Delivered Lumens	REMOTE DIM 0-10V	1.5W	EA	ETL Listed to UL2108, IP65	Alphabet 750S-30K-ST-PC-(FACE TYPE)	<ol style="list-style-type: none"> <li>1. Luminaire shall be U.L. (or equivalent approved agency) listed and labeled "Suitable for wet locations."</li> <li>2. Electrical Engineer/Contractor to verify compatibility of light source, gear and dimming system.</li> <li>3. Luminaire finish to be verified by Architect</li> <li>4. Provide manufacturer's dimensioned shop drawings showing all materials, finishes and components for Lighting Designer and Architect review prior to fabrication.</li> </ol>
FS3A	SITE	Handrail Pucks with Asymmetric distribution	PER ARCHITECT	LED 3000K 80+ CRI L70 @ 90,000 hrs 170 Delivered Lumens	REMOTE DIM 0-10V	1.5W	EA	ETL Listed to UL2108, IP65	Alphabet 750S-30K-VA-PC-(FACE TYPE)	<ol style="list-style-type: none"> <li>1. Luminaire shall be U.L. (or equivalent approved agency) listed and labeled "Suitable for wet locations."</li> <li>2. Electrical Engineer/Contractor to verify compatibility of light source, gear and dimming system.</li> <li>3. Luminaire finish to be verified by Architect</li> <li>4. Provide manufacturer's dimensioned shop drawings showing all materials, finishes and components for Lighting Designer and Architect review prior to fabrication.</li> </ol>

#### 4.3 APPENDIX B – LIGHT FIXTURE CUTSHEETS

- A. Contractor shall provide luminaires that meet the complete performance descriptions in Part 2 and the Appendix above, along with luminaire detail drawings and sketches. If there are any discrepancies between luminaire descriptions, catalogue numbers, sketches, or catalogue cuts that are unresolved during the bid period, the more costly option will be considered as included in the bid prices. The information in standard catalogue extracts are for general information only, and the product provided must meet all criteria described in the Luminaire Schedule and in this specification section above.



**3G-PM3**  
3 LIGHT MADISON  
PENDANT MOUNTED

Extruded aluminum housing with fabricated mitered corners  
Housing design features a beveled edge with no visible hardware  
Machined aluminum double gimbals. Adjustable and lockable  
2.75" Regressed LED source for enhanced glare control  
Lumen range up to 5000lm (80+, 90+, and 97+ CRI options)  
Adjustable aircraft cable suspension  
1% dimming standard with integral drivers



**ORDERING INFORMATION**

**PROJECT:**  **TYPE:**   
**CATALOG #:**  **DATE:**

CAT. NO	LUMEN OUTPUT	CRI	COLOR TEMP	BEAM ANGLE	VOLTAGE
<b>3G-PM3</b>	<b>10</b> - 1000 LUMENS	<b>S80</b> - 80+ CRI	<b>27K</b> - 2700K	<b>10D</b> - 10° <sup>3</sup>	<b>UNV</b> - 120/277V
	<b>15</b> - 1500 LUMENS	<b>H90</b> - 90+ CRI <sup>2</sup>	<b>30K</b> - 3000K	<b>20D</b> - 20°	<b>120</b> - 120V
	<b>22</b> - 2200 LUMENS	<b>H97</b> - 97+ CRI <sup>2</sup>	<b>35K</b> - 3500K	<b>40D</b> - 40°	<b>347</b> - 347V
	<b>30</b> - 3000 LUMENS		<b>40K</b> - 4000K	<b>60D</b> - 60°	(0-10V ONLY)
	<b>40</b> - 4000 LUMENS			<b>90D</b> - 90° <sup>*</sup>	
	<b>50</b> - 5000 LUMENS <sup>1</sup>				

\* 90D reflector supplied standard with lens

DRIVER	GIMBAL FINISH	HOUSING	CABLE LENGTH
<b>DIM</b> - 0-10V (STANDARD 100-1%) <b>LE</b> - PHASE DIMMING <sup>4</sup> (TRIAC/ELV, 100-1%) <b>DO1</b> - 0-10V (eidoLED, 100-0.1%) <b>DALI</b> - DALI (eidoLED, 100-1%) <sup>5</sup> <b>DHL2</b> - LUTRON HI-LUME LDE1 (1% ECOSYSTEM) <b>DMX</b> - DMX (eidoLED, 100-0%)	<b>NG</b> - NATURAL (STANDARD) <b>BG</b> - BLACK <b>WG</b> - WHITE	<b>BK</b> - BLACK <b>WH</b> - WHITE <b>SV</b> - SILVER <b>CF</b> - CUSTOM  Housing interior & exterior will be powder coated the same color	<b>60"</b> - 60" (STANDARD) <b>120"</b> - 120"  Mounting canopies provided in matte white finish as standard

OPTIONS
<b>2C</b> - 2 CIRCUIT <b>SF70</b> - SOFTENING LENS <b>LS70</b> - LINEAR SPREAD LENS <b>SB70</b> - SANDBLASTED LENS <b>HXB70</b> - BLACK HEXCELL LOUVER <b>BCN</b> - BLACK CANOPY <b>SCN</b> - SILVER CANOPY
Maximum 3 optical accessories. See optical accessories page for more options

<sup>1</sup> 5000lm option not available with phase dimming (LE/LTEA) or Lutron Hi-Lume (DHL2) option. 5000lm option not available in 347V  
<sup>2</sup> 90+ CRI available up to 4000lm. 97+ CRI in 30K and 35K as standard and available up to 3000lm  
<sup>3</sup> 10 degree reflector available up to 2200lm  
<sup>4</sup> Forward Phase/Reverse Phase driver available in 120V only  
<sup>5</sup> DALI-2 (Type 6) provided as standard. Please consult factory for DALI (Type 8) options

AUGUST 26, 2022

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3G reserves the right to change, without notice, specifications or materials for product improvement.



Bell Auditorium Expansion

Issue for Permit / Bid  
**16 January 2023**

Type:  
**FB1**

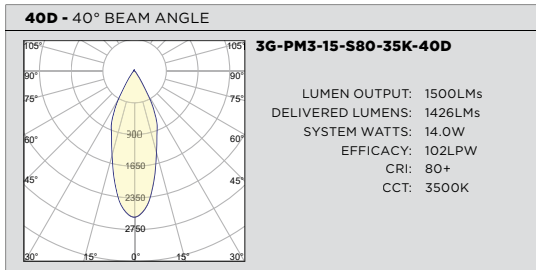
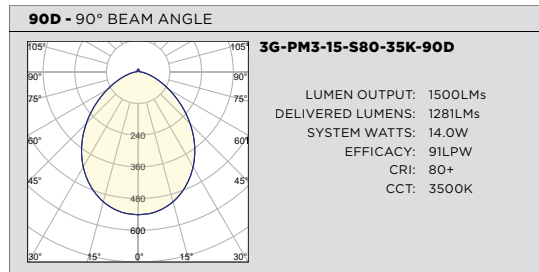
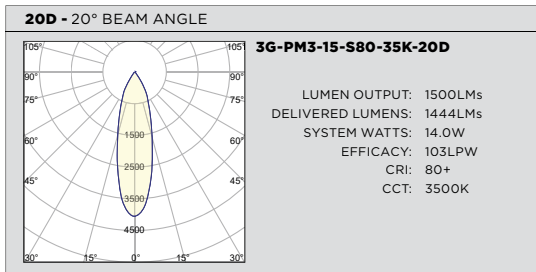
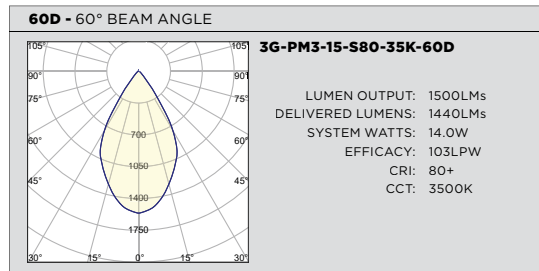
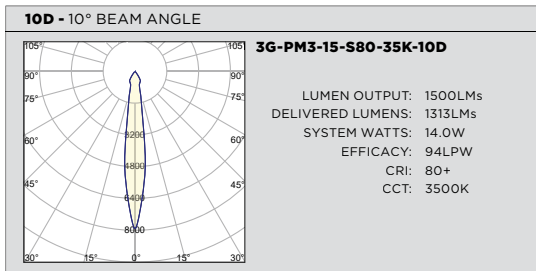
**PERFORMANCE CHART** BASED ON 20° BEAM AND 3500K SOURCE (PER FIXTURE HEAD)

LUMEN OUTPUT	80+ CRI			90+ CRI			97+ CRI		
	DELIVERED LUMENS	SYSTEM WATTS	EFFICACY (LPW)	DELIVERED LUMENS	SYSTEM WATTS	EFFICACY (LPW)	DELIVERED LUMENS	SYSTEM WATTS	EFFICACY (LPW)
<b>1000LMs</b>	1080	10.3	105	951	10.3	92	886	10.3	86
<b>1500LMs</b>	1444	14.0	103	1271	14	91	1184	14	85
<b>2200LMs</b>	2089	22.0	95	1838	22	84	1713	22	78
<b>3000LMs</b>	2815	31.3	90	2477	31.3	79	2308	31.3	74
<b>4000LMs</b>	3958	43.0	92	3483	43	81	N/A	N/A	N/A
<b>5000LMs</b>	4207	47.3	89	N/A	N/A	N/A	N/A	N/A	N/A

LUMEN OUTPUT ADJUSTMENT FACTORS	CCT	Multiplier
	2700K	0.945
	3000K	0.985
	3500K	1.00
	4000K	1.01

**PHOTOMETRY** (PER FIXTURE HEAD)



Bell Auditorium Expansion

Issue for Permit / Bid  
**16 January 2023**

Type:  
**FB1**

**TECHNICAL****HOUSING**

- Extruded aluminum housing with fabricated mitered corners
- Housing design features a beveled edge with no visible hardware
- Integral driver compartment fabricated in cold rolled steel
- Standard polyester powder coated interior and exterior available in matte white, matte black, and matte silver

**ADJUSTABILITY**

- Solid aluminum, 70mm machined double gimbals with dual axis adjustability (45°x45°)
- Each double gimbal can be locked into place

**OPTICS**

- Regressed LED source for enhanced glare control
- Proprietary anodized, aluminum reflectors are field replaceable (10° reflector not interchangeable)
- Available in 10°, 20°, 40°, 60°, and 90°
- Fixture head designed to accept 3 optical accessories

**ELECTRICAL**

- Standard 0-10V, constant current drivers with 100-1% dimming range and >0.9 power factor
- Standard 120/277V universal voltage drivers. Optional 347V, 0-10V drivers
- 120V Forward Phase/Reverse Phase driver option with 100-1% dimming range
- eldoLED 0-10V driver option available with 100-0.01% dimming range
- eldoLED DALI and Lutron EcoSystem driver options available with 100-1% dimming range
- DMX driver option available with 100-0% dimming range
- All drivers are integral and easily accessible through the top of the fixture housing

**LED SYSTEM**

- Citizen LED module (field replaceable)
- Color consistency <2 SDCM
- Standard (80+ CRI). Optional (90+ and 97+ CRI)
- Available in 27K, 30K, 35K, and 40K
- L90 >50,000 hours
- 5 Year Warranty

**MOUNTING**

- Suitable for drywall, concrete, wood, grid ceiling, and other architectural ceilings (see mounting details)
- Adjustable aircraft cable suspension with locking fasteners (60" length standard)
- Standard, 18-gauge, 5 conductor single circuit power feed (clear braided finish)
- Fixture mounts to a standard junction box
- All mounting canopies provided in matte white powder coated finish as standard

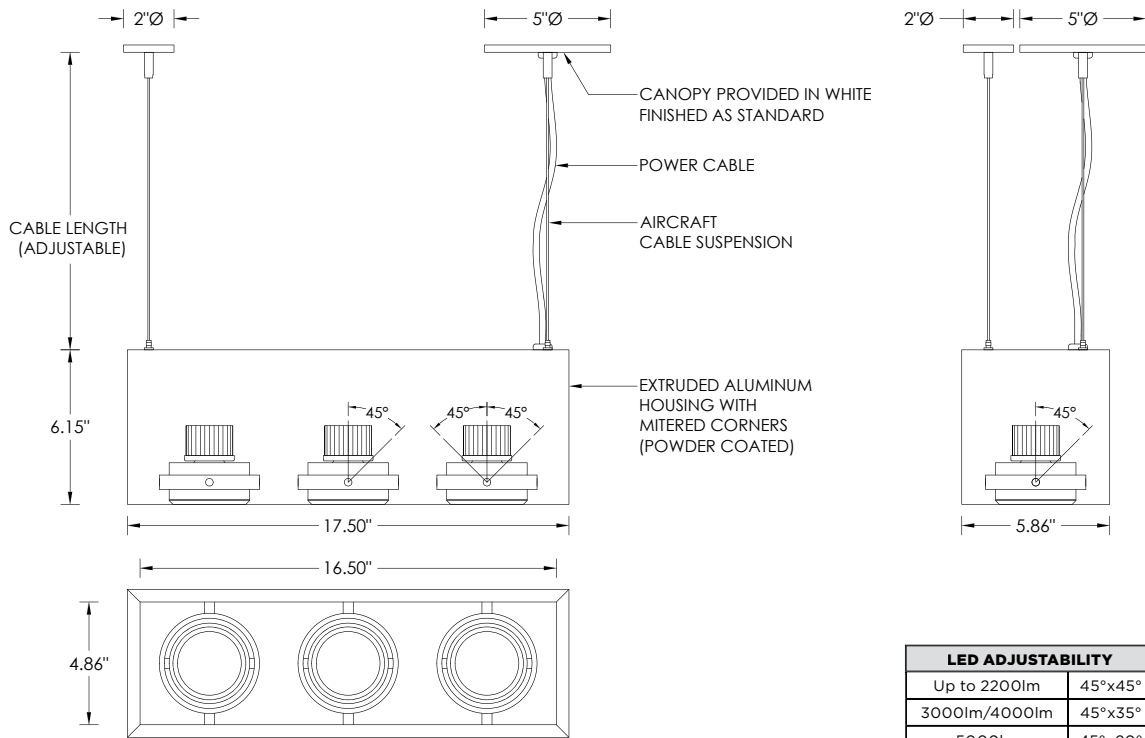
**LISTING**

- ETL listed and tested to cUL standards. Suitable for dry and damp locations

**WARRANTY**

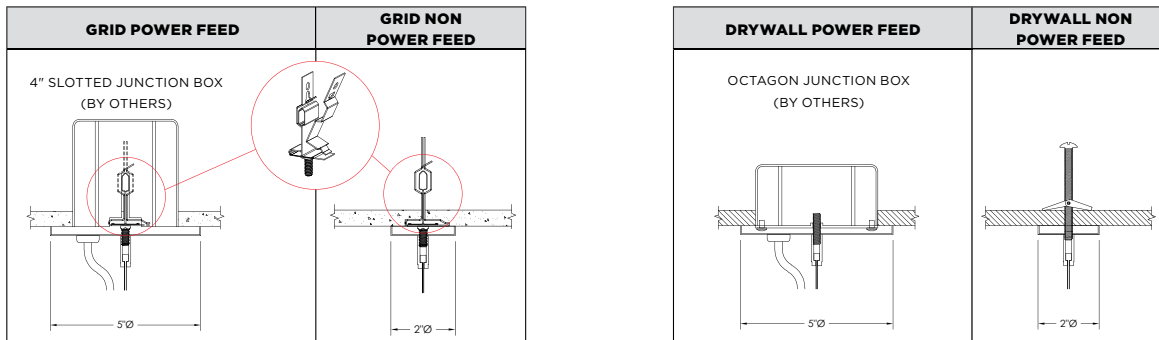
- 5 Year Warranty on LED and drivers
- Manufacturer 1 Year Warranty for defects in material and workmanship under normal use
- Ambient temperature at fixture should not exceed 25°C

**DRAWINGS AND DIMENSIONS**



LED ADJUSTABILITY	
Up to 2200lm	45°x45°
3000lm/4000lm	45°x35°
5000lm	45°x20°

**MOUNTING DETAILS**







Type(s)

Project

Date

Notes

**GENERAL INFORMATION**

An LED luminaire crafted by lighting experts with a proven history of quality spot fixtures, ColorSource Spot V brings a richness of color, increased brightness, and leading technology at a price point you'll love. Featuring a five-color array of red, green, blue, indigo, and lime, the ColorSource Spot V provides soft pastels and bold saturated colors from a single fixture. Featuring wireless DMX/RDM control using Multiverse® technology, NFC configuration from your mobile device, and next level brightness, ColorSource Spot V is the ultimate in versatility.

**APPLICATIONS**

- Theatres and performance spaces
- Houses of worship
- Universities and schools
- Hospitality
- Retail
- Exhibition centers
- Meeting rooms
- Clubs
- Cafeteriums

**PRODUCT FEATURES**

- Five-color array (red, green, blue, indigo, and lime)
- Simple user interface with seven-segment display
- powerCON® TRUE1® TOP connector
- DMX/RDM in and thru (5-pin XLR)
- Multiverse wireless DMX/RDM
- NFC (near field communication) configuration
- LED droop compensation
- Optically calibrated
- Tour-ready, aluminum housing
- Combine with available adapters to transform your fixture into a fully functional Fresnel or CYC light

**ORDERING INFORMATION**

**ColorSource Spot V Light Engine with Shutter Barrel**

(For use with fixed-field lens tubes only)

MODEL	DESCRIPTION	ETL PART NUMBER	CE PART NUMBER
CSSPOTVMVS	ColorSource Spot V with Multiverse, with shutter barrel, black	7423A1011	7423M1211

**ColorSource Spot V Light Engine Body**

(For use with zoom lens tubes and adapters and for retrofit of existing fixtures)

MODEL	DESCRIPTION	ETL PART NUMBER	CE PART NUMBER
CSSPOTVMV	ColorSource Spot V with Multiverse, body only, black	7423A1010	7423A1210

Color options: -1 = white, -5 = silver gray, -8 = custom colors.  
 Also available without Multiverse wireless control. Contact your dealer for ordering information.  
 Fixture ships with a soft-focus diffuser in a gobo holder, a C-clamp, and a 1.5 m powerCON TRUE1 TOP power-input cable with a connector of choice. See page 5 for connector options.  
 Please note: Lens tubes to be ordered separately. C-clamps included in North America regions only.



Bell Auditorium Expansion

Issue for Permit / Bid  
**16 January 2023**

Type:  
**FB2**

## PRODUCT SPECIFICATIONS

## Source

LED details	60 Lumileds LUXEON® C and LUXEON Rebel LEDs
Max lumens	9,498
Lumens per watt	48
L70 rating (hours to 70% output)*	54,000 hours

## Color

Colors used	Red, green, blue, indigo, lime
Color temperature range	Color mixing
Calibrated array	Yes
Red shift	No

## Optical

Beam angle range	Swappable lens tubes, 5–90 degrees
Gate size	80 mm
Aperture size	6.25–14 in (depending on lens tube)
Pattern projection	Yes
Pattern size	A or B
Camera flicker control/Hz range	5,000 Hz (default) and 25,000 Hz (via RDM)
Notes	Can be used with LED CYC and Fresnel adapters

## Control

Input method	DMX512 via 5-pin XLR connector
Protocols	DMX512/RDM
Modes (footprint)	4 modes, see page 4
RDM configuration	Yes
UI type	Seven-segment, three-button interface
Local control	Yes
Onboard presets	Yes (12)
Onboard sequences	Yes (5)
Onboard effects	No
FixtureLink	Yes
Notes	15-bit virtual dimming engine

## Wireless

Band	2.400–2.480 GHz
Range	100 m indoors, 500 m line of sight (subject to conditions)
Max receivers	DMX: No limit RDM: Varies by transmitter used Multiverse SHoW Baby®: 585 Multiverse Transmitter: 5,000
Broadcast power	100 mW

## Electrical

Voltage range	100–240 VAC 50/60 Hz
Input method	powerCON TRUE1 TOP power in and thru
Inrush	55 A at 120 V (First half-cycle) 59 A at 240 V (First half-cycle)
Fixtures per circuit*	8 fixtures (R20 module or similar)
Wattage typical / standby	199 W / 2 W at 100 V 197 W / 2 W at 120 V 194 W / 2 W at 240 V
Current draw typical / standby	2 A / 0.07 A at 100 V 1.65 A / 0.08 A at 120 V 0.90 A / 0.10 A at 240 V

\*Note: All measurements are for 120 V, 60 Hz. Results may vary in different regions.

## Thermal

Ambient operating temp	0°–40° C (32°–104° F)
Fan (controllable)	Yes (yes)
Droop compensation	Yes
dB range	24.4 dBA average at 1 m
BTUs/hour	672

## Physical

Materials	Die-cast, all metal housing
Color options	Black, white, silver, or custom color
Mounting options	Yoke
IP rating	IP20
Weight	7.7 kg (17 lb) (without lens)
Included accessories	Hanging yoke, 1.5 m power cable, soft-focus diffuser in an A-size gobo holder
Notes	See page 5 for power cable options

## Warranty

Fixture	5 years
LED array	10 years

## Regulatory and Compliance

Approved regulatory standards	cETLus Listed Conforms to UL 1598 Listed Conforms to UL 924 Listed Certified to CSA C22.2 No. 250 Listed Certified to CSA C22.2 No. 141 Listed CE, UKCA, RCM, and CCC Compliant
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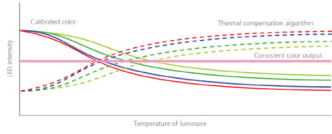
All LED sources experience some lessening of light output and some color shift over time. LED output will vary with thermal conditions. In individual situations, LEDs will be used for different durations and levels. This can eventually lead to minor alterations in color performance, necessitating slight adjustments to presets, cues or programs.



Bell Auditorium Expansion

Issue for Permit / Bid  
16 January 2023Type:  
FB2

PRODUCT FEATURES



**LED DROOP COMPENSATION**  
ETC's custom software adjusts for the changes that naturally occur as LEDs heat up and cool down so you never have to worry about color shift.



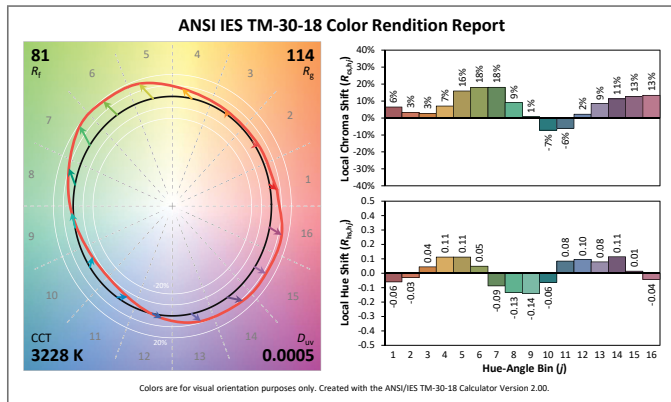
**RGBIL ARRAY**  
The custom five-color blend of LEDs incorporates indigo and lime to increase spectral reach and color depth.



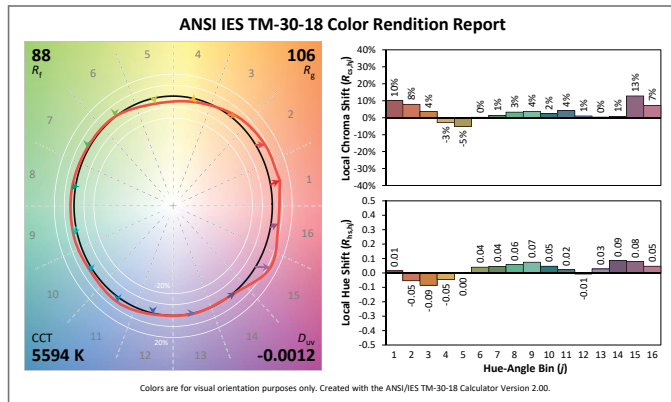
**WIRELESS**  
Multiverse gives you up to 10 universes of wireless DMX/RDM control. And NFC configuration is standard with ETC's free Set Light app on your mobile device.

COLOR METRIC INFORMATION

COLORSOURCE SPOT V 3200 K TM-30-18



COLORSOURCE SPOT V 5600 K TM-30-18



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PHOTOMETRY INFORMATION

Degrees and Lumens

DEGREE	MAXIMUM OUTPUT FIELD LUMENS	DISTANCE TO ACHIEVE 50 FC
5	5906	36 m/118.1 ft
10	5615	23.2 m/76 ft
14	6690	16.5 m/54 ft
19	6031	12.8 m/42 ft
19 EDLT	6863	13.1 m/43 ft
26	7086	10.4 m/34.1 ft
26 EDLT	8418	11 m/36 ft
36	7890	8.1 m/26.5 ft
36 EDLT	8145	8.2 m/27 ft
50	7864	6.1 m/20 ft
50 EDLT	7980	5.8 m/18.9 ft
70	9498	4.6 m/15 ft
90	9360	4 m/13.1 ft
15-30	9050	7.6 m/25 ft
25-50	7220	11.3 m/37.2 ft

The MyETC: Photometrics app provides full photometry information. For information about the Photometrics app, visit [etcconnect.com/Apps/](http://etcconnect.com/Apps/).

CONTROL

DMX Input Channel Profiles

DMX PROFILE	DMX CHANNELS	CHANNEL ASSIGNMENTS	NOTES
Stn: Standard (Default mode)	6	1-Intensity 2-Red 3-Green 4-Blue 5-Strobe 6-Fan	Indigo and Lime are mixed automatically.
RGB	3	1-Red 2-Green 3-Blue	
1ch: 1-channel	1	1-Intensity	This mode controls the intensity of Preset 1.
Dir: Direct	8	1-Intensity 2-Red 3-Green 4-Blue 5-Indigo 6-Lime 7-Strobe 8-Fan	



## ADDITIONAL ORDERING INFORMATION

## Fixture Accessories

MODEL	DESCRIPTION	PART NUMBER	
400CC	C-clamp (not included with CE fixtures)	7060A2009 (not CE)	
400SC	Safety cable	7060A1022	
400PH-A	Pattern holder (A size) (included)	7060A1013	
400PH-B	Pattern holder (B size)	7060A1014	
400PH-G	Glass pattern holder	7060A1019	
400RS	Drop-In iris	7060A1012	
400CF	Color frame, 159 mm (6.25 in)	7060A3043	
407CF	Square color frame, 190 mm (7.5 in)	7061A3007	
400DN	Donut	7060A1015	
400TH	Top hat, 159 mm (6.25 in)	PSF1021	
400PTH6	Top hat, 191 mm (7.5 in)	PSF1023	
410TH	Top hat, 305 mm (12 in) (for 10° standard lens tubes)	PSF1024	
405TH	Top hat, 356 mm (14 in) (for 5° standard lens tubes)	PSF1025	
400HH	Half hat	PSF10216	

## Power Input Cables

Use information below to order 15 m (5 ft) power input leads with factory-fitted connectors. CE fixtures ship with powerCON TRUE1 TOP to bare end cables in the box.

MODEL	DESCRIPTION	PART NUMBER (NOT CE)	
T1PA-A	1.5 m (5 ft) TRUE1 TOP to parallel blade U-ground (Edison) connector (ETL only)	2500B7029-A	
T1PA-B	1.5 m (5 ft) TRUE1 TOP to 20 A two-pin and ground (stage-pin) connector (ETL only)	2500B7029-B	
T1PA-C	1.5 m (5 ft) TRUE1 TOP to grounded 20 A twistlock connector (ETL only)	2500B7029-C	
T1PA-X	1.5 m (5 ft) TRUE1 TOP to bare-end power input lead (ETL only)	2500B7029-X	

## Power Thru Jumpers

Note: Power thru jumpers connect to a fixture's output (thru) connector to provide a link to successive fixtures.

MODEL	DESCRIPTION	PART NUMBER	
T1PJ-5	1.5 m (5 ft) TRUE1 TOP to TRUE1 TOP fixture to fixture jumper (ETL only)	2500B7030	
T1PJ-10	3 m (10 ft) TRUE1 TOP to TRUE1 TOP fixture to fixture jumper (ETL only)	2500B7031	

## Diffusers

The Soft Focus Diffuser fits into a standard A-size pattern holder and delivers beautiful, homogenized light. You can also use the Soft Focus Diffuser with patterns for dappled and soft-edge projections.

The Smooth Wash Diffuser is used when extra-smooth blending of multiple ColorSource Spot V luminaires is required. The smooth wash diffuser is placed into the gel-frame slot of the lens tube.

MODEL	DESCRIPTION	PART NUMBER	
S4LED-SFD	Soft Focus Diffuser (included)	7460A4019	
S4LED-SWD6	Smooth Wash Diffuser for 159 mm (6.25 in) gel frame slots	7460K1001	
S4LED-SWD7	Smooth Wash Diffuser for 190 mm (7.5 in) gel frame slots	7460K1002	
S4LED-SWD12	Smooth Wash Diffuser for 305 mm (12 in) gel frame slots (for 10° standard lens tubes)	7460K1003	
S4LED-SWD14	Smooth Wash Diffuser for 356 mm (14 in) gel frame slots (for 5° standard lens tubes)	7460K1004	



**Multiverse**

Model	Description	Part Number
CT-5900	City Theatrical Multiverse SHoW Baby	4360A1091
CT-5902	City Theatrical Multiverse Node 900 MHz / 2.4 GHz	4360A1092
CT-5903	City Theatrical Multiverse Node 2.4 GHz	4360A1093
CT-5910	City Theatrical Multiverse Transmitter 900 MHz / 2.4 GHz	4360A1094
CT-5911	City Theatrical Multiverse Transmitter 2.4 GHz	4360A1095
CT-5912	City Theatrical Multiverse Transmitter 900 MHz	4360A1096

**PREFERRED LENSING OPTIONS** (Lenses sold separately)**Fixed Beam Lenses**

MODEL	DESCRIPTION	PART NUMBER
LED50LT	LED-specific 50° EDLT lens	7460A2008
LED50LT-1	LED-specific 50° EDLT (white) lens	7460A2008-1
436EDLT	36° EDLT lens	7060A2048
436EDLT-1	36° EDLT (white) lens	7060A2048-1
426EDLT	26° EDLT lens	7060A2047
426EDLT-1	26° EDLT (white) lens	7060A2047-1
419EDLT	19° EDLT lens	7060A2046
419EDLT-1	19° EDLT (white) lens	7060A2046-1
490LT	90° lens	7060A2052-K
490LT-1	90° (white) lens	7060A2052-1K
470LT	70° lens	7060A2051-K
470LT-1	70° (white) lens	7060A2051-1K
414LT	14° lens	7060A2050-K
414LT-1	14° (white) lens	7060A2050-1K
410LT	10° lens	7060A2001-K
410LT-1	10° (white) lens	7060A2001-1K
405LT	5° lens	7060A2000-K
405LT-1	5° (white) lens	7060A2000-1K

**Zoom Lens Assemblies**

Use with light-engine body models.

MODEL	DESCRIPTION	PART NUMBER
41530LT	Source Four 15°–30° Zoom lens	7060A2030-K
42550LT	Source Four 25°–50° Zoom lens	7060A2032-K

**LED Adapters**

MODEL	DESCRIPTION	PART NUMBER
S4LEDCYC	LED CYC adapter	7460A2011
S4LEDFRES	LED Fresnel adapter	7460A2016



Bell Auditorium Expansion

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**16 January 2023**Type:  
**FB2**

PHYSICAL

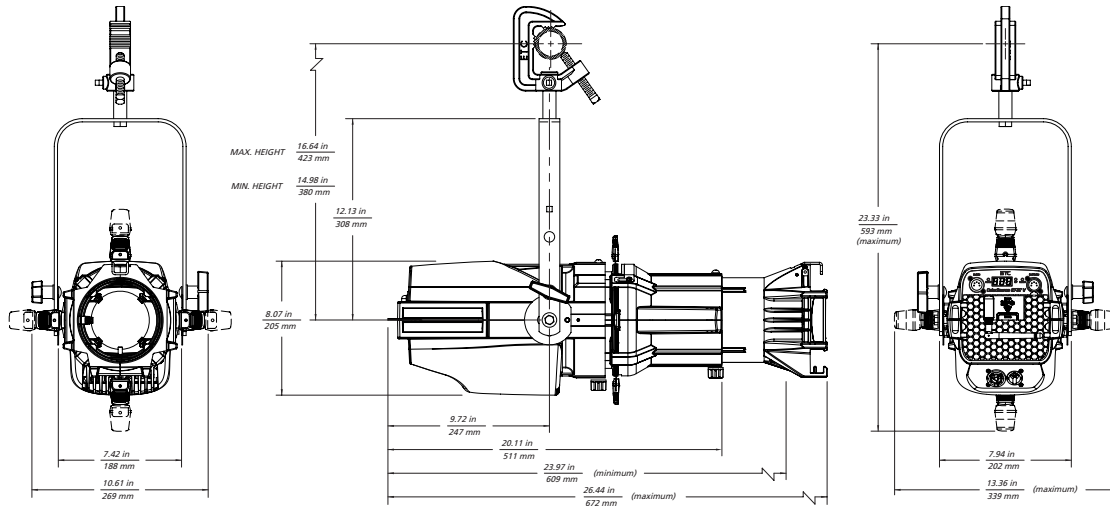
ColorSource Spot V Weights

	WEIGHT*		SHIPPING WEIGHT	
	kg	lb	kg	lb
With Barrel	7.7	17.0	10.0	22.0
Without Barrel	5.9	13.0	7.4	16.3

\* Does not include mounting hardware or lens tube

ColorSource Spot V Dimensions

	HEIGHT		WIDTH		DEPTH	
	mm	in	mm	in	mm	in
ColorSource Spot V	593	23.33	339	13.36	672	26.44



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 \*Trademark and patent info: [etconnect.com/IP](http://etconnect.com/IP)

[etconnect.com](http://etconnect.com)

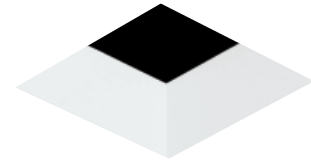


Bell Auditorium Expansion

Issue for Permit / Bid  
 16 January 2023

Type:  
 FB2

# ELEMENT™ 3" LED FIXED DOWNLIGHT



SHOWN IN FLANGELESS BEVEL SQUARE

The ELEMENT 3" Next Generation Fixed recessed downlight features a patented high/low lamp positioning which allows the LED to be positioned closer to the aperture for maximum light output and efficiency or higher in the ceiling to minimize glare and flash on the trim. LED options include premium warm dimming, tunable white, Xicato and Xicato Artist Series. Trim options include flanged or flangeless and flangeless in wood ceiling.

- Housing reduced by 60%
- Patented high/low lamp positioning
- 2-step standard
- Standard dimming down to 1%
- Trim reflector options
- Solite Soft Focus lens option

### LUMEN MULTIPLIER (CRI/CCT)

CCT	80 CRI MULTIPLIER	90 CRI MULTIPLIER
2700K	0.95	0.80
3000K	1.00	0.85
3500K	1.05	0.90

Lumen output will vary by CCT and CRI. See photometric charts for output information.

### SPECIFICATIONS

	STATIC WHITE		XICATO		WARM DIM		TUNABLE WHITE	
	HIGH OUTPUT	LOW OUTPUT	STANDARD SERIES	ARTIST SERIES	HIGH OUTPUT	LOW OUTPUT	HIGH OUTPUT (5000K)	HIGH OUTPUT (4000K)
DELIVERED LUMENS	1800/1450	1319/1124	1129	945	1300	900	1272	1150
WATTS	17	12	15	15	17	12	18	18
EFFICACY	106/85	110/94	75	63	76	75	72	64
CRI	80+/90+		80+	95+	90+		90+	
CBCP	10° - 19,414   18° - 5,848 25° - 5,416   40° - 3,230 60° - 2,305		21° - 3,184 43° - 2,733 60° - 1,014		18° - N/A   25° - N/A   40° - 1,622   60° - N/A			
CCT	2700K, 3000K, or 3500K		2700K, 3000K, or 3500K <sup>3</sup>		3000K - 1800K		5000K - 2700K	4000K - 1800K
COLOR CONSISTENCY	2-step		1 X 2-step		3-step		2-step	
VOLTAGE	120V or 277V							
DIMMING <sup>1</sup>	Standard reverse-phase, forward-phase, TRIAC, and 0-10V dimming (down to 1%) Lutron Hi-lume EcoSystem (down to 0.1%) Lutron Hi-lume 2-Wire (down to 1%)   eldoLED 0-10V or Dali (down to 0.1%)						eldoLED 0-10V or Dali (down to 0.1%)	
POWER SUPPLY	Constant current driver with +.9 power factor and +80% efficiency							
OPTICS	Field changeable: 10°, 18°, 25°, 40°, or 60° TIR		Field changeable: 21°, 43°, or 60° Reflector		Field changeable: 18°, 25°, 40°, or 60° TIR			
ADJUSTABILITY	High/low lamp positioning; 45° collar rotation							
CEILING APPEARANCE	Flanged, flangeless or flangeless in wood ceiling							
CEILING THICKNESS	Flanged: Up to 2-1/2" Flangeless: No ceiling thickness limitations   Flangeless in wood ceiling: 1/2" to 1-1/2" Note: Thicker ceilings impact light cutoff							
CEILING APERTURE	3-7/8" ceiling cutout							
HOUSING	IC Airtight, Non-IC Airtight, Chicago Plenum. IC suitable up to R60 spray foam insulation. Sauna/Steam-room use available only with combination of H Shower trim, LO Low Output housing, and I IC housing rating.							
CONSTRUCTION	Housing: Heavy-Gauge, Cold-Rolled Steel   Trim: Die-Cast Aluminum							
FINISH	Housing: Black powder coat   Trim: Antique Bronze, Black, Satin Nickel, or White (paintable)							
GENERAL LISTINGS	ETL Listed. Damp Location. Shower version Wet Listed.							
CALIFORNIA TITLE 24	Registered CEC Appliance Database. Can be used to comply with CEC 2019 Title 24 Part 6 (JA8-2016, JA8-2019) (for 90 CRI versions).							
L70	50,000 hours min							
WARRANTY <sup>2</sup>	5 years							

Data in chart reflect 3000K/90 CRI values unless noted.  
Custom output/custom RAL/custom CCT available, contact Quotes Department

Ordering grids available on page 2.

Accepts two optical controls and an optional trim-mounted lens.

<sup>1</sup>See ELEMENT-Lighting.com for dimmer compatibility.

<sup>2</sup>Visit ELEMENT-Lighting.com for specific warranty limitations and details.

<sup>3</sup>3500K Xicato module not available for Artist series.

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UPDATED 9/29/22



Bell Auditorium Expansion

Issue for Permit / Bid  
16 January 2023

Type:  
FB3 Series



# ELEMENT™ 3" LED FIXED DOWNLIGHT

ORDERING GRIDS

HOUSING

PRODUCT	CEILING APPEARANCE	OUTPUT	LAMP	BEAM SPREAD	FUNCTION	HOUSING RATING	DRIVER	
E3R ELEMENT 3" ROUND	LF FLANGELESS	-LH HIGH OUTPUT, 17W <sup>2</sup>	827 80 CRI, 2700K, 2-STEP	0 10°	D DOWNLIGHT	I IC AIRTIGHT	INTEGRATED DRIVERS 120V/277V	
	FF FLANGED	-LO LOW OUTPUT, 12W <sup>3</sup>	830 80 CRI, 3000K, 2-STEP	1 18°				
E3S ELEMENT 3" SQUARE	WC WOOD CEILING <sup>1</sup>		835 80 CRI, 3500K, 2-STEP	2 25°		C CHICAGO PLENUM	UNIVERSAL PHASE/0-10V 1% (LEAVE BLANK) <sup>6</sup>	
			927 90 CRI, 2700K, 2-STEP	4 40°				
			930 90 CRI, 3000K, 2-STEP	6 60°				
			935 90 CRI, 3500K, 2-STEP					
			WD 90 CRI, 3000-1800K, WARM DIM, 3-STEP					
			TW52 90 CRI, 5000K-2700K, TUNABLE WHITE, 2-STEP <sup>4</sup>					
			TW41 90 CRI, 4000K-1800K, TUNABLE WHITE, 2-STEP <sup>4</sup>					
			-X XICATO, HIGH OUTPUT, 14W <sup>9</sup>	127 80 CRI, 2700K, 1X2-STEP, XICATO				21 21° XICATO
				130 80 CRI, 3000K, 1X2-STEP, XICATO				43 43° XICATO
				135 80 CRI, 3500K, 1X2-STEP, XICATO				60 60° XICATO
	A27 95 CRI, 2700K, 1X2-STEP, XICATO ARTIST							
	A30 95 CRI, 3000K, 1X2-STEP, XICATO ARTIST							

Trims are required and must be ordered separately.  
 For dimming details, refer to dimmer compatibility chart.  
<sup>1</sup>WC - Wood ceiling option accommodates flangeless trims only.  
<sup>2</sup>LH - High output available for wet applications. Not available for sauna/steam-room.  
<sup>3</sup>LO - Sauna/steam-room use available only with combination of H shower trim, LO low output housing, and I IC housing rating.  
<sup>4</sup>TW52/TW41/ELTO/ELTD - Tunable white only available in high output, only available with ELTO (0-10V, linear), or ELTD (Dali). For 0-10V logarithmic dimming consult Quotes Department.  
<sup>5</sup>0 - 10° optic has a unique LED module not available with warm dim or tunable white. Changing optics to 18°, 25°, 40° or 60°, will require a new LED module.  
<sup>6</sup>Universal dimming is reverse-phase, forward-phase, TRIAC, and 0-10V, 277V is only compatible with 0-10V dimming.  
<sup>7</sup>Lutron Hi-lume and eldoLED drivers not compatible with round flangeless (E3RLF) or round wood ceiling (E3RWC) housings.  
<sup>8</sup>HLLECO - Lutron has put their entire 0.1% ECO drivers on indefinite hold which impacts all -HLLECO item numbers. Please consult factory for alternatives. This does not impact -HL2W.  
<sup>9</sup>X - XICATO housings utilize dedicated standard phase, 0-10V, 120V and 277V drivers. If ordering Xicato with standard drivers (non-Lutron or eldoLED), at the end of the item number please specify:  
**-010** for 0-10V 120V, **-277** for phase 277V or **-010-277** for 0-10V 277V. For example: E3RLF-XA2743DI-**010** or E3RLF-XA2743DI-**277** or E3RLF-XA2743DI-**010-277**. Due to the size of some of the Xicato Reflectors, it may not be feasible to tilt the fixture in the 'low' position. It is still tiltable in the 'high' position.

TRIM

PRODUCT	CEILING APPEARANCE	STYLE	APERTURE	FINISH
E3R ELEMENT 3" ROUND	L FLANGELESS	B BEVEL	-0 NO LENS	Z ANTIQUE BRONZE
E3S ELEMENT 3" SQUARE	F FLANGED UP TO 1" CEILING THICKNESS	F FLAT	-H SHOWER <sup>1</sup>	B BLACK
	F15 FLANGED 1.5"-1.5" CEILING THICKNESS		-L LENSED	S SATIN NICKEL
	F20 FLANGED 1.6"-2.0" CEILING THICKNESS			W WHITE
	F25 FLANGED 2.1"-2.5" CEILING THICKNESS			

Wood ceiling option accommodates flangeless trims only.  
<sup>1</sup>H - Sauna/steam-room use available only with combination of H shower trim, LO low output housing, and I IC housing rating.

FROSTED BOROSILICATE LENS KIT

PRODUCT	DESCRIPTION
240E3SBLSP-B	BOROSILICATE LENS KIT   E3 SQUARE BEVEL TRIM
240E3SQLSP-B	BOROSILICATE LENS KIT   E3 SQUARE FLAT TRIM
240E3RBLSP-B	BOROSILICATE LENS KIT   E3 ROUND BEVEL TRIM
240E3RDLSP-B	BOROSILICATE LENS KIT   E3 ROUND FLAT TRIM

Includes frosted borosilicate lens, lens spring, and screws to mount to ELEMENT 3" trim.

PLASTER PLATES

PRODUCT	DESCRIPTION
150E3RPPLT-A	3" PLASTER PLATE   ROUND DIE-CAST METAL <sup>1</sup>
150E3SPPLT-A	3" PLASTER PLATE   SQUARE DIE-CAST METAL <sup>1</sup>
150E3RTPPLT-W	3" PLASTER PLATE   ROUND SHEET METAL <sup>2</sup>
150E3STPPLT-W	3" PLASTER PLATE   SQUARE SHEET METAL <sup>2</sup>

Plaster plates are used to convert flanged housings into flangeless housings.  
<sup>1</sup>Ships standard with flangeless housings. Round not compatible with Lutron Hi-lume or eldoLED drivers.  
<sup>2</sup>Optional, thinner, meshed sheet-metal mud plates available for minimized plaster feathering to meet installer preference. Round not compatible with Lutron Hi-lume or eldoLED drivers. Square not compatible with eldoLED drivers.

PREMIUM LENS HOLDER

PRODUCT	LENSES
240E3LENSHLDR	1 ONE LENS
	2 TWO LENSES

Provides more secure mounting of additional lenses than the lens holder that ships with each fixture.  
 Not compatible with the 10° beam spread.

REPLACEMENT OPTICS

PRODUCT	BEAM SPREAD
353E4LEDCOPT	18 18°
	25 25°
	40 40°
	60 60°

353E4LEDCOPT

LENSES / LOUVERS<sup>1</sup>

PRODUCT	DESCRIPTION
140MR16SF	SOLITE SOFT FOCUS LENS
140MR16SB	SANDBLASTED LENS
140MR16LL	LINEAR SPREAD LENS
140MR16DF	DIFFUSER SPREAD LENS
EL2RHCBK	EGGCRATE/HEXCELL LOUVER

<sup>1</sup>For additional lenses, louvers, optical controls and accessories, reference ELEMENT-lighting.com/Products/Accessories. ELEMENT allows up to two lenses or louvers per fixture.

REPLACEMENT REFLECTORS<sup>1</sup>

PRODUCT	BEAM SPREAD
352LEDXREF	21 21°
	43 43°
	60 60°

352LEDXREF

<sup>1</sup>For use with Xicato modules only.



## Bell Auditorium Expansion

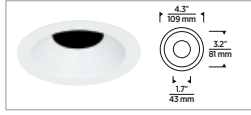
Issue for Permit / Bid  
**16 January 2023**

Type:  
**FB3 Series**

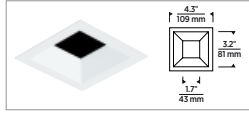
# ELEMENT™ 3" LED FIXED DOWNLIGHT

TRIMS

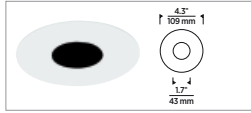
FLANGED



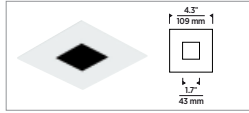
ROUND BEVEL



SQUARE BEVEL



ROUND FLAT



SQUARE FLAT

FLANGELESS



ROUND BEVEL



SQUARE BEVEL



ROUND FLAT



SQUARE FLAT

FINISH



ANTIQUE BRONZE



BLACK

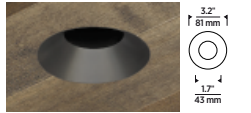


SATIN NICKEL



WHITE (PAINTABLE)

FLANGELESS IN WOOD CEILING



ROUND BEVEL (ANTIQUE BRONZE)



SQUARE BEVEL (SATIN NICKEL)



ROUND FLAT (ANTIQUE BRONZE)



SQUARE FLAT (SATIN NICKEL)

LENS OPTION



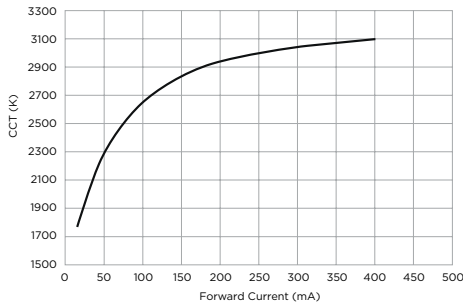
SHOWN WITH AND WITHOUT A LENS (SQUARE FLANGED BEVEL)



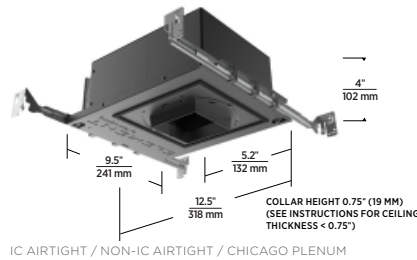
SHOWN WITH AND WITHOUT A LENS (ROUND FLANGELESS BEVEL)

WARM DIM CURVE

CCT vs. Forward Current,  $T_c=25^\circ\text{C}$



HOUSING



Bell Auditorium Expansion

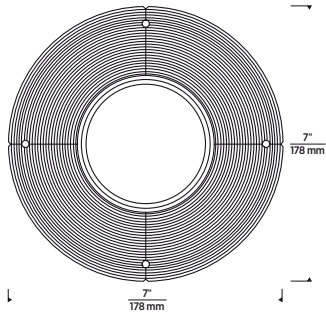
Issue for Permit / Bid  
16 January 2023

Type:  
FB3 Series

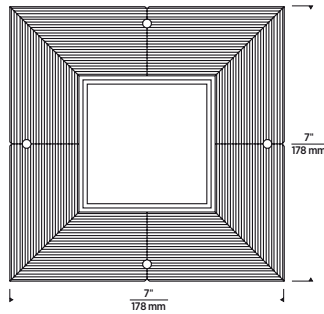
# ELEMENT™ 3" LED FIXED DOWNLIGHT

PLASTER PLATES

INCLUDED DIE-CAST

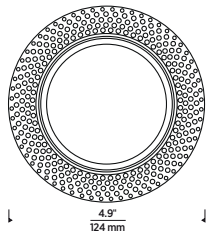


ROUND DIE-CAST (INCLUDED FOR FLANGELESS INSTALLATION)

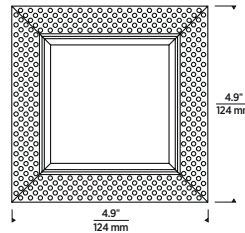


SQUARE DIE-CAST (INCLUDED FOR FLANGELESS INSTALLATION)

OPTIONAL SHEET METAL

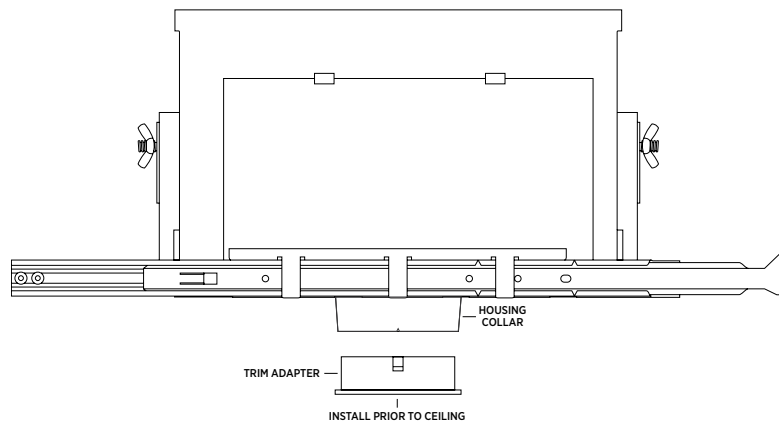


ROUND SHEET METAL (OPTIONAL FOR FLANGELESS INSTALLATION)

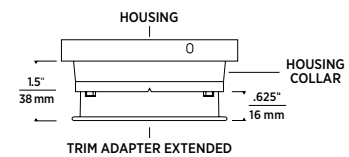
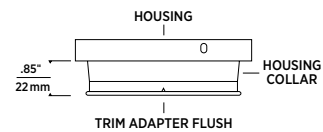


SQUARE SHEET METAL (OPTIONAL FOR FLANGELESS INSTALLATION)

FLANGELESS IN WOOD CEILING TRIM ADAPTER



TRIM ADAPTER INSTALLED



Wood ceiling housings ("WC" designation in the ordering grid) ship with an adjustable trim adapter that inserts into the housing aperture and allows standard ELEMENT 3" flangeless trims to achieve a truly flangeless, flush ceiling appearance in special applications such as wood or stone installation. For use in new construction. Consult installation instructions regarding plenum requirements and ceiling thickness ratios.

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Bell Auditorium Expansion

Issue for Permit / Bid  
16 January 2023

Type:  
FB3 Series

















# ELEMENT™ 3" LED FIXED DOWNLIGHT

## TRIM-MOUNTED REFLECTORS

ELEMENT Specular Reflectors reduce glare while creating a clean, quiet ceiling appearance. Available finishes include Anodized Silver for a decorative accent or Anodized Black for an ultimate quiet ceiling aesthetic. These beautiful trim accessories have been specifically designed to minimize any effect on light performance, color and output. Specular Reflectors are available for both adjustable and fixed downlights and are compatible with ELEMENT 3" trims and housings.

- Can be easily installed or removed
- Assembles to existing trim
- Compatible with fixed and adjustable housings
- Finish Options: Anodized Black (B) or Anodized Silver (S)

### SPECIFICATIONS

COMPATIBLE TRIMS		NON-SLOTTED (FOR FIXED)	
	3" round, flanged, bevel		<b>E3TREFNS1 (B OR S)</b>
	3" square, flanged, bevel		<b>E3TREFNS5 (B OR S)</b>
	3" round, flanged, flat		<b>E3TREFNS1 (B OR S)</b>
	3" square, flanged, flat		<b>E3TREFNS3 (B OR S)</b>
	3" round, flangeless, bevel		<b>E3TREFNS2 (B OR S)</b>
	3" square, flangeless, bevel		<b>E3TREFNS6 (B OR S)</b>
	3" round, flangeless, flat		<b>E3TREFNS4 (B OR S)</b>
	3" square, flangeless, flat		<b>E3TREFNS3 (B OR S)</b>

May require lamp to be placed in high position.  
Not compatible with lensed trims.

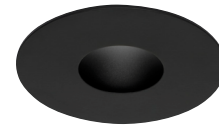
### ORDERING GRID

#### E3 TRIM-MOUNTED REFLECTORS

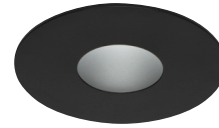
PRODUCT	STYLE	FINISH
<b>E3TREF</b>	<b>NS1</b> NON-SLOTTED	<b>B</b> ANODIZED BLACK
	<b>NS2</b> NON-SLOTTED	<b>S</b> ANODIZED SILVER
	<b>NS3</b> NON-SLOTTED	
	<b>NS4</b> NON-SLOTTED	
	<b>NS5</b> NON-SLOTTED	
	<b>NS6</b> NON-SLOTTED	

#### E3TREF

Reflectors are placed on top of the inside of the trim or affixed via screws (only if provided).



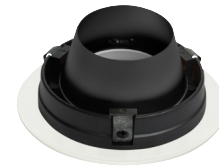
SHOWN IN ANODIZED BLACK  
(BELOW CEILING VIEW)



SHOWN IN ANODIZED SILVER  
(BELOW CEILING VIEW)



SHOWN IN ANODIZED SILVER  
(BELOW CEILING VIEW)



SHOWN IN ANODIZED BLACK  
(TRIM MOUNTED)



SHOWN IN ANODIZED BLACK AND  
SILVER (REFLECTOR ONLY)



Bell Auditorium Expansion

Issue for Permit / Bid  
**16 January 2023**

Type:  
**FB3 Series**

# ELEMENT™ 3" LED

## FIXED DOWNLIGHT

PHOTOMETRICS

Description: 3" LED Module  
10° Beam - 0° Tilt,  
80 CRI, 3000K

Model: E3 Citizen LED

Input Power (Watts): 16.3

Input Power Factor: 0.98

Absolute Luminous Flux (Lumens): 1337

Lumen Efficacy (Lumens per Watt): 82

Description: 3" LED Module  
18° Beam - 0° Tilt,  
80 CRI, 3000K

Model: E3 Citizen LED

Input Power (Watts): 18.1

Input Power Factor: 0.98

Absolute Luminous Flux (Lumens): 1598

Lumen Efficacy (Lumens per Watt): 88.1

Description: 3" LED Module  
25° Beam - 0° Tilt,  
80 CRI, 3000K

Model: E3 Citizen LED

Input Power (Watts): 18.3

Input Power Factor: 0.98

Absolute Luminous Flux (Lumens): 1754

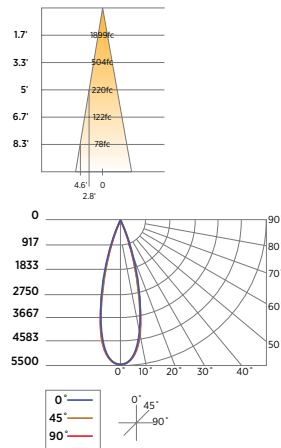
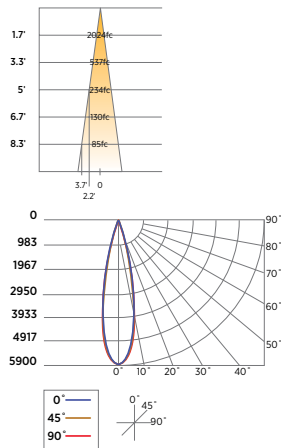
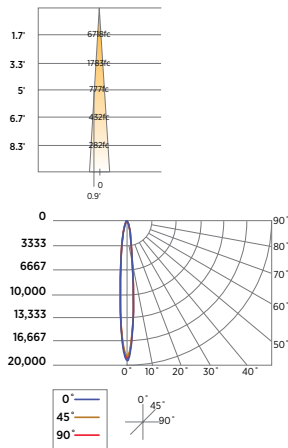
Lumen Efficacy (Lumens per Watt): 95.5

Output difference between CCTs - 5%, CRIs - 15%.

ANGLE	0°	45°	90°
0°	19414	19414	19414
5°	10254	10254	10254
10°	3511	3511	3511
15°	1342	1342	1342
20°	383	383	383
25°	126	126	126
30°	84	84	84
35°	54	54	54
40°	31	31	31
45°	22	22	22
50°	18	18	18
55°	11	11	11
60°	6	6	6
65°	3	3	3
70°	2	2	2
75°	0	0	0
80°	0	0	0
85°	0	0	0
90°	0	0	0

ANGLE	0°	45°	90°
0°	5848	5848	5848
5°	5500	5478	5491
10°	3919	3944	3905
15°	2103	2212	2149
20°	1058	1199	1075
25°	507	548	508
30°	250	237	250
35°	148	140	141
40°	93	98	94
45°	51	69	61
50°	33	46	37
55°	21	27	24
60°	4	15	10
65°	2	3	2
70°	2	2	2
75°	0	0	0
80°	0	0	0
85°	0	0	0
90°	0	0	0

ANGLE	0°	45°	90°
0°	5422	5416	5427
5°	4916	4872	4888
10°	3800	3718	3721
15°	2040	2115	2016
20°	870	979	900
25°	400	441	414
30°	190	190	196
35°	103	103	105
40°	60	65	61
45°	27	43	31
50°	16	25	17
55°	7	12	7
60°	2	5	2
65°	2	2	2
70°	1	1	2
75°	0	0	0
80°	0	0	0
85°	0	0	0
90°	0	0	0



Bell Auditorium Expansion

Issue for Permit / Bid  
16 January 2023

Type:  
FB3 Series

# ELEMENT™ 3" LED

## FIXED DOWNLIGHT

PHOTOMETRICS

Description: 3" LED Module  
40° Beam - 0° Tilt,  
80 CRI, 3000K

Model: E3 Citizen LED

Input Power (Watts): 16.9

Input Power Factor: 0.98

Absolute Luminous Flux (Lumens): 1774

Lumen Efficacy (Lumens per Watt): 104.6

Description: 3" LED Module  
60° Beam - 0° Tilt,  
80 CRI, 3000K

Model: E3 Citizen LED

Input Power (Watts): 18.4

Input Power Factor: 0.98

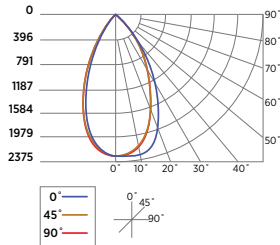
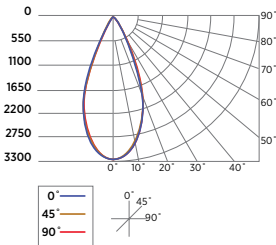
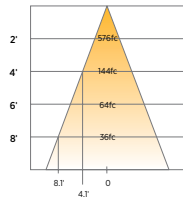
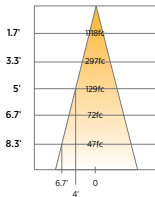
Absolute Luminous Flux (Lumens): 1536

Lumen Efficacy (Lumens per Watt): 83.5

Output difference between CCTs - 5%, CRIs - 15%.

ANGLE	0°	45°	90°
0°	3230	3230	3230
5°	3107	3126	3159
10°	2824	2830	2871
15°	2415	2407	2463
20°	1863	1866	1937
25°	1111	1125	1128
30°	490	521	479
35°	221	232	205
40°	115	114	110
45°	65	64	59
50°	30	38	22
55°	14	22	11
60°	6	9	4
65°	1	3	1
70°	1	1	1
75°	1	1	1
80°	0	0	0
85°	0	0	0
90°	0	0	0

ANGLE	0°	45°	90°
0°	2305	2305	2305
5°	2313	2298	2268
10°	2295	2248	2155
15°	2219	2116	1938
20°	1964	1876	1714
25°	1548	1544	1330
30°	1113	1176	1013
35°	749	835	704
40°	450	511	428
45°	230	283	221
50°	94	140	91
55°	38	69	35
60°	18	31	16
65°	8	13	6
70°	0	4	0
75°	0	0	0
80°	0	0	0
85°	0	0	0
90°	0	0	0



Bell Auditorium Expansion

Issue for Permit / Bid  
16 January 2023

Type:  
FB3 Series

# ELEMENT™ 3" LED

FIXED DOWNLIGHT

PROJECT INFORMATION

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JOB NAME AND INFORMATION

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FIXTURE TYPE AND QUANTITY

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NOTES

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Bell Auditorium Expansion

Issue for Permit / Bid  
**16 January 2023**

Type:  
FB3 Series



Spec Guide

# ZipWave | Wall Cove | 707

Wall cove lighting system for wall wash and grazing applications.



ZipWave: indirect cove light.

### Benefits & Features

#### Perfect Light Distribution

Optimized distribution, no tuning necessary. Designed for Armstrong® AXIOM® Indirect Light Coves and site-built coves.

#### Superior Light Quality with High Efficiency

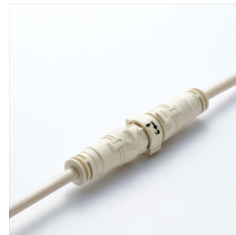
Output up to 1666 lm/ft (5465 lm/m) (HO), 132 lm/W (SO). 80 or 90 CRI & tunable white (2200K-6500K) available.

#### Easy Installation, Minimal Electrical Circuits

Simply drops into cove with no tools required. Plug & play integral power and control circuits provided. Up to 533' can be powered with one 277v feed.

#### Better Beam Performance

EdgeSoft™ lens for soft distribution down wall surface without reflected diode image.



Quick Connect Cables.



Fixture installed in AXIOM Classic-Edge cove



Bell Auditorium Expansion

Issue for Permit / Bid  
16 January 2023

Type:  
FB4 Series



Build Your Specification

<b>707-Z9</b>	<b>SL</b>				<b>0</b> >>
<b>System &amp; Rail Type</b>	<b>System Type</b>	<b>System Length</b>	<b>Rail Length</b>	<b>Mounting</b>	<b>Arm/Cord Length</b>
707-Z9 ZipWave	SL Standard Linear	Specify overall system length in ft/in or M/mm.	<b>24</b> 24" (610mm) <b>36</b> 36" (914mm) <b>48</b> 48" (1219mm) <b>60</b> 60" (1524mm) <b>72</b> 72" (1829mm) <b>96</b> 96" (2438mm) <b>ZZ</b> Other rail length or layout (please specify)	<b>EW</b> Engineered Wall Cove <b>AW</b> Armstrong® Wall Cove <b>ZZ</b> Other (please specify)	<b>0</b> None
See <a href="#">Rail Length Chart</a> for more details					

>> <b>IP</b>				<b>Z</b> >>
<b>Power Location</b>	<b>Power Type</b>	<b>Voltage</b>	<b>Emergency Power</b>	<b>LED Type</b>
IP Integral Power	<b>Integral Power</b> <b>AE</b> eldoLED 0-10v, 1.0% Dimming <b>AT</b> eldoLED 0-10v, 0.1% Dimming <b>AD</b> eldoLED DALI, 0.1% Dimming <b>AX</b> eldoLED DMX, 100-0% Dimming <b>AH</b> Hi-lume 1% EcoSystem, Soft On / Fade to Black Technology, LDE1 <b>AH2</b> Hi-lume 1% 2-wire LTEA2W (120V forward phase only) <b>ZZ</b> Other (please specify)	<b>1</b> 120v <b>2</b> 120v-277v <b>X</b> Not Yet Specified	<b>0</b> No Emergency Power <b>ZZ</b> Emergency Power (specify requirements)	<b>Z</b> Zipper Board
See <a href="#">Power Guide</a> for driver features & limitations.				

>>		<b>C1</b>		<b>AL</b>	
<b>Lumen Output</b>	<b>Color Temperature</b>	<b>Optics</b>	<b>Sensors</b>	<b>Finish</b>	<b>Options</b>
<b>LO</b> Low Output <b>SO</b> Standard Output <b>HO</b> High Output* <b>ZZ</b> Other (please specify)	<b>80+ CRI</b> <b>27</b> 2700K <b>30</b> 3000K <b>35</b> 3500K <b>40</b> 4000K <b>90+ CRI</b> <b>279</b> 2700K <b>309</b> 3000K <b>359</b> 3500K <b>409</b> 4000K <b>ZZ</b> Tunable White Available See <a href="#">Guide</a> for details	<b>C1</b> Clear with EdgeSoft™	<b>0</b> None <b>ZZ</b> Sensor (specify requirements)	<b>AL</b> Clear Anodized	<b>0</b> None
See <a href="#">IES Files</a> page for details. See <a href="#">Power Guide</a> for driver features & limitations.					



**Jumper Cables Sold Separately:**

Vode offers a 2' (Part Number: PWH-707-Z9-24-MF-WJ) or 6' (Part Number: PWH-707-Z9-72-MF-WJ) jumper for corner installations. Please indicate on your order the type and quantity required.

Standard 5 Year Limited Warranty. See details [here](#). Contact factory for options on Limited Warranties up to 20 years.

Listed to UL standards for damp location by a Nationally Recognized Testing Laboratory (NRTL) recognized by OSHA. Certain limitations exist for each Certification. Contact factory for verification.



Bell Auditorium Expansion

Issue for Permit / Bid  
**16 January 2023**

Type:  
**FB4 Series**

## Applications

### General Interior and Open Office



Airbnb 650 Townsend, San Francisco, CA



BioMed Center New England, Providence, RI



Bell Auditorium Expansion

Issue for Permit / Bid  
**16 January 2023**

Type:  
FB4 Series

## Applications

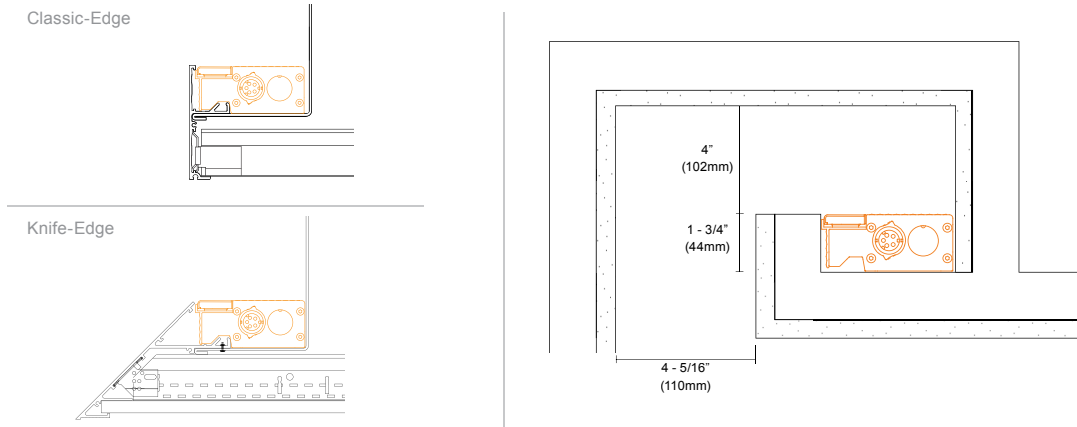
Vode supplies ZipWave cove product only. Armstrong cove products supplied by Armstrong.

### Armstrong® AXIOM® Indirect Light Cove, Ceiling-to-Wall

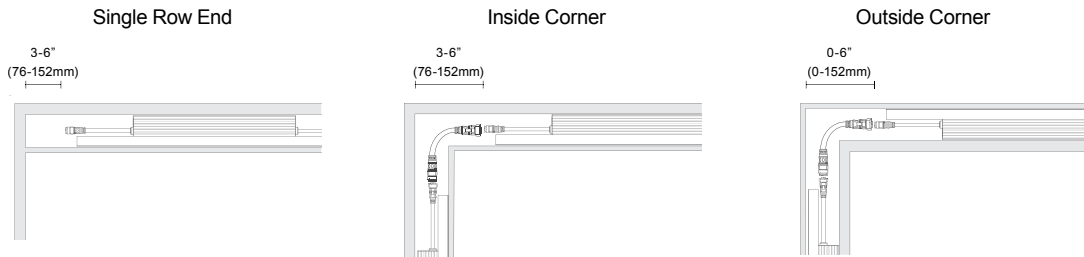
ZipWave perfectly integrates into Armstrong AXIOM Indirect Light Coves and Field Coves to provide seamless light quality in office, hospitality, civic and retail applications.

### Engineered or Site-built Wall Cove

ZipWave can easily be placed into a wide variety of engineered commercial lighting coves and site-built coves. Up to 533 feet (162m) of Low Output fixtures can be powered by a single 277v power feed.



## Corner Layout



### Jumper Cables Sold Separately:

Vode offers a 2' (Part Number: PWH-707-Z9-24-MF-WJ) or 6' (Part Number: PWH-707-Z9-72-MF-WJ) jumper for corner installations. Please indicate on your order the type and quantity required.

## Structure

Rail Lengths	24" (610mm) - 96" (2438mm). 3 Modified lengths available. See <a href="#">Rail Length Chart</a> for more details.
Rail Dimensions	1.6" (41mm) x 3.8" (97mm) x length.
Construction	Extruded and machined 6063 aluminum.
Mounting	Integral power housing compatible with Armstrong AXIOM Indirect Light Coves, and Field Coves, engineered and site-built coves.
System Run Length	24" (610mm) minimum. Unlimited maximum.
Operating Temperature	32°F to 104°F (0°C to 40°C).
Humidity	0-95%, non-condensing.
Weight	1.1 lbs per ft (0.50kg per 305mm). Weight will vary slightly due to driver selection.

## Materials

LED Board Construction	Aluminum core PCB, black LCP connectors, RoHS compliant.
Lens	High-impact extruded acrylic glass (PMMA).
Cable	Ø8mm, 6 wire, UL21388, Mylar Black with UV resistant PVC jacket.

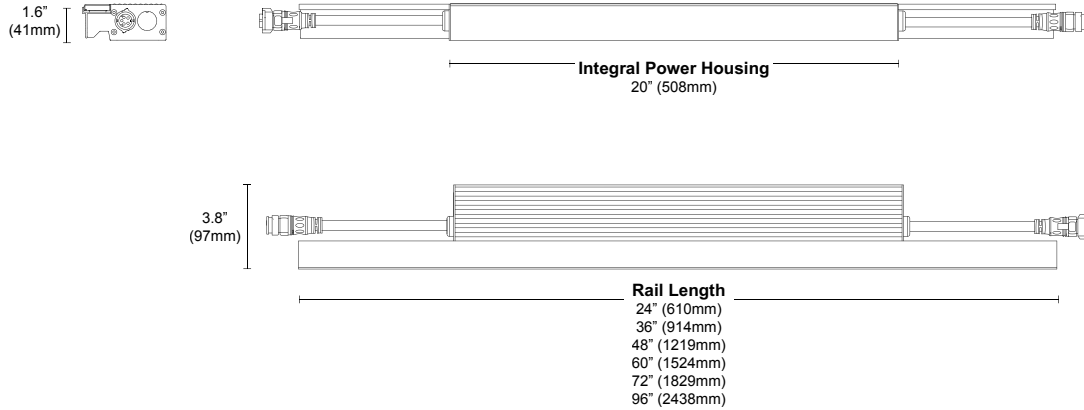


Bell Auditorium Expansion

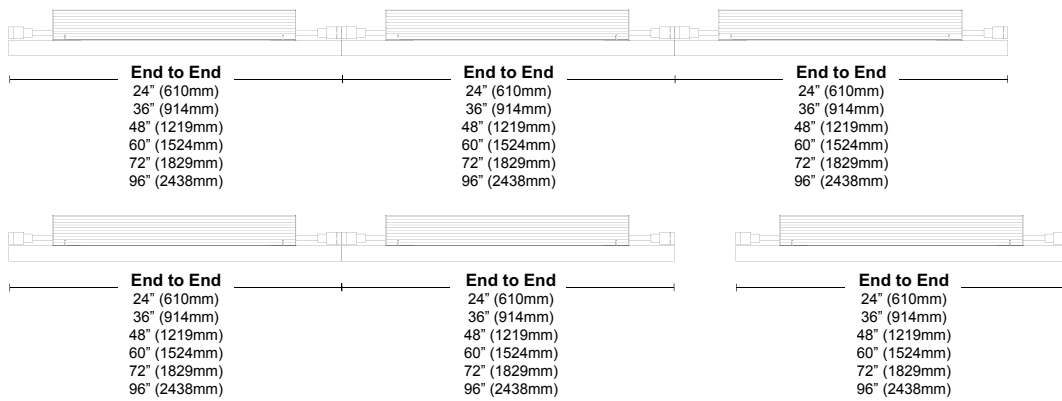
Issue for Permit / Bid  
16 January 2023

Type:  
FB4 Series

Dimensions



Layout



System Length per Power Feed

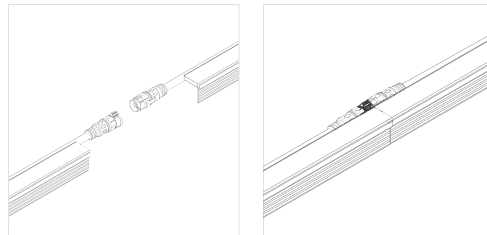
24" - 72" Rail Lengths

Input Voltage	Output		
	LO	SO	HO
120	267' (81m)	134' (40m)	67' (20m)
277	615' (187m)	308' (93m)	154' (46m)

96" Rail Lengths (any system that contains at least one 96" rail)

Input Voltage	Output		
	LO	SO	HO
120	209' (63m)	107' (32m)	54' (16m)
277	481' (146m)	247' (75m)	124' (37m)

Quick Connect Cables



Power and Controls

Power Type	Class 2 (<60V output) constant current driver.
Controls	Dimming (0.1%, 1%), 0-10V, DALI, DMX, Lutron Hi-lume 1% are available. See <a href="#">Power Guide</a> for details.
Input Voltage	120V - 277V, 50/60hz.
Power Location	Integral power only. Power cable is 27" (686mm) with 7.875" (200mm) male-male jumper.



Bell Auditorium Expansion

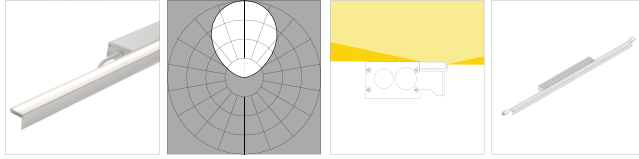
Issue for Permit / Bid  
16 January 2023

Type:  
FB4 Series

## Performance | Zipper Board Optics

Zipper Board Optics design has 72 diodes per foot (305mm).

### Clear with EdgeSoft (C1), fixture only



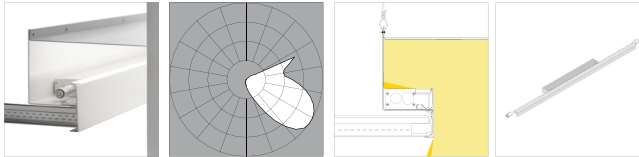
L80 >60,000 hours

Low Output (LO)	80 CRI (80min., 84 avg.)				90 CRI (90min., 96 avg.)			
	2700K	3000K	3500K	4000K	2700K	3000K	3500K	4000K
Efficacy - Lumens per Watt	101	104	106	108	87	90	91	95
Lumens per foot (305mm)	407	420	429	437	351	362	370	377
Watts per foot (305mm)	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1

Standard Output (SO)	2700K	3000K	3500K	4000K	2700K	3000K	3500K	4000K
Efficacy - Lumens per Watt	123	127	129	132	106	109	112	116
Lumens per foot (305mm)	815	840	858	875	702	724	739	754
Watts per foot (305mm)	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7

High Output (HO)	2700K	3000K	3500K	4000K	2700K	3000K	3500K	4000K
Efficacy - Lumens per Watt	116	119	122	124	100	103	105	109
Lumens per foot (305mm)	1551	1600	1633	1666	1337	1380	1408	1436
Watts per foot (305mm)	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5

### Clear with EdgeSoft (C1), in cove<sup>1</sup>



L80 >60,000 hours

Low Output (LO)	80 CRI (80min., 84 avg.)				90 CRI (90min., 96 avg.)			
	2700K	3000K	3500K	4000K	2700K	3000K	3500K	4000K
Efficacy - Lumens per Watt	53	55	56	57	46	47	48	49
Lumens per foot (305mm)	213	220	224	229	184	189	193	197
Watts per foot (305mm)	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1

Standard Output (SO)	2700K	3000K	3500K	4000K	2700K	3000K	3500K	4000K
Efficacy - Lumens per Watt	64	66	68	69	56	57	59	60
Lumens per foot (305mm)	426	439	448	457	367	379	386	394
Watts per foot (305mm)	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7

High Output (HO)	2700K	3000K	3500K	4000K	2700K	3000K	3500K	4000K
Efficacy - Lumens per Watt	61	62	64	65	52	54	55	56
Lumens per foot (305mm)	809	835	852	869	698	720	734	749
Watts per foot (305mm)	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5

#### NOTES & LIMITATIONS

<sup>1</sup>Based on testing 4" rail section placed inside 4" cove section of an Armstrong AXIOM Indirect Light Cove, classic profile. Lumen measurement complies with IES-LM-79-08 testing procedures.

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Bell Auditorium Expansion

Issue for Permit / Bid  
16 January 2023

Type:  
FB4 Series



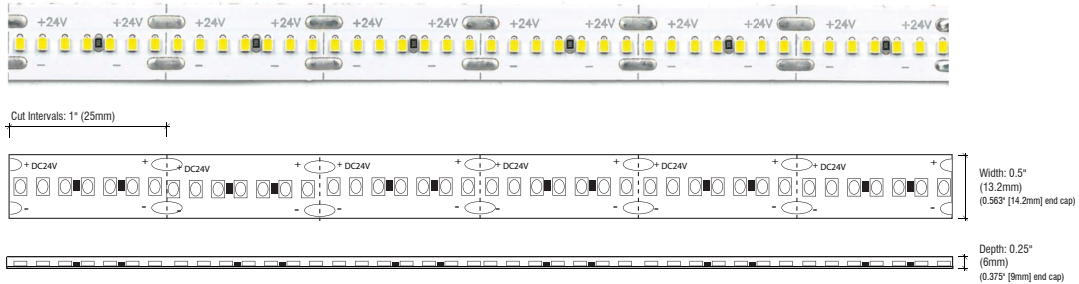
# DIRECT VIEW 200 (OUTDOOR)

DL-SERIES | RUBBER COATED | LINEAR LED LIGHTING

Fixture Type: \_\_\_\_\_

Project: \_\_\_\_\_

Location: \_\_\_\_\_



MODEL:	DL27K-WR-24V	DL30K-WR-24V	DL35K-WR-24V	DL40K-WR-24V	DL50K-WR-24V
Kelvin	2700K	3000K	3500K	4100K	5000K
Lumens	189 lm/ft	195 lm/ft	205 lm/ft	220 lm/ft	237 lm/ft
Rating	IP67	IP67	IP67	IP67	IP67

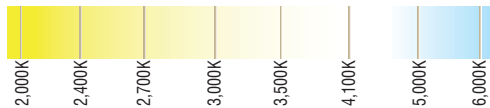
## PRODUCT FEATURES

- Suitable for most direct view applications
- 90+ CRI
- Dimmable
- 50,000 hour life
- 5-year warranty
- UL-listed for indoor and outdoor use
- 3M™ Industrial adhesive backing
- For use with 24V power supplies

## SPECIFICATIONS

Series	DL - Direct View 200 (Outdoor)
Input Voltage	24VDC / Constant Voltage
Watts per Foot	2.6W/ft @ Maximum Run Length
Beam Spread	120°
Max Run Length	Unlimited, power every 20ft
Cut Intervals	1" (25mm)
End Cap Dimensions	0.563" (14.2mm) × 0.375" (9mm)
Tape Dimensions	0.5" (13.2mm) × 0.25" (6mm)
CRI	90+
Diode	2016
Dimming Options	PWM, Triac, 0-10V, DMX, Hi-Lume
Temp Range	-40°F (-40°C) to 149°F (65°C)

## KELVIN COLOR TEMPERATURE SCALE



## TOTAL WATTAGE USED AT EACH LENGTH

1ft	2ft	3ft	4ft	5ft	6ft	7ft	8ft	9ft	10ft	11ft	12ft	13ft	14ft	15ft	16ft	17ft	18ft	19ft	20ft
3	6.6	10.2	13.6	17	20.3	23.5	26.6	29.5	32.4	35.1	37.7	40.2	42.6	44.8	46.9	48.6	49.2	51	52.8

Conforms to ANSI/UL Standard 2108  
Certified to CAN/CSA Standard C22.2 No. 250.0



Questions/Support | 800-789-3810 | quotes@kelvix.com

050422JH



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Type:  
FB5 Series

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# CH-502-A

## EXTRUDED ALUMINUM MOUNTING CHANNEL

Fixture Type: \_\_\_\_\_

Project: \_\_\_\_\_

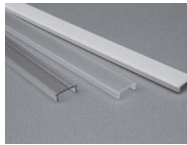
Location: \_\_\_\_\_

### PRODUCT FEATURES

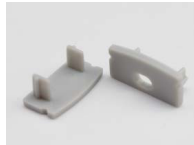
- Available in 2 meter sections
- Extruded aluminum construction
- Anodized matte finish
- Consult factory for custom lengths & finishes

### SPECIFICATIONS

Model	CH-502-A
Length	78.74" (2m)
External Width	0.688" (17.1mm)
Internal Width	0.5" (12.2mm)
Height	0.313" (8mm)



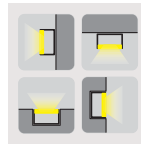
Clear lens (CL)  
Frosted lens (FR)  
White lens (WH)



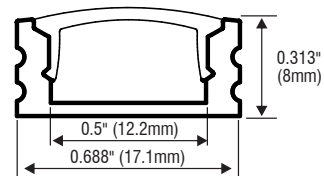
End cap with hole  
End cap without hole



Mounting clips (CP)  
Pivot mounting clips (PV)

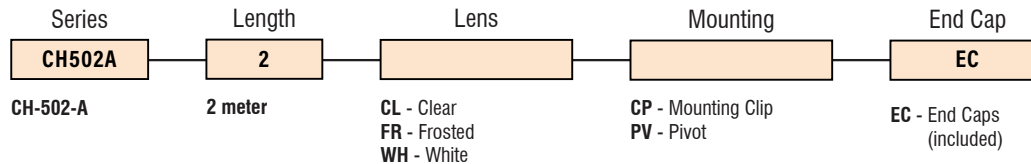


Applications



### ORDERING INFORMATION

Example: **CH502A-2-CL-CP-EC**



Questions/Support | 800-789-3810 | quotes@kelvix.com

0117187NH



Bell Auditorium Expansion

Issue for Permit / Bid  
**16 January 2023**

Type:  
FB5 Series



# NOVA 3

ROUND, DIRECT ILLUMINATION

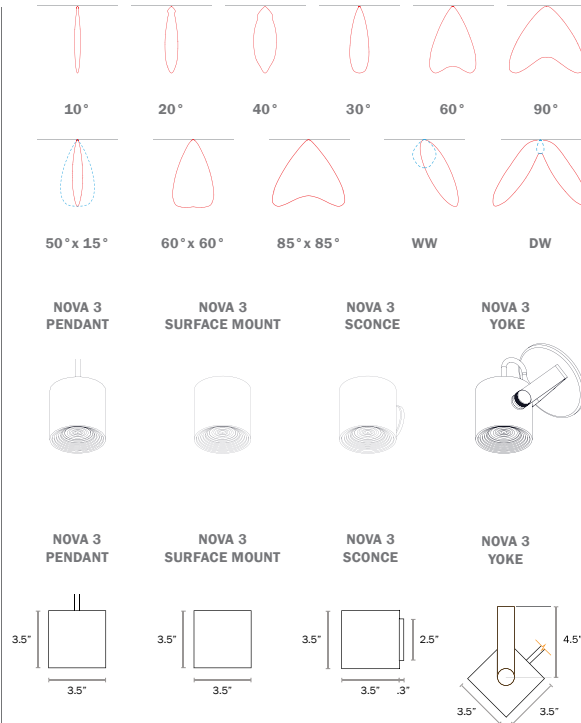


## SPECIFICATIONS

<b>PROFILE</b>	Round
<b>SIZE</b>	3.5" diameter
<b>LED OUTPUT</b>	500lm - 2,000lm
<b>CCT/CRI</b>	2700K/3000K/3500K/4000K • 90 CRI
<b>DIMMING/DRIVER</b>	Canopy and Remote Driver: 0-10V, Phase, DALI, DMX, eldoLED, Lutron®, PoE (Molex, Igor, NuLEDs). Dimming to 0% for select models
<b>POWER</b>	3.7W to 15.8W per fixture
<b>INPUT</b>	100VAC or 277VAC Phase dimmable versions are 120VAC only
<b>OPTICS</b>	10° - 90° distribution optics, including reflectors, lenses, wall washes and square beam shaping optics. Field replaceable without tools.
<b>FINISHES</b>	Powder coat - TGIC polyester
<b>MATERIAL</b>	Extruded aluminum with galvanized steel hardware
<b>ENVIRONMENT</b>	Indoor dry or damp locations
<b>WELL</b>	For UGR values and recommended options that contribute to meeting the WELL Building Standard™ see <a href="#">WELL addendum</a> .

\*Safety and Performance information available on last page. Output and other specifications available on page 8.

## DISTRIBUTIONS & PROFILES



Not to scale. Dimensions are nominal. Consult factory for CAD drawing



## NOVA 3 – SPECIFICATIONS ROUND, DIRECT ILLUMINATION

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Type:  
FB6

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PRODUCT SUBMITTAL QUICK WORKSHEET

Grid with numbers 1-12

EXAMPLE: NRP3 - 159027R2HL - DRDV00 - BABK/12 - NLT - EMB

1. MODEL (CHOOSE 1), 2. OUTPUT (CHOOSE 1), 3. CRI, 4. CCT (CHOOSE 1)

1 Available for V01 dimming only.
2 Available for V00, V01, P01, ELDOVO, DALI, and DMX dimming only.

5. OPTICS\* (CHOOSE 1), 6. OPTICAL ACCESSORY (CHOOSE 1), 7. DRIVER LOCATION\* (CHOOSE 1), 8. DIMMING\* (CHOOSE 1)

\*Beam angles noted above are nominal.
\*\*See page 4 for glow optical options.
2 Available for Pendant and Surface Mount only.

See 'Dimensions and Mounting' on page 3 to ensure correct driver location specification.
See 'Dimming/driver location compatibility' on page 8 to ensure correct dimming specification.
DRD and JRM Surface Mount do not include a canopy.
DRD is not available for Yoke.
JDD mounting only available with Pendant mounting.
JDD Deep Canopy diameter depends on LED driver.
JRM available for Surface Mount only. Mud ring provided by others.

\*See 'Driver', 'Sensor', and 'dimming/driver compatibility' charts for sensor and dimming compatibility.
1 Available for Remote driver only.
2 Choose if desired PoE solution not listed. Contact customer service to review and confirm the PoE system of your choice.

9. SHELL COLOR\* (CHOOSE 1), 10. SUSPENSION\* (CHOOSE 1), 11. SENSOR OPTIONS\* (OPTIONAL CHOOSE 1), 12. EMERGENCY OPTIONS\* (OPTIONAL)

\*See page 5 for finish chart.
\*\*Manually type the finish code into the parametric code above.

\*Default quantity is 1 sensor per fixture, type alternate quantity / ## into product code above if desired and contact ALW to request price adjustment. Sensor descriptions available on page 9.
\*Not all sensors are compatible with all drivers. See 'Driver', 'Sensor' and lamping charts for driver details and sensor compatibility.
\*Available for remote driver locations only.

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NOVA 3 - SPECIFICATIONS ROUND, DIRECT ILLUMINATION

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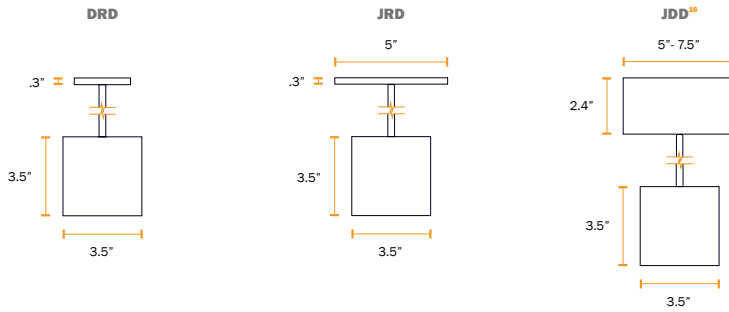
Issue for Permit / Bid
16 January 2023

Type:
FB6

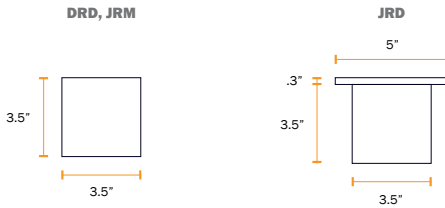


## DIMENSIONS AND MOUNTING

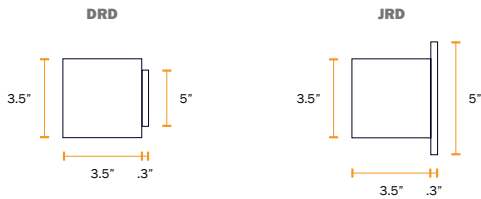
### NOVA 3 PENDANT



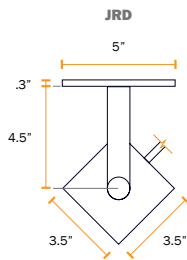
### NOVA 3 SURFACE MOUNT



### NOVA 3 SCONCE



### NOVA 3 YOKE



Not to scale. Dimensions are nominal. Consult factory for CAD drawings  
 JRD and JDD canopies fit standard 3.5" and 4" round and octagonal junction boxes.  
<sup>16</sup>JDD Deep Canopy diameter depends on LED driver size.

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## NOVA 3 - SPECIFICATIONS ROUND, DIRECT ILLUMINATION

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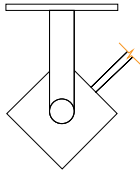
Type:  
FB6

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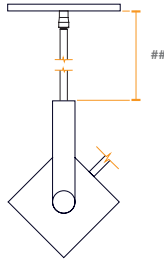
**DIMENSIONS AND MOUNTING**

**YOKE  
STANDARD CANOPY<sup>17</sup>**



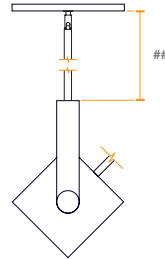
**YOKE  
RIGID STEM<sup>17</sup>**

includes 10° hang straight



**YOKE  
SWIVEL STEM<sup>17</sup>**

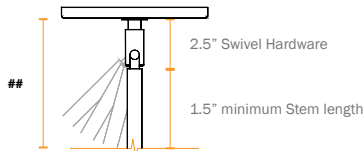
360° rotation x 90° tilt swivel



## = length in inches from bottom of canopy to top of yoke

**PENDANT SUSPENSION OPTIONS**

**SWIVEL STEM**

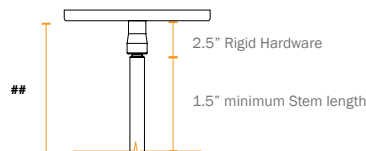


Order Code = **SS##**

## = length in inches from bottom of canopy to top of fixture. Includes the swivel hardware. Minimum length for swivel hardware + stem is 4". Total length (##) for swivel hardware alone is 2.5".

360° rotation x 90° tilt swivel

**RIGID STEM**



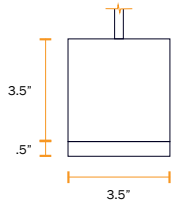
Order Code = **RS##**

## = length in inches from bottom of canopy to top of fixture. Includes the rigid hardware. Minimum length for rigid hardware + stem is 4". Total length (##) for rigid hardware alone is 2.5".

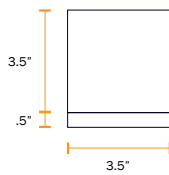
Includes 10° hang straight

**NOVA GLOW DIMENSIONS**

**NOVA  
GLOW RING/DISK  
PENDANT**

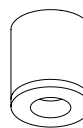


**NOVA  
GLOW RING/DISK  
SURFACE MOUNT**



**NOVA GLOW OPTICS**

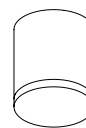
**NOVA  
GLOW RING**



Order Codes

GN = Glow Narrow Beam  
GM = Glow Medium Beam  
GW = Glow Wide Beam

**NOVA  
GLOW DISK**



Order Code

GD = Glow Solid Diffuser

Not to scale. Dimensions are nominal consult factory for CAD drawings.  
<sup>17</sup>Shown as JRD/DRD shallow canopy configuration. See page 3 for other configurations.

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**NOVA 3 - SPECIFICATIONS  
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**FB6**

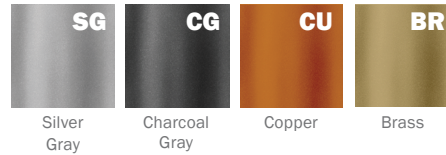


## FINISHES

### BASIC POWDER COAT



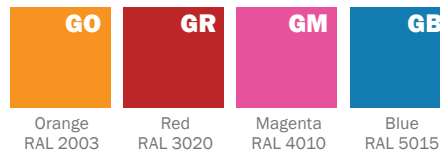
### METALLIC POWDER COAT



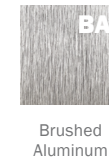
### SATIN ANODIZED EFFECT POWDER COAT



### GLOSS POWDER COAT (80-95% GLOSS)



### ALUMINUM\*



Contact ALW Quotes for sample paint finish swatches.

\*Brushed aluminum finish available for an additional fee.

## SPECIAL ORDER FINISHES\*



### RAL CLASSIC COLORS (80-95% GLOSS): RAL\_ \_ \_ \_

Most RAL Classic Colors are available for a minimum setup fee. On your specification submittal choose your RAL color by entering the 4-digit RAL code (Ex: RAL 3003). See [www.alwusa.com/finishes](http://www.alwusa.com/finishes)



### CUSTOM COLOR MATCH: CCM\_ \_ \_ \_

Custom powder coat color matching is available for a premium setup fee. Consult ALW for additional information.



### CATALOG COLORS: CAT\_ \_ \_ \_

The complete range of powder coat colors from Tiger Drylac and TCI catalogs are available for a minimum setup fee. Consult ALW for a catalog color you would like to specify.

\*An individual setup fee will apply to each unique Special Order Finish per purchase order. (ex: RAL 5023 and RAL 2008 are specified for multiple line items on a purchase order. 2x setup fees will apply)

\*Printed or on-screen colors are only approximations - consult actual Color Chip Set before specifying)

## CORD OPTIONS



Black  
Order Code = **BK**

Standard cord for Yoke suspensions.



White  
Order Code = **WH**



Clear Silver Braid  
Order Code = **CB**



Cloth Cover  
Order Code = **CC**

For remote and deep canopy drivers only.

Specify cloth cord color in the suspension section of the part number. See page 6 for all cloth cord color options.

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## NOVA 3 - SPECIFICATIONS ROUND, DIRECT ILLUMINATION

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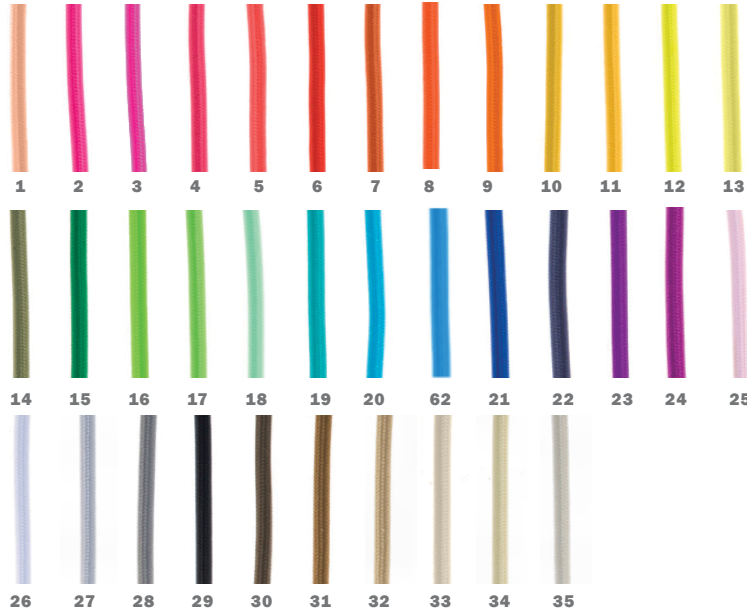
Type:  
FB6

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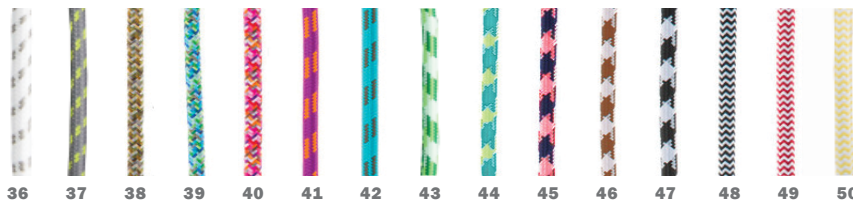
**CLOTH CORD COLOR OPTIONS**

FOR DAMP AND DRY LOCATIONS ONLY



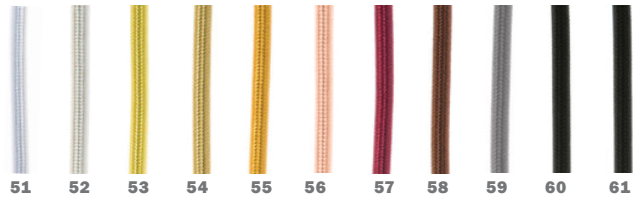
**SOLID COLOR CLOTH CORDS**

- 1. Peach
- 2. Pink
- 3. Neon Pink
- 4. Hot Pink
- 5. Neon Coral
- 6. Red
- 7. Adobe
- 8. Orange
- 9. Neon Orange
- 10. Goldenrod
- 11. Sunshine Yellow
- 12. Neon Yellow
- 13. Citrus Yellow
- 14. Olive Green
- 15. Kelly Green
- 16. Neon Green
- 17. Lime Green
- 18. Mint Green
- 19. Turquoise
- 20. Skyblue
- 21. Cobalt Blue
- 22. Navy
- 23. Purple
- 24. Magenta
- 25. Blush
- 26. White
- 27. Silver
- 28. Gray
- 29. Black
- 30. Antique Brown
- 31. Chocolate Brown
- 32. Flax
- 33. Khaki
- 34. Sand
- 35. Ivory



**PATTERNED CLOTH CORDS**

- 36. White & Gray Dot
- 37. Gray & Citrus Yellow Dot
- 38. Neutral Tweed
- 39. Cool Tweed
- 40. Warm Tweed
- 41. Magenta & Orange Stripe
- 42. Turquoise & Brown Stripe
- 43. Green Argyle
- 44. Turq. & Yellow Houndstooth
- 45. Navy & Coral Houndstooth
- 46. Brown & Ivory Houndstooth
- 47. Black & White Houndstooth
- 48. Black & White Zigzag
- 49. Red & White Zigzag
- 50. Yellow & White Zigzag



**METALLIC CLOTH CORDS**

- 51. Pearl Metallic
- 52. Champagne Metallic
- 53. Yellow Gold Metallic
- 54. Brass Metallic
- 55. Copper Metallic
- 56. Copper Penny
- 57. Currant Metallic
- 58. Bronze Metallic
- 59. Gunmetal
- 60. Black Patent
- 61. Black Satin

SPECIFY **CLOTH CORD COLOR** IN SUSPENSION OPTIONS IN PRODUCT CODE. PRINTED OR ON-SCREEN COLORS ARE ONLY APPROXIMATIONS - CONSULT SAMPLE BEFORE SPECIFYING

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**NOVA 3 – SPECIFICATIONS  
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**PERFORMANCE DETAILS**

OPTICS OPTION	CRI	OUTPUT OPTION	DELIVERED LUMENS <sup>18</sup>	EFFICACY (LM/W)	SYSTEM WATTS(W)	CCT OPTIONS
<b>R1 - 10°</b> <b>R2 - 20°</b> <b>R4 - 40°</b> <b>L3 - 30°</b> <b>L6 - 60°</b> <b>L9 - 90°</b> <b>S1 - 50° x 15°</b> <b>S2 - 55° x 55°</b> <b>S3 - 85° x 85°</b> <b>GN</b> <b>GM</b> <b>GW</b> <b>GD<sup>19</sup></b>	Ra = 90 ± 3	500	467	126	3.7	2700K 3000K 3500K 4000K
		800	747	129	5.8	
		1000	934	128	7.3	
		1500	1401	124	11.3	
		2000	1868	118	15.8	

<sup>\*</sup>Based on L6-60° lens for all outputs, 4000K 90CRI.

<sup>\*</sup>Refer to IES files for full performance data.

<sup>18</sup>Actual lumens measured in field may differ +/- 10%.

<sup>19</sup>Glow Diffuse optics delivered lumens are up to 35% lower than the specified output.

**TM-30-18 DETAILS (90 CRI LAMPING)**

CCT	CRI (Ra)	CRI (R9)	TM-30 Rf	TM-30 Rg
2700K	90.5	59.7	89.4	99.6
3000K	92.5	66.5	89.9	98.7
3500K	93.8	74.2	89.8	98.1
4000K	94.2	78.8	89.8	98.5

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**NOVA 3 – SPECIFICATIONS**  
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**DRIVERS**

PRODUCT CODE	DESCRIPTION
V00	0-10V dimming down to 0%
V01	0-10V dimming down to 1%
P01	ELV/TRIAC Phase dimming down to 1%
ELDVO	eldoLED, 0-10V dimming down to 0%
DALI	DALI flicker-free dimming down to 0%.
DMX	DMX flicker-free dimming down to 0%.
LDE1	ECOSYS1, (LDE1) Lutron Hi-Lume 1% EcoSystem LED driver with Soft-on, Fade-to-Black dimming technology
LTEA	LTEA. Lutron Hi-Lume 1% 2-wire TRIAC dimming (120V forward-phase only)
POEM	POE MOLEX. Molex CoreSync PoE LED Driver dimming down to 0.1%
POEI	IGOR PoE LED Driver. Contact ALW to assist with your project.
POEN	NuLEDS PoE LED Driver. Contact ALW to assist with your project.
POE	PoE Ready LED Driver. Contact ALW to assist with your project.

\*Contact ALW for specific dimming level requests. ALW lighting fixtures are intended for use with a wide range of sensors, lighting controls, LED drivers, and building management systems. If there are specific components required for your application that aren't listed on this spec sheet, please contact ALW customer support today to specify a compatible solution of your choice.

DRIVER/LED LAMPING COMPATIBILITY			
	STANDARD LAMPING*	CA TITLE 24 JA8/JA10 <sup>20</sup>	IEEE P1789 & HD TV STUDIO <sup>21</sup>
V00	●	●	
V01	●	●	
P01	●	●	
ELDVO	●	●	●
DALI	●	●	●
DMX	●	●	●
LDE1	●	●	●
LTEA	●	●	
POEM	PER REQUEST	●	●
POEI	PER REQUEST	●	●
POEN	PER REQUEST	●	●
POE	PER REQUEST	●	●

DRIVER LOCATION/DRIVER COMPATIBILITY			
	INTERNAL	DEEP CANOPY	REMOTE
V00		●	●
V01		●	●
P01		●	●
ELDVO		●	●
DALI		●	●
DMX		●	●
LDE1		●	●
LTEA		●	●
POEM			●
POEI			●
POEN			●
POE			●

● - Indicates compatibility

\*Standard lamping - 500-2000LM

<sup>20</sup> Fixtures specified with 90CRI 2700K, 3000K, 3500K, and 4000K lamping with applicable LED drivers have the ability to conform to California Title 24 JA8 and JA10 Appendices.

<sup>21</sup> The following drivers conform to IEEE P1789 Flicker Standard: 'IEEE Recommended Practices for Modulating Current in High-Brightness LEDs for Mitigating Health Risks to Viewers'. These drivers may also be installed in HD TV Studio applications utilizing high frequency camera equipment.

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**NOVA 3 – SPECIFICATIONS  
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Type:  
FB6



**SENSORS\***

PRODUCT CODE	DESCRIPTION	DRIVER LOCATION	SENSOR LOCATION	
<b>N</b>	None. Choose when sensors are not desired.	-	-	
<b>COOPER</b> <b>WLNX</b>	Fixture is built with 0/10V wiring to connect to Wavelinx Wireless sensors and power/relay packs (sensors and equipment not provided by ALW)	Deep Canopy Remote	Remote	
<b>ENLIGHTED™</b> <b>ENLGH</b>	Enlighted® remote connected lighting smart sensor - occ/daylight/networking (Enlighted Part: SU-5S-H-CL)	Remote		
<b>LUTRON VIVE</b>	<b>FCJS</b>	Lutron® Vive remote RF wireless fixture control (Lutron Part: FCJS-ECO or FCJS-010)		Remote
	<b>FCJS/S</b>	Lutron® Vive remote RF wireless fixture control + daylight/occ sensor (Lutron Part: FCJS-ECO or FCJS-010, & FC-Sensor)		Remote
<b>MOLEX POE CORESYNC</b> <b>MLX</b>	Molex PoE sensors for use with Molex/PoE drivers. Customer will need to determine who to purchase PoE equipment from.	Remote		
<b>NLIGHT WIRED®</b> <b>NLT</b>	Fixture is built to connect to nLight Wired remote components specified by agency. Contact ALW to review project details.	Remote		
<b>NLIGHT WIRELESS®</b> <b>NLTAIR</b>	Fixture is built to connect to nLight Air (Wireless) remote components specified by agency. Contact ALW to review project details.	Remote		
<b>VALUE SENSORS</b> <b>OS/PH/HV</b>	<i>Hubbell WASP High Voltage 0-10V remote surface mount occ/daylight sensor. 120/277/347VAC input (Hubbell Part: WSPDSMUNV) Automated Dimming Functionality: Connect fixture 0/10V wires to sensor in the field. Adjust occ/photocell settings as desired. On/Off or Manual Dimming Functionality: Turn photocell functionality OFF. Cap off 0/10V wires on sensor. Connect fixture 0/10V wires to wall dimmer in the field.</i>	Deep Canopy Remote		

\*All connected lighting sensors/systems must be programmed in the field by an electrical commissioner familiar with the system. Refer to the 'Sensor Compatibility' and 'Driver/Sensor Compatibility' charts to specify compatible sensors, LED lamping, and LED driver systems.

SENSOR COMPATIBILITY					
PRODUCT CODE	SENSOR TYPE	MAX MOUNT HT	CA TITLE 24	STD*	
<b>COOPER WAVELINX</b> <b>WLNX</b>		15 ft	●	●	
<b>ENLIGHTED™</b> <b>ENLGH</b>	OCCUPANCY/PHOTOCELL	40 ft	●	●	
<b>LUTRON VIVE</b>	<b>FCJS</b>	WIRELESS CONTROL	12 ft	●	●
	<b>FCJS/S</b>	OCCUPANCY/PHOTOCELL	12 ft	●	●
<b>MOLEX POE CORESYNC</b> <b>MLX</b>		16 ft	●	●	
<b>NLIGHT WIRED</b> <b>NLT</b>		15 ft	●	●	
<b>NLIGHT WIRELESS</b> <b>NLTAIR</b>		15 ft (average)	●	●	
<b>VALUE SENSORS</b> <b>OS/PH/HV</b>	OCCUPANCY/PHOTOCELL	45 ft	●	●	

● - Indicates compatibility    ■ - On/off sensor functionality only  
\*Standard Lamping (STD) - 500 - 2000LM

DRIVER/SENSOR COMPATIBILITY									
	WLNX	ENLGH	MLX	FCJS	FCJS/S	NLT	NLTAIR	OS/PH/HV	NO SENSOR
<b>V00</b>	●	●		●	●			■	●
<b>V01</b>	●	●		●	●			■	●
<b>P01</b>								■	●
<b>ELDVO</b>						●	●	▲	●
<b>DALI</b>								■	●
<b>DMX</b>								■	●
<b>LDE1</b>				●	●				●
<b>LTEA</b>								■	●
<b>POEM</b>			●						●
<b>POEI</b>	Sensor types will depend on the PoE system configuration. Contact ALW for details.								
<b>POEN</b>	Sensor types will depend on the PoE system configuration. Contact ALW for details.								
<b>POE</b>	Sensor types will depend on the PoE system configuration. Contact ALW for details.								

● - Indicates compatibility  
▲ - Fixture can have automated dimming via sensor OR on/off functionality and manual dimming  
■ - On/off sensor functionality only

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**NOVA 3 – SPECIFICATIONS**  
**ROUND, DIRECT ILLUMINATION**

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**16 January 2023**

Type:  
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**PHOTOMETRICS NOVA**

BEAM ANGLE (°)	POLAR PLOT (CD)	MTG HEIGHT (FT)	LIGHT LEVEL (FC)	BEAM DIAMETER (FT)	SPACING CRITERION (SC) <sup>22</sup> (0°- 180°) (90°- 270°)	MAX INTENSITY (CD)
<b>R1</b> 10°		6.0	439.8	1.0	0.17 0.17	15831
		8.0	247.4	1.3		
		10.0	158.3	1.7		
		12.0	109.9	2.0		
		14.0	80.8	2.4		
		16.0	61.8	2.7		
<b>R2</b> 20°		6.0	124.4	2.3	0.37 0.37	4478
		8.0	70.0	3.1		
		10.0	44.8	3.8		
		12.0	31.1	4.6		
		14.0	22.8	5.4		
		16.0	17.5	6.1		
<b>R4</b> 40°		6.0	61.3	4.3	0.63 0.63	2206
		8.0	34.5	5.7		
		10.0	22.1	7.2		
		12.0	15.3	8.6		
		14.0	11.3	10.1		
		16.0	8.6	11.5		
<b>L3</b> 30°		6.0	106.4	3.2	0.5 0.5	3831
		8.0	59.9	4.2		
		10.0	38.3	5.3		
		12.0	26.6	6.3		
		14.0	19.5	7.4		
		16.0	15.0	8.4		
<b>L6</b> 60°		6.0	35.7	6.7	1.0 1.0	1466
		8.0	20.1	8.9		
		10.0	12.8	11.1		
		12.0	8.9	13.3		
		14.0	6.6	15.6		
		16.0	5.0	17.8		
<b>L9</b> 90°		6.0	13.5	11.1	1.58 1.58	705
		8.0	7.6	14.8		
		10.0	4.9	18.5		
		12.0	3.4	22.2		
		14.0	2.5	26.0		
		16.0	1.9	29.7		

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**NOVA 3 - SPECIFICATIONS**  
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**PHOTOMETRICS NOVA**

BEAM ANGLE (°)	POLAR PLOT (CD)	MTG HEIGHT (FT)	LIGHT LEVEL (FC)	BEAM DIAMETER (FT)	SPACING CRITERION (SC) <sup>22</sup> (0°- 180°) (90°- 270°)	MAX INTENSITY (CD)
<b>S1</b> 50° x 15°		6.0	98.8	3.7	0.82 0.3	3618
		8.0	55.6	5.0		
		10.0	35.6	6.2		
		12.0	24.7	7.5		
		14.0	18.2	8.7		
		16.0	13.9	10.0		
<b>S2</b> 55° x 55°		6.0	34.4	6.3	0.92 0.92	1317
		8.0	19.3	8.4		
		10.0	12.4	10.5		
		12.0	8.6	12.6		
		14.0	6.3	14.7		
		16.0	4.8	16.8		
<b>S3</b> 85° x 85°		6.0	15.5	9.5	1.45 1.45	879
		8.0	8.7	12.6		
		10.0	5.6	15.8		
		12.0	3.9	18.9		
		14.0	2.8	22.1		
		16.0	2.2	25.2		
<b>WALL WASH</b>		6.0	15.1	5.1	1.77 1.13	1236
		8.0	8.5	6.8		
		10.0	5.4	8.5		
		12.0	3.8	10.2		
		14.0	2.8	11.9		
		16.0	2.1	13.6		
<b>DOUBLE WALL WASH</b>		6.0	5.5	7.1	0.88 2.7	1176
		8.0	3.1	9.4		
		10.0	2.0	11.8		
		12.0	1.4	14.1		
		14.0	1.0	16.5		
		16.0	0.8	18.8		

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**NOVA 3 – SPECIFICATIONS**  
**ROUND, DIRECT ILLUMINATION**

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**PHOTOMETRICS NOVA GLOW**

BEAM ANGLE (°)	POLAR PLOT (CD)	MTG HEIGHT (FT)	LIGHT LEVEL (FC)	BEAM DIAMETER (FT)	SPACING CRITERION (SC) <sup>22</sup> (0°- 180°) (90°- 270°)	MAX INTENSITY (CD)
<b>GN</b>		6.0	247.8	1.3	0.21 0.21	8922
		8.0	139.4	1.7		
		10.0	89.2	2.2		
		12.0	62.0	2.6		
		14.0	45.5	3.1		
		16.0	34.9	3.5		
<b>GM</b>		6.0	89.3	2.2	0.34 0.34	3216
		8.0	50.3	2.9		
		10.0	32.2	3.7		
		12.0	22.3	4.4		
		14.0	16.4	5.2		
		16.0	12.6	5.9		
<b>GW</b>		6.0	56.3	3.9	0.53 0.53	2025
		8.0	31.6	5.2		
		10.0	20.3	6.5		
		12.0	14.1	7.8		
		14.0	10.3	9.1		
		16.0	7.9	10.4		
<b>GD</b>		6.0	10.6	13.2	1.14 1.14	381
		8.0	6.0	17.6		
		10.0	3.8	22.0		
		12.0	2.6	26.4		
		14.0	1.9	30.9		
		16.0	1.5	35.3		

<sup>\*</sup>NOVA Photometric calculations based on 1500lm 4000K 90CRI fixture combination. Actual results may vary in the field.  
<sup>\*</sup>NOVA GLOW Photometric calculations based on NOVA 2 GLOW at 1500lm 4000K 90CRI fixture combination. Actual results may vary in the field.  
<sup>\*</sup>For footcandle and output multipliers refer to the [ALW IES File Multipliers Chart](#).  
<sup>22</sup>Spacing criterion refers to maximum distance luminaires can be spaced to provide uniform illumination on the working plane or surface.  
 Luminaire spacing = Spacing Criterion (SC) x Mounting Height (MH) (ex. 1.14 (SC) x 10' (MH) = 11.4' Luminaire Spacing).

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**NOVA 3 – SPECIFICATIONS  
ROUND, DIRECT ILLUMINATION**

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**FB6**



## ADDITIONAL OPTIONS & SPECIFICATIONS

### LED PERFORMANCE

> 55,000 hours at 80% lumen maintenance, LM80 / TM-21

### COLOR CONSISTENCY

3 SDCM; 90 CRI typical

### HOUSING

Extruded aluminum with galvanized steel hardware

### SAFETY & REGULATORY

Can be used to comply with **Title 24 JAB and JA10** requirements. Contact ALW customer support today and we can help you with your project requirements.

UL Listed (U.S. & Canada). Suitable for dry or damp locations. Conforms to UL 2108, 8750 Certified to CSA std. CSA C22.2# 9 & #250.0

### OPERATING TEMPERATURE

Luminaire should be installed and operated ONLY in dry or damp environments where the ambient temperature ranges from -4 °F to 104 °F (-20 °C to 40 °C). Luminaire operation in environments outside the listed temperature range voids the warranty AND may damage the product or adversely impact lamp life, lumen output and color consistency.

### CONTROLS, SENSORS, & LED DRIVER

ALW lighting fixtures are intended for use with a wide range of sensors, lighting controls, LED drivers, and building management systems. Our component portfolio is continually expanding to adopt to the latest technologies and specification needs. We currently support integration with Lutron, Enlighted, EldoLED, nLight, Osram, Philips, and more. If there's a component or system needed that you don't see on the spec sheet please contact ALW customer support today so we can review your requirements.

### WARRANTY

LIMITED WARRANTY. Visit [alwusa.com/warranty](http://alwusa.com/warranty) for more information.

### WEIGHT

NOVA 3			
PENDANT	SURFACE MOUNT	SCONCE	YOKE
1.2 lbs/ 0.6 kg	1.2 lbs/ 0.6 kg	1.2 lbs/ 0.6 kg	1.2 lbs/ 0.6 kg

NOVA 3 GLOW	
PENDANT	SURFACE MOUNT
1.5 lbs/ 0.7 kg	1.5 lbs/ 0.7 kg

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**NOVA 3 – SPECIFICATIONS**  
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**Carina**

The Carina light has a wide, curved shape comprised of hand-blown glass and formed aluminum. Its compact design works perfectly in multiples and maintains a strength on its own.

**DIMENSIONS**  
6.25" W x 5.5" H

**LAMPING**  
3.5W LED E12 base

**LUMENS**  
350

**COLOR TEMP**  
2700K

**INPUT VOLTAGE**  
120V, dimmer compatible

**MOUNTING**  
5" round black canopy

**CORD LENGTH**  
8' (custom available)

**WEIGHT**  
2 lbs

**GLASS COLOR**  
Tea

Crystal  
Bronze  
Smoke  
Olive  
Sapphire

**METAL FINISH**  
Dark Bronze  
Champagne

**COLLECTION**  
Parallel



Dark Bronze/Crystal  
PCR-101



Dark Bronze/Sapphire  
PCR-102



Dark Bronze/Bronze  
PCR-103



Dark Bronze/Olive  
PCR-104



Dark Bronze/Smoke  
PCR-105



Dark Bronze/Tea  
PCR-106



Champagne/Crystal  
PCR-201



Champagne/Sapphire  
PCR-202



Champagne/Bronze  
PCR-203



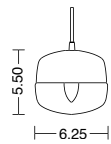
Champagne/Olive  
PCR-204



Champagne/Smoke  
PCR-205



Champagne/Tea  
PCR-206



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**FB7**

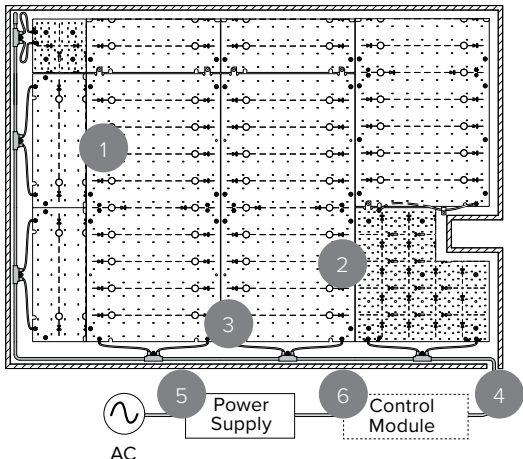
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## COOLEEDGE TILE INTERIOR - SPECIFICATIONS

PROJECT		REFERENCE TYPE	
SPECIFIED BY		QUANTITY	
DATE		NOTE	For Luminous Surfaces

### SYSTEM OVERVIEW



Create luminous ceilings, feature walls, and large graphics displays with Cooleedge TILE Interior products

1	TILE Interior
2	TILE Interior Cut-out Kit <i>(optional)</i>
3	TILE Interior T-Cable
4	TILE Interior Starter Cable*
5	Power Supply
6	Control Module <i>(optional)</i>

\*Included in TILE Interior Starter Kit

### GENERAL

Location	Indoor, dry location only
Operating Temp.	0-40°C (32-104°F)
Storage Temp.	-40-85°C (-40-185°F)
Relative Humidity	90% max (non-condensing)
Operating Voltage	58 VDC
Electrical Connections	Tool-less snap connectors
Mounting Surface	Non-conductive (drywall, plywood, etc)

### SPECIFICATION

UL Listed lighting system inclusive of flexible light emitting sheets, connectors, low voltage cables, and LED drivers. Light output from the system must be +/- 10% of 900/600/300/150 lumens/sq ft across the total illuminated area post-installation. Color Rendering Index (CRI) must be >90 and color consistency between light sheets must be typical 2 SDCM. Electrical connections between cables and light emitting sheets must be tool-less and allow more than one connect/disconnect iteration. System must be configurable on-site and include the capability to accommodate obstacles, angles, and curves. System warranty is a minimum of 5 years.

### FEATURES

- Four choices of constant lumen output ensure consistent highly calibrated illumination
- Color consistency of typically 2 SDCM between TILES meets stringent requirements for large area installations
- Cut-to-fit means systems are adaptable to any size installation and can accommodate obstacles and shapes
- Constant voltage electrical architecture is fully scalable without loss of performance or need to reconfigure drivers
- Low setback distances, flexibility, and no requirement for a heat sink enable optimal integration with luminous surfaces
- Multiple options for dimming, lumen level, and CCT offer the most adaptable illumination for large surface areas available today
- Mounts directly to most common non-conductive construction materials (eg. drywall, plywood)

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110-13551 Commerce Parkway  
Richmond, BC V6V 2L1 Canada

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T +1 844 455 4448  
W cooleedgelighting.com

Cooleedge Lighting reserves the right to change materials or modify the design of its product without notification as part of the company's continuing product improvement program.

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Type:  
FB8

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# COOLEdge TILE INTERIOR - SPECIFICATIONS

## PHOTOMETRICS<sup>1</sup>

Light Output (lm/sqft)	900 <sup>3</sup> , 600, 300, 150
Correlated Color Temperature (CCT)	2200K, 2700K, 3000K, 3500K, 4000K, 5700K
Color Rendering Index (CRI)	≥ 90 (except 2200K, CRI88)
Color Uniformity	2 SDCM (typical)
Lumen Maintenance <sup>2</sup>	L80 = 75,000hr

<sup>1</sup> Photometric files available from [cooledgelighting.com](http://cooledgelighting.com)

<sup>2</sup> Based on LM80 data & TM-21 calculations

<sup>3</sup> Not available in 2200K

## POWER

Light Output (lm/sqft)	CCT	Power (W/sqft)	EcoDesign Class
900	2200K	N/A	N/A
	2700K	8.7	F
	3000K	8.4	F
	3500K	8.2	F
	4000K	8.1	F
	5700K	7.4	E
600	2200K	6.7	N/A
	2700K	5.8	F
	3000K	5.6	F
	3500K	5.5	F
	4000K	5.3	F
	5700K	5.1	F
300	2200K	3.2	F
	2700K	2.8	F
	3000K	2.7	F
	3500K	2.7	F
	4000K	2.6	F
	5700K	2.5	E
150	2200K	1.6	F
	2700K	1.4	F
	3000K	1.3	F
	3500K	1.3	F
	4000K	1.3	F
	5700K	1.3	F



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## IESNA TM-30-15 DATA

CCT	Rf	Rg
2200K	87	99
2700K	88	97
3000K	88	97
3500K	87	96
4000K	87	96
5700K	90	100

## CERTIFICATIONS



**RoHS**



Contact Cooleedge for ordering information for JA8 compliant models.



## WARRANTY



5 Year Limited Warranty:  
Parts and workmanship when used with a Cooleedge approved power supply.

**COOLEEDGE™**  
Light as a building material



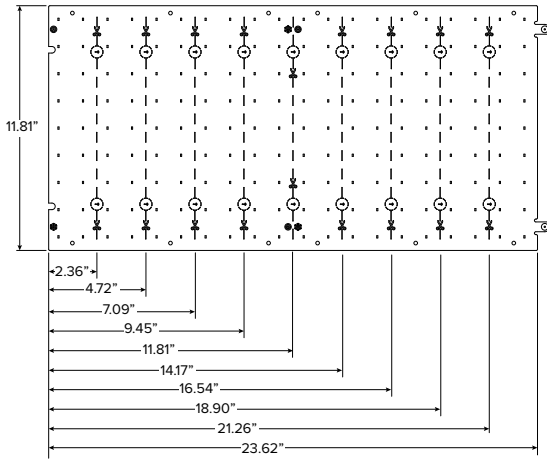
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**16 January 2023**

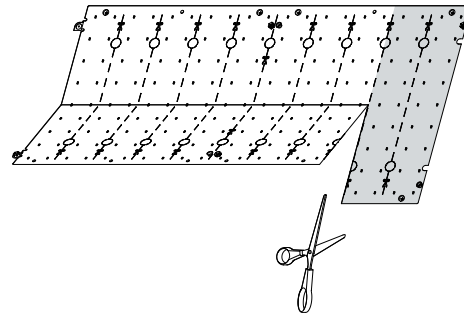
Type:  
**FB8**

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**1 TILE INTERIOR**



Weight = 0.18lbs/ 82g



**HOW TO ORDER**

Example: TILE-INT-600-40-R2

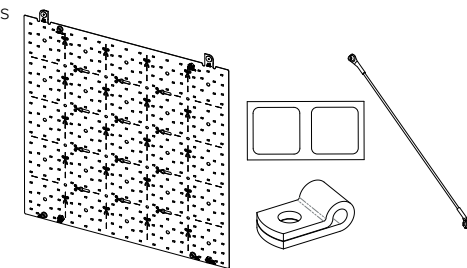
TILE	-	INT	-	-	-	R2	
<u>PRODUCT</u> TILE		<u>TYPE</u> INT = Interior		<u>FLUX</u> 900 = 900lm/sqft 600 = 600lm/sqft 300 = 300lm/sqft 150 = 150lm/sqft		<u>CCT</u> 22 = 2200K 27 = 2700K 30 = 3000K 35 = 3500K 40 = 4000K 57 = 5700K	<u>Version</u> R2 = Revision 2

**2 TILE INTERIOR CUT-OUT KIT**

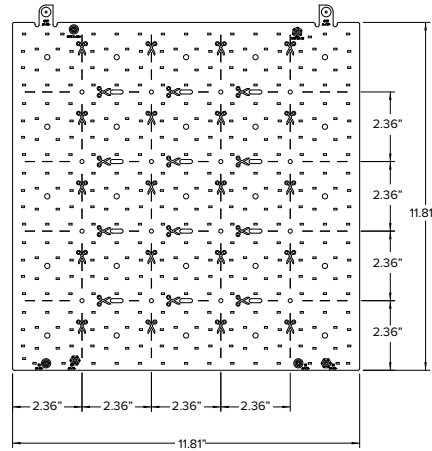
**Purpose:** Cut-to-fit around obstacles located in the middle of a luminous surface such as standoffs, support cables/rods, beams, pipes, etc.; used in corners where a full TILE does not fit in the space; or to step cut along angles and curves in a luminous surface. (Optional)

**INCLUDED**

- (1) Cut-out TILE (11.81"x 11.81")
- (2) Insulating Patches
- (1) Cable Clamp
- (1) Jumper Cable



Weight = 0.10lbs/ 45g



**HOW TO ORDER**

Example: TACC-INT-CUT-600-35-K

TACC	-	INT	-	CUT	-	-	-	K	
<u>PRODUCT</u> TACC = TILE Accessory		<u>TYPE</u> INT = Interior		<u>COMPONENT</u> CUT = Cut-out Kit		<u>FLUX</u> 900 = 900lm/sqft 600 = 600lm/sqft 300 = 300lm/sqft 150 = 150lm/sqft		<u>CCT</u> 22 = 2200K 27 = 2700K 30 = 3000K 35 = 3500K 40 = 4000K 57 = 5700K	<u>KIT</u> K = Kit

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**COOLEGGE™**  
Light as a building material



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FB8



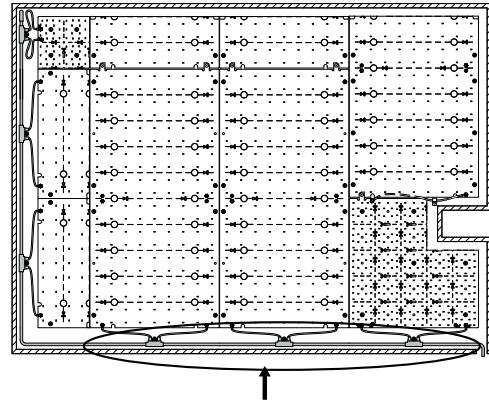
**3 TILE INTERIOR T-CABLE**

**Purpose:** Makes the electrical connection to the first TILE in each run from the Starter Cable that supplies power from the power/control components. Each “T” connects to a TILE via snap connectors. (Required)

**HOW TO ORDER**

Example: TCBL-T10

TCBL	-	
<b>PRODUCT</b> TCBL = TILE Cable		<b>TYPE</b> T4 = 4 T-Connectors (weight = .13lb) T10 = 10 T-Connectors (weight = .66lb)

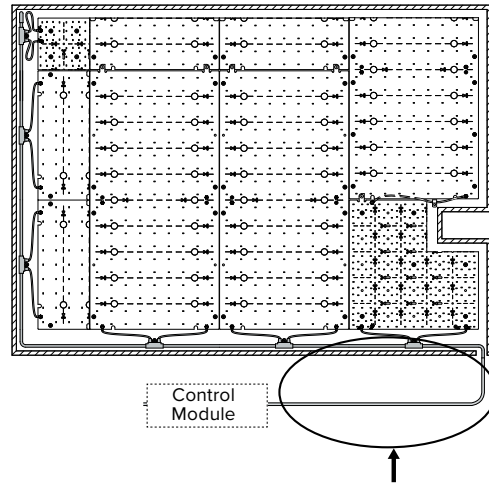
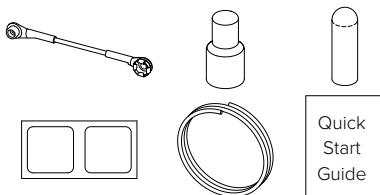


**4 TILE INTERIOR STARTER KIT**

**Purpose:** Includes the Starter Cable that makes the connection from the Power/Control components to the T-Cable and other accessories required for wire termination and connections. Insulation patches are required to cover areas of TILES where cuts have been made. (Required)

**INCLUDED**

- (4) Cut TILE Reuse Jumper Cable
- (2) Splice Connectors
- (4) End Caps
- (10) Insulating Patches
- (1) 16 AWG (1.3mm<sup>2</sup>) Cable, 10 ft (3m) Length
- (1) Quick Start Guide



**HOW TO ORDER**

Example: TACC-STR-K

TACC	-	STR	-	K
<b>PRODUCT</b> TACC = TILE Accessory		<b>TYPE</b> STR = Starter		<b>KIT</b> K = Kit

PSD-0001-R07-03082022 (LTR) 4/5

**COOLEGE™**  
Light as a building material



Bell Auditorium Expansion

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**5 POWER AND CONTROL**

Specifications for the power supplies and Cooledge Control Modules shown below are available in:  
 - Power and Control Specifications (UL Listed)

The models shown below are those that are compatible with TILE Interior Systems for regions where cUL Listed products are required.

**POWER SUPPLIES (58V)**

**Purpose:** Convert AC main (line) power to safe, low voltage DC power. (Required)

Order Code	# Controller Channels *	Enclosure
EPSPD-090-1CH-58V-010	1	Yes
EPSS-200-58V	2	Yes
EPSS-400-58V	4	Yes

\*Class 2 (max 90W) output

**COOLEGE CONTROL MODULES (58V)**

**Purpose:** Receives 58VDC power from the power supply and converts it to max. 90W per channel of controlled output to drive TILE Interior sheets. Also receives input control from one of 4 protocol options to control dimming levels. (Optional)

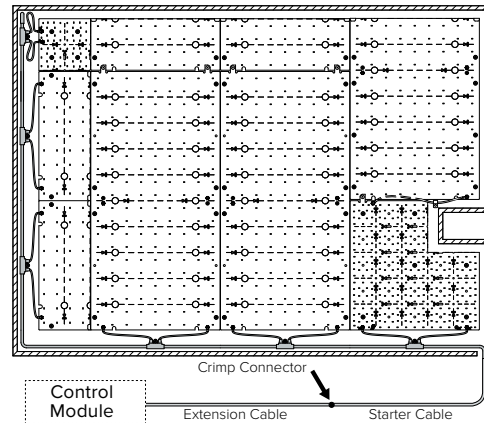
Order Code	Protocols
CTR-SCT-DALI-58V	0-10V, DALI
CTR-SCT-DMX-58V	DMX
CTR-SCT-CAS-58V	Casambi (wireless)

**ADDITIONAL ACCESSORIES**

**EXTENSION CABLES**

- 16 AWG cable (non-plenum rated)
- Available in 10' & 20' lengths

**Purpose:** Cable between TILE Starter Cable and Control Module that extends the distance the Control Module and power supply may be remotely located away from the TILES. Please consult Cooledge for additional information including requirements for plenum rated cables.



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**COOLEGE™**  
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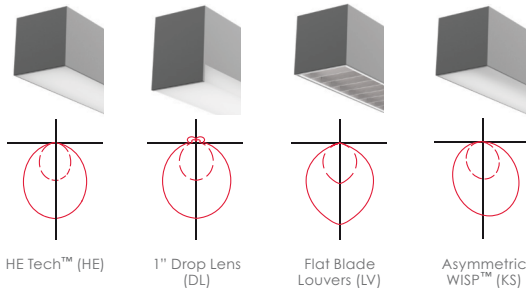


**PERFORMANCE**

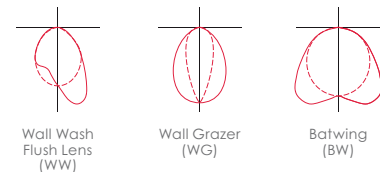
OUTPUT	OPTICS	NOMINAL		
		LUMEN OUTPUT	INPUT WATTS	EFFICACY
LH (High)	HE Tech™	1114 lm/ft	9.8 W/ft	114 lm/W
	1" Drop Lens	926 lm/ft	9.8 W/ft	96 lm/W
LS (Standard)	HE Tech™	575 lm/ft	4.8 W/ft	120 lm/W
	1" Drop Lens	478 lm/ft	4.8 W/ft	102 lm/W

based on static white 35K HE lens fixtures. For the complete photometric data of this fixture refer to page 4.

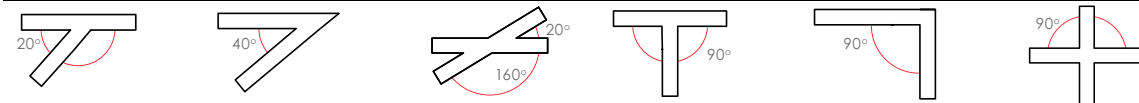
**DOWNLIGHT LENS OPTIONS**



**OTHER OPTIONS**



**MULTIPLE INTERSECTIONS AND CORNERS OPTIONS**



# ALD3ST

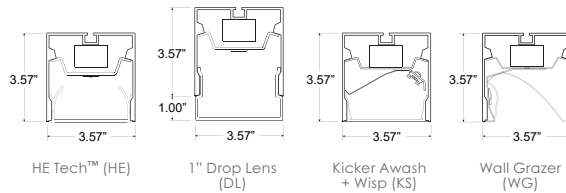
Direct - Suspended - Surface - Wall

ALD3ST combines clean lines with high performance direct distribution, for a functional and aesthetically pleasing slim profile.

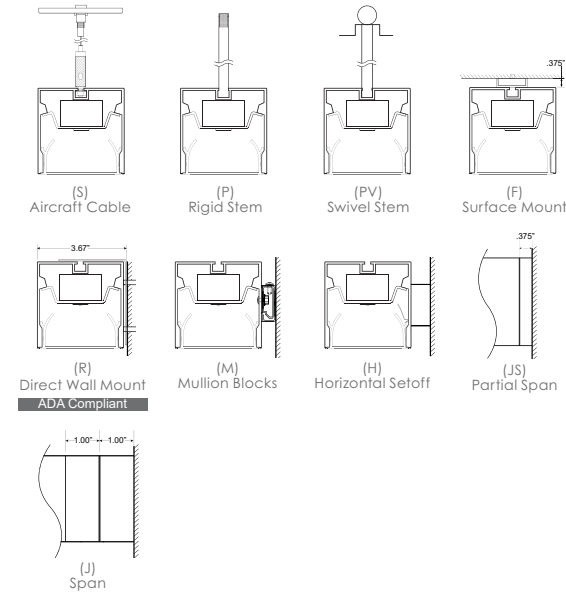
**Replacement of ACCOLADE - D3**

- Unique patterns with fully lit corners and intersections possible with Design Assist.
- Individual units and continuous runs in exact lengths.
- Adjustable mounting options for ease of installation.
- Custom color options.
- Quickship nominal options.

**DIMENSIONS**



**MOUNTING OPTIONS**



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ALD3ST - ACCOLADE | SPECIFICATION

PERFORMANCE AT 3500K

OUTPUT	OPTICS	NOMINAL		
		LUMEN OUTPUT	INPUT WATTS	EFFICACY
LH <small>(High)</small>	HE Tech™	1114 lm/ft	9.8 W/ft	114 lm/W
	Asymmetric Wisp	972 lm/ft	9.8 W/ft	99 lm/W
	1" Drop Lens	926 lm/ft	9.8 W/ft	95 lm/W
	Flat Blade Louver*	990 lm/ft	9.8 W/ft	101 lm/W
LS <small>(Standard)</small>	HE Tech™	575 lm/ft	4.8 W/ft	119 lm/W
	Asymmetric Wisp	469 lm/ft	4.8 W/ft	98 lm/W
	1" Drop Lens	478 lm/ft	4.8 W/ft	100 lm/W
	Flat Blade Louver*	511 lm/ft	4.8 W/ft	106 lm/W

Custom tuned output available from 25% to 125% of high output. Please consult factory for custom lumen output and wattage. For the complete photometric data of this fixture and Tunable White CCT, go to page 4. \*Flat Blade Louver calculated using the aluminum finish.

PROJECT INFORMATION

Project Info	Date
Type	Quantity



Need help? Don't see what you need?

Please reach out to our factory for any specific request or questions you have. Our talented Design Assist team at: [designassist@alights.com](mailto:designassist@alights.com)

ALD3ST

ALD3ST	LENGTH OR PATTERN TYPE	INTERSECTION TYPE	OUTPUT	LED CCT	LED CRI	VOLTAGE	DIRECT OPTICS
ALD3ST	_ Nominal Length* M_ Exact Length** PL_ "L" Shape*** PU_ "U" Shape*** PR_ Rectangle / Square*** CP Custom Pattern****	IT "T" Intersection* IX "X" Intersection* IY "Y" Intersection**	LH High output LS Standard output C_ Custom output* DW Dim-to-warm*	27 2700K 30 3000K 35 3500K 40 4000K TW Tunable White + White + DW Dim-to-warm*	_ 80+ CRI CRI 90+ CRI*	U 120V-277V 3 347V	HE HE Tech™ KS Awash Kicker + WISP™ DL 1" Drop Lens* LV Flat Blade Louvers** PFW Polycarbonate Flush WISP™ WW Direct Wall Wash WG Direct Wall Grazer BW Direct Batwing Wide

\*Specify in feet to the nearest foot (i.e. 12)  
 \*\*Specify in inches to the nearest 1/8 (i.e. 1/8, 1/4, 3/8, 1/2)  
 \*\*\*Specify in inches to the nearest 1/8 (See Pattern Guide for configurations)  
 \*\*\*\*Contact Design Assist

\*Not available with Drop Lens and Awash Kicker + WISP. Available with Flat Blade Louvers only in 90° degrees.  
 \*\*Fully illuminated intersection available with HE Tech and Polycarbonate Flush WISP optics only, Contact Design Assist.

\*Available from 25% to 125% of LED High Output.

\*Standard CCT range is 27-50K. Contact design assist for custom range

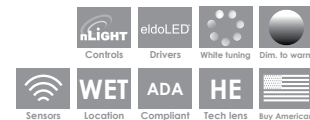
\*Not offered with (TW) Tunable white or (DW) Dim-to-warm.

\*Not available with Wet Location. \*\*Aluminum Standard. Not available in Wet Location.

MOUNTING	FINISH	DIMMING	EMERGENCY	SENSORS	OPTIONS
S Aircraft Cable* P_ Rigid Stem** PV_ Swivel Stem** R Direct Wall Mount M_ Mullion Blocks*** H_ Horizontal Setoff Bracket**** F Surface Mount***** JS Partial Span J Full Span <small>Standard power cord exit point is 3" away from endcap. Contact Design Assist for custom location.                      *Standard 48" field adjustable cable, specify length to nearest inch if over 48". Black power cord provided for satin black and titanium finish and white power cord provided for all other fixture finishes, unless otherwise specified.                      **Indicate stem length to nearest inch. 4.00" minimum.                      ***Enter 1 for 1" depth. Enter 5 for 1/2" depth                      ****Enter 1 for 1" depth. Enter 5 for 1/2" depth. Not available in Wet Location.                      *****Available for ceiling and wall surface mounting.</small>	T Titanium W White B Black O_ Other* <small>*Specify RAL#</small>	D Standard 0-10V dimming* D1 HiLume Ecosystems 1% (LDEI) D2 Phase dimming** D4 DALI dim-to-off (EidoLED) NAIR nLight @AIR (dim-to-off) NWIR nLight @Wired (dim-to-off) DO Dimming - Other*** <small>* 1% Dimming standard unless otherwise specified. **Reference Lutron LITEA driver for compatible dimmers. ***Reference ERP-PWB driver for compatible dimmers. **** Specify if other dimming driver is needed. Contact Design Assist.</small>	EC Emergency - circuited* E_ Emergency - battery** <small>*Not available on fixtures &lt;4' length. Smallest EM circuit is 2'ft. If entire fixture is on EM circuit, no need to call out EC in part number.                      **Factory-installed emergency battery pack. Specify desired quantity of batteries. Not available on fixtures &lt;4' length. Not available for 347V. See technical data for more information.</small>	OF Occupancy Sensor - Fixture PF Photocell / Daylight Sensor - Fixture OPF Occupancy / Daylight Sensor - Fixture <small>*Sensor will be matched to dimming input.</small>	MRL 2" LED Downlight Module* M Multi-Circuit R Right End cap Feed L Left End cap Feed K Natatorium Application*** Q Wet Location**** MRI MRI <small>*Specify required quantity, see LED Module Addendum for additional ordering details, page 10.                      **Submit multi-circuiting requirements                      ***Not available with aircraft cable nor horizontal setoff bracket. See guide and contact Design Assist. Not compatible with Drop Lens and Flat Blade Louvers.                      ****Client must specify power feed location. Not available with aircraft cable nor horizontal setoff bracket. Wet location suitable in full coverage and/or mullion mounted applications (direct to sky not recommended); not suitable for extreme weather applications. Refer to Wet Location brochure and contact Design Assist for more information. Not compatible with Drop Lens and Flat Blade Louvers.</small>



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**LIGHT DISTRIBUTION**

DISTRIBUTION

Direct Symmetric  
Direct Asymmetric

OUTPUT

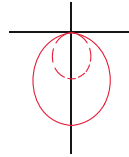
LH: High output - 9.8 W/ft  
LS: Standard output - 4.8 W/ft  
C: Custom tuned output - Contact Design Assist

**PHOTOMETRIC DATA**

DIRECT SYMMETRIC  
LH - 3500K - HE TECH™

Lumens: 1114lm/ft  
Input watts: 9.8 W/ft  
Efficacy: 114 lm/W

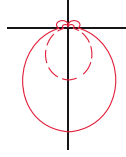
LH: \_\_\_\_\_  
LS: - - - - -



DIRECT SYMMETRIC  
LH - 3500K - DROP LENS

Lumens: 926 lm/ft  
Input watts: 9.8 W/ft  
Efficacy: 94 lm/W

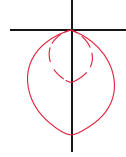
LH: \_\_\_\_\_  
LS: - - - - -



DIRECT SYMMETRIC  
LH - 3500K - FLAT LOUVERS

Lumens: 990 lm/ft  
Input watts: 9.8 W/ft  
Efficacy: 101 lm/W

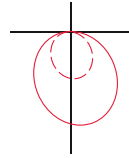
LH: \_\_\_\_\_  
LS: - - - - -



DIRECT ASYMMETRIC  
LH - 3500K - ASYMMETRIC WISP

Lumens: 469 lm/ft  
Input watts: 9.8 W/ft  
Efficacy: 98 lm/W

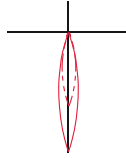
LH: \_\_\_\_\_  
LS: - - - - -



DIRECT SYMMETRIC  
LH -17°- 3500K - DOWNLIGHT MODULE

Lumens: 982 lm  
Input watts: 9.9 W  
Efficacy: 99 lm/W

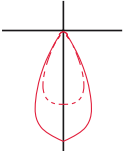
LH: \_\_\_\_\_  
LS: - - - - -



DIRECT SYMMETRIC  
LH -48°- 3500K - DOWNLIGHT MODULE

Lumens: 985 lm  
Input watts: 9.9 W  
Efficacy: 100 lm/W

LH: \_\_\_\_\_  
LS: - - - - -



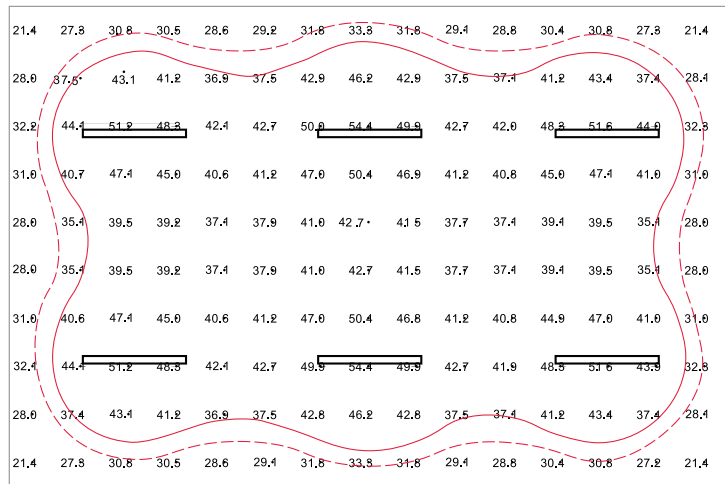
**SAMPLE INSTALLATION - WORKSPACE**

LH DOWN - 3500K

Room dimensions: 20'L x 30'W x 12'H  
Reflectance: 80% / 50% / 20%  
Mounting height: 9 ft A.F.F.  
Fixture length: 4 ft  
Calculation grid: 2 ft x 2 ft  
Calculation plane (horizontal): 2.5 ft A.F.F.  
Average Illuminance: 38 fc  
Fixture spacing: 8 ft x 10 ft  
Uniformity: 1.6:1 (avg/min)

TOP VIEW

30 fc: \_\_\_\_\_  
25 fc: - - - - -



LIGHT LOSS FACTORS (LLF)

OUTPUT	CCT	CRI 80+					CRI 90+				
		%	OPTICS				%	OPTICS			
			HE Tech™	Asymmetric WISP	Drop Lens	Flat Blade Louver		HE Tech™	Asymmetric WISP	Drop Lens	Flat Blade Louver
LH <small>(High)</small>	4000k	100%	1135 lm/ft	991 lm/ft	946 lm/ft	1011 lm/ft	88.3%	1002 lm/ft	877 lm/ft	835 lm/ft	893 lm/ft
	3500k	97.9%	1114 lm/ft	972 lm/ft	926 lm/ft	990 lm/ft	85.4%	969 lm/ft	848 lm/ft	808 lm/ft	863 lm/ft
	3000k	94.2%	1069 lm/ft	935 lm/ft	891 lm/ft	952 lm/ft	80.7%	916 lm/ft	801 lm/ft	763 lm/ft	816 lm/ft
	2700k	90.6%	1028 lm/ft	900 lm/ft	857 lm/ft	916 lm/ft	76.5%	868 lm/ft	760 lm/ft	724 lm/ft	773 lm/ft
LS <small>(Standard)</small>	4000k	100%	586 lm/ft	478 lm/ft	488 lm/ft	522 lm/ft	88.3%	517 lm/ft	423 lm/ft	461 lm/ft	431 lm/ft
	3500k	97.9%	575 lm/ft	469 lm/ft	478 lm/ft	511 lm/ft	85.4%	500 lm/ft	409 lm/ft	446 lm/ft	417 lm/ft
	3000k	94.2%	552 lm/ft	451 lm/ft	460 lm/ft	492 lm/ft	80.7%	473 lm/ft	387 lm/ft	421 lm/ft	394 lm/ft
	2700k	90.6%	531 lm/ft	434 lm/ft	442 lm/ft	473 lm/ft	76.5%	448 lm/ft	366 lm/ft	399 lm/ft	373 lm/ft

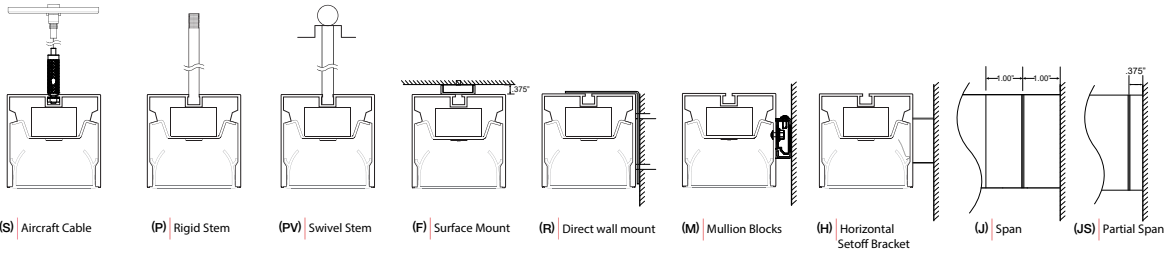
For standard output (LS) -50%.

TUNNABLE WHITE | LIGHT LOSS FACTORS (LLF)

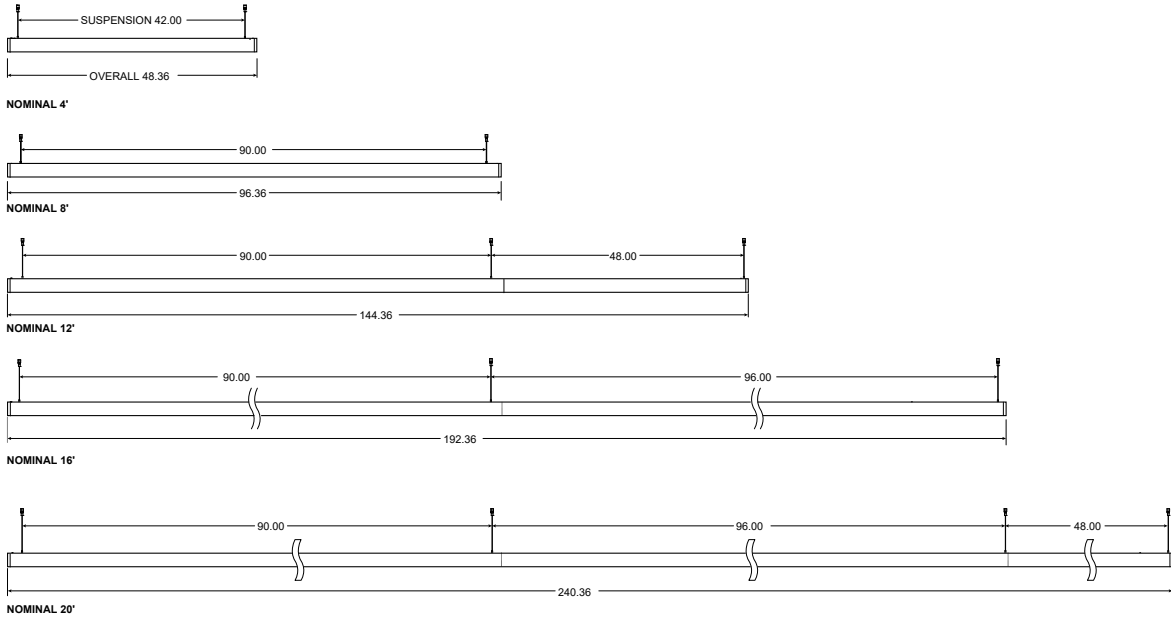
OUTPUT	CCT	CRI 80+				
		%	OPTICS			
			HE Tech™	Asymmetric WISP	Drop Lens	Flat Blade Louver
LH <small>(High)</small>	5000k	100%	860 lm/ft	687 lm/ft	783 lm/ft	837 lm/ft
	2700k	91.0%	783 lm/ft	643 lm/ft	733 lm/ft	783 lm/ft
LS <small>(Standard)</small>	5000k	100%	410 lm/ft	361 lm/ft	412 lm/ft	440 lm/ft
	2700k	92.2%	378 lm/ft	338 lm/ft	386 lm/ft	412 lm/ft

For standard output (LS) -50%. Values are applicable for Tunable White and Dim-to-warm only.





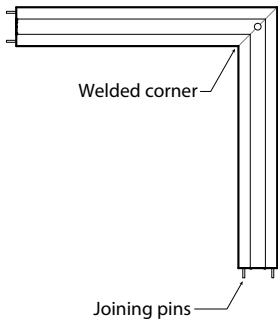
MOUNTING LENGTHS



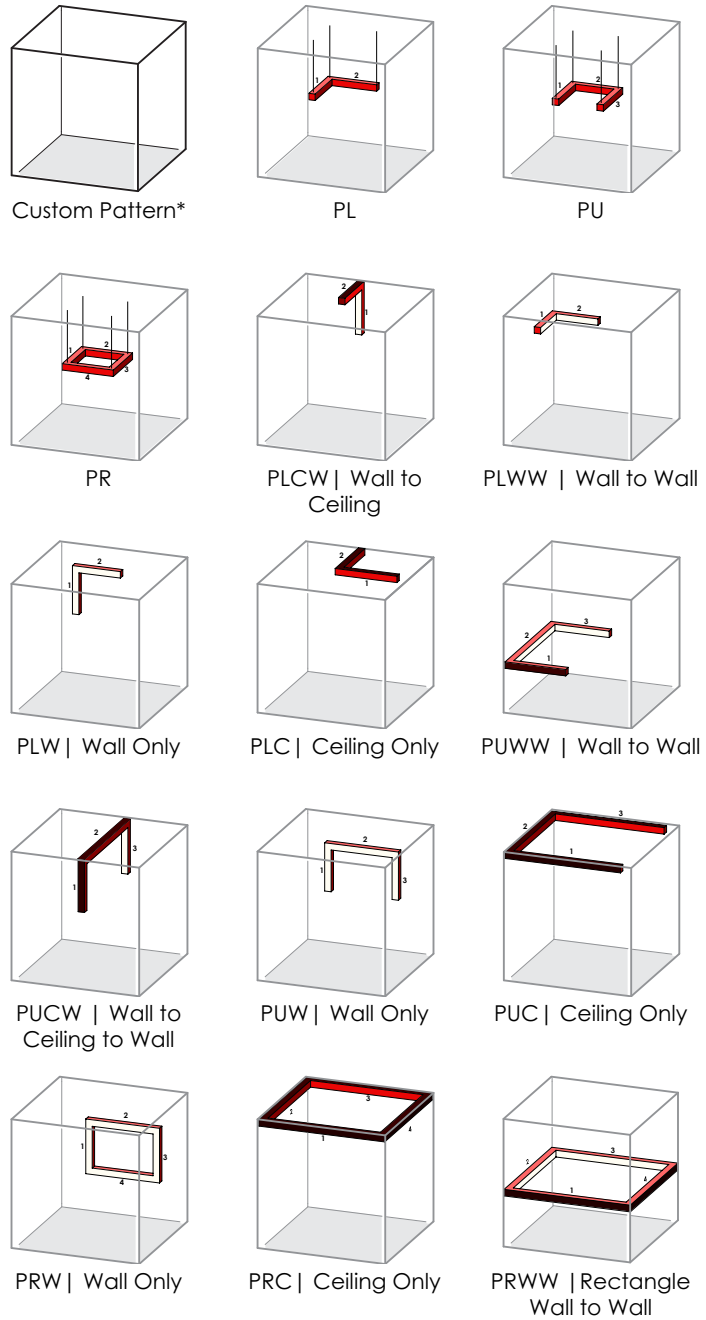
\*Standard dimensions shown for suspension points, all aircraft cable mounting lengths are adjustable on site.  
 \*For nLight AIR applications: gripper needs to be at least 3.5" from the antenna. Refer to nLight dimensions section for more details.



CORNER DETAIL



STANDARD PATTERNS



\*Contact design assist for custom patterns.

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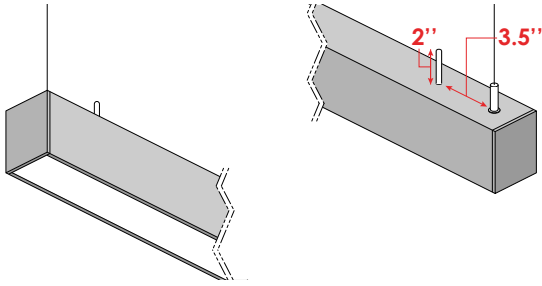
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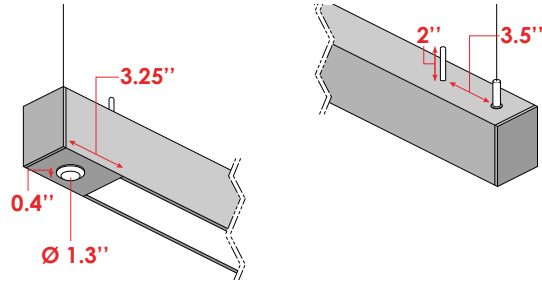
NLIGHT® DIMENSIONS

AIR : r10



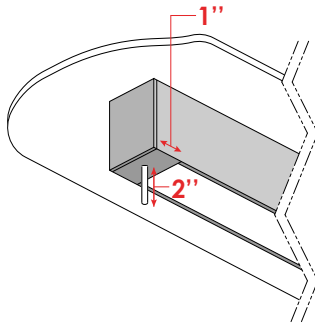
\*Fixture mounted sensors and filler panel for nLight AIR only.

AIR : res7



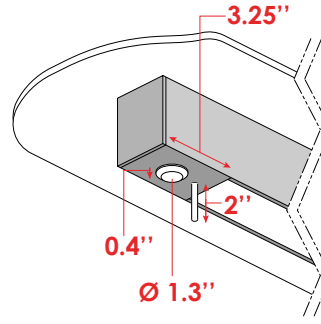
\*Fixture mounted sensors and filler panel for nLight AIR only.

AIR : r10 Surface



\*Fixture mounted sensors and filler panel for nLight AIR only.

AIR : res7 Surface



\*Fixture mounted sensors and filler panel for nLight AIR only.



**LINEAR DIMENSIONS**

Nominal or exact lengths to the nearest 1/8th of an inch available as individual fixtures or joined to create continuous row lengths, minimum fixture lengths is 12 inches. Patterns comprised of 90 degree precisely welded fully illuminated corners provide a multitude of geometric options and architectural transitions.

**Custom** - Contact [Design Assist](#) for modifications to product not detailed within specification sheets.

**OPTICS**

HE Tech™ patented high efficacy extruded diffuse acrylic lens technology with integrated opaque white reflector delivers superior lumen output with optimal uniform lens surface luminance for direct distribution.

Flat Blade Louvers are used to cut down on glare and better control the light source on ALD3ST. This option includes a linear film diffuser (inserted between the louvers and the LEDs), that enhances glare control and lends light sources. The standard finish is aluminum. Other colors and custom finish options available, specify RAL# or contact factory regarding custom finish requirement.

Drop Lens is a light diffuser option for ALD3ST that turns the luminaire into a decorative graphical statement. The diffuser drops down from the luminaire's main body of 1" and sits flush with the metal end caps. Once lit, the drop lens glows vividly and offers a wider diffusion pattern.

Awash Kicker + WISP produces a soft asymmetric distribution with a diffuse white extruded acrylic lens.

Polycarbonate Flush WISP is an alternative option of the diffuse white extruded lens with polycarbonate material properties such as impact resistance.

Wall Grazer optic offers a custom designed high efficiency parabolic reflector combined with an extruded diffuser for a powerful uniform wall grazing effect.

Perimeter fill - Wall wash, Wall grazer and Batwing wide for direct distributions are film optics that refract light along with an HE Tech™ extruded diffuse acrylic lens with integrated opaque white reflector.

**LED LIGHT SOURCE**

Custom manufactured linear board array uses high performance Nichia® LED in combination with a performance driven heat sink technology. Tested in accordance with LM79 and LM-80; L70>60,0000hr; operated at reduced output for high efficacy and lumen maintenance. 2700K, 3000K, 3500K, and 4000K with 80+ CRI standard; other color temperatures and 90+ CRI available upon request, contact factory. LED color variation maintained at a 3-step MacAdam ellipse (SDCM 3x). LEDs are available in Low, Standard, and High outputs. Refer to photometry for delivered lumens. Custom output available in the range 25% to 125% of high output, contact factory.

**LED DIMMING DRIVER**

Factory tuned constant current electronic 0-10V control dimming driver is standard. Specification grade dimming down to 1%. Driver life of 50,000 hrs with ambient operating temperature range of -20°C to 50°C, maximum case temperature of 80°C. Electrical specifications at maximum driver load: PF >0.9, THD <20%, >85% Efficiency. Other available drivers include Lutron Hi-lume 1% EcoSystem LED Driver (LDE1) with Soft On, Fade to Black dimming technology; and DALI protocol drivers. Other Lutron and specialty drivers available, contact factory.

**EMERGENCY**

This luminaire is provided with a factory installed LED emergency lighting battery pack for both normal and emergency operation, 120-277v only. This fixture integrated unit contains long-life Ni-Cad recyclable battery, 24 hour charger, and converter circuit. Test switch and charge indicator provided. Test button to be remote located within 3 feet of the luminaire, in accordance with local code. Emergency mode provides constant power to a nominal 12W LED load for a period of 90 minutes, delivering 1200 lumens of unwavering illumination throughout the full 90 minute emergency duration. Unless otherwise specified, the emergency battery pack will illuminate one 2 foot end in the direct portion of the fixture. Not available in fixtures <4ft'.

Emergency circuiting provided as a separate circuit from normal power circuit according to NEC requirements, specify circuit length and location.

**CONTROLS**

Low-profile integral occupancy and daylight sensors are available to deliver high performance control in an architecturally pleasing package.

Integrated nLight® for system networking wired and wireless:

**NLIGHT® AIR WIRELESS**

The integrated API smart sensor is part of each luminaire in the nLight® AIR network, which can be grouped to control multiple luminaires. The granularity of control with the digital PIR occupancy detection and daylight sensing makes a great solution for any application. Optionally you can order nLight® AIR less sensors for compatibility with an nLight Air wireless system. The rIO, rES7, rMSOD, and rCMS models are available for integration.

**CONTROLS AND SYSTEM NETWORKING OPTIONS**

For wired networking via Cat-5e, choose an nLight® wired module. The nIO EZ PH, nIO EZDL CCT, nES7 and nCM are available for integration.

nLight enabled, remote mounted controls provided by others. Please contact an Acuity controls representative for more information.

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**MOUNTING**

Suspension with aircraft cables or pendant stems, and full or partial span mounting available.

Aircraft cable set includes 48" standard length 1/16" stainless steel adjustable aircraft cables with secure micro grippers to field set suspension length and adjustable suspension points to accommodate existing architecture, comes factory pre-installed in fixture. 4-1/2" x 4-1/2" square white canopies. Cord strain also included. Power cord options available for aircraft cable. Black power cord provided for black and titanium finish, white power cord provided for all other fixture finishes unless otherwise specified.

Rigid pendant stem-set includes 1/4" hollow white threaded rod for suspension and power feed. Factory pre-drilled power feed and tapped holes, submit dimension requirements when ordering. Standard specification length, 6" minimum. 5" square mono point white canopies.

Swivel stem set includes 1/4" hollow white threaded rod for suspension and power feed, standard specification length, 6" in minimum. 5" in square mono point white 45-degree angle swivel stem. Factory pre-drilled power feed and tapped holes, submit dimension requirements when ordering.

Specify if another suspension length is required. Canopies provided as required for the quantity of power feed and non-power feed locations (crossbar included). Specify if another shape, size, or color is required.

Direct wall mounting is ADA compliant. Fixture mounts directly to wall surface requiring field drilled mounting and power feed holes. Factory pre-drilled holes can be drilled and tapped for 1/2" chase nipple, submit dimension requirements when ordering.

Direct wall mounting bracket is used with the top groove of the fixture to mount flush to the wall surface to provide a firm flexible mounting option, requiring field drilled mounting and power feed hole. Factory pre-drilled hole for power feed can be drilled, submit dimension requirements when ordering.

Surface ceiling die-cast mounting blocks with sheet metal brackets are used to provide a firm flexible mounting option in any orientation the system might be installed in. Submit whip length if required.

Mullion die-cast mounting blocks with sheet metal offset box are used to mount fixture to a horizontal or vertical window mullion and can also be used to offset fixture from wall providing flexible mounting option in horizontal orientation of 1.5" in. 1/2" deep die-cast aluminum blocks with 1/2" or 1" sheet metal deep box are available standard, 1 1/2" and 2" deep blocks also available upon request. (2) kit blocks provided for fixtures 8ft or less, fixtures larger than 8ft provided with (3) kit blocks every 12ft. Power feed holes pre-drilled and pre-installed mullion blocks parts at factory. Standard mullion block center location point has a 3" distance from endcap. Submit custom dimension requirements when ordering.

Partial / Full span mounting conditions utilize special expansion joint end caps to mount fixture to the wall (blocking required) and feed power through the end cap, specify end feed location. Additional attachment hardware provided as required depending on partial span condition. Provide architectural details at time of ordering for inclusion in factory shop drawings; field verified dimensions required for full span mounting.

**STRUCTURE**

Robust, high quality 60% recycled aluminum extruded housing. 0.040" thick aluminum internal gear trays. Flat or flanged aluminum end caps. Aluminum joiner brackets. 2 lbs/ft approximate fixture weight.

**FINISH**

Electro-statically applied powder coat finish. Standard finish options include titanium, white, and black. Other colors and custom finish options available, specify RAL# or contact factory regarding custom finish requirement.

**LISTING**

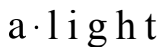
UL/CUL rated for damp locations. Tested under UL 1598 and certified to CEC/CSA C22.1, NEC, ANSI/NFPA 70, and NOM-001-SEDE.

UL Wet location label available. Complies with UL definition of wet locations to prevent the accumulation of water on live parts, electrical components, other conductor not identified for use in contact with water through the provision of weep holes. Waterproof connector to be provided by others. Installing contractor responsible for properly sealing and waterproofing all mounting and power feed locations.

The ALD3ST is assembled in the U.S.A. and comply with the Buy America(n) Act (BAA) government procurement requirements under FAR, DFARS, and DOT.

**WARRANTY**

A-Light warrants that, for a period of five (5) years from the date of shipment to the original customer at the original installed location, each product will be free from any defects in material and workmanship which cause the product to fail to operate in accordance with the products' performance specifications as they exist at the time of shipment. This limited warranty is void under certain conditions. Please refer to the full terms and conditions on our website.



Bell Auditorium Expansion

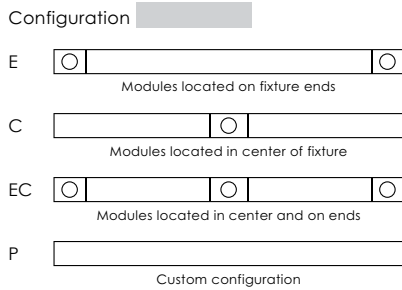
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16 January 2023

Type:  
FB9



REQUIRED SPECIFICATION INFORMATION AS ADDENDUM TO CUT SHEET

**LED DOWNLIGHT MODULE  
(MRL\_)**



**Wattage**

4	4W
8	8W

**Voltage**

U	Universal 120V - 277
3	347V

**CCT**

30	3000K (ansi binned warm white)
35	3500K (ansi binned warm white)
40	4000K (ansi binned neutral white)

**Beam Angle**

17	17° total beam angle (narrow spot)
48	48° total beam angle (wide flood)

**Dimming**

D	Dimming for module (if dimming is desired for entire fixture and MRL modules choose D on this sheet and under options on fixture cutsheet)
---	--

**MODULE CONSTRUCTIONS:** Heavy-duty, milled-aluminum plate module contains one recessed cutout and a flush mounted LED module.

Internal gimbal device allows easy lamp adjustability, with continuous rotation greater than 360°, aimable vertically up to 15° angle on D (3.5") series and 30° on G (5") series.

**CIRCUITING STANDARDS:** LED *downlight* modules are on a separate circuit from linear section of the fixture. "D" dimming is required on the addendum if dimming is desired for LED *downlight* modules. If dimming is also desired for the linear section, "D" must be specified on the fixture cutsheet as well.

**LAYOUT:** Indicate quantity of modules per row after "MRL\_" in fixture cutsheet nomenclature. i.e. MRL1, MRL2, MRL3, etc.

Module length to be determined by factory and shown in submittal drawings for approval. Typical module length is approximately 6".

All module lengths are approximate until ceiling and row configuration is known. Module lengths may be specially constructed for irregular row lengths in certain ceilings. Modules may be specified up to 48" long.

**INTEGRAL DRIVER:** Universal 120v - 277 or 347v driver.

**FINISH:** Electrostatically applied post powder coat module finish. Color will match luminaire unless otherwise specified.



**LISTING:** UL/CUL. Damp location is standard.

*All precise module lengths will be determined by factory to accommodate for row length variations due to ceiling type and to allow for proper ventilation.*





USA / [deltalight.us](http://deltalight.us) / +1(954) 677 9800  
 Canada / [deltalight.ca](http://deltalight.ca) / +1(905) 813 6130

Date \_\_\_\_\_

\_\_\_\_\_

Name \_\_\_\_\_

\_\_\_\_\_

Client \_\_\_\_\_

\_\_\_\_\_

Project name \_\_\_\_\_

\_\_\_\_\_

Quote# \_\_\_\_\_

\_\_\_\_\_

Type/Quantity \_\_\_\_\_

\_\_\_\_\_

**Listings**

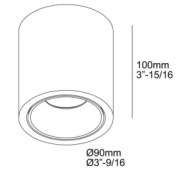
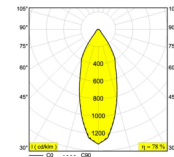


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Specification Sheet

**BOXY R 93033 DIM8**  
**6 251 70 811 932 ED8**

[Weblink](#)



Available colors: BLACK-BLACK (6 251 70 811 932 ED8 B-B)  
 BLACK-GOLD MATT (6 251 70 811 932 ED8 B-MMAT)  
 WHITE-BLACK (6 251 70 811 932 ED8 W-B)  
 WHITE-WHITE (6 251 70 811 932 ED8 W-W)  
 BLACK-FLEMISH GOLD (6 251 70 811 932 ED8 B-FG)  
 BLACK-FLEMISH BRONZE (6 251 70 811 932 ED8 B-FBR)

1 x LED 10,4W / CRI>90 / 3000K / 1128lm  
 REFLECTOR FL-33°  
 INCL. DIMMABLE LED POWER SUPPLY 500mA-DC  
 MAINS DIMMING  
 For other CRI or KELVIN, contact factory

LED Technics: Light source: 1128 lm // 10 W // 109 lm/W  
 Luminaire: 883 lm // 12 W // 74 lm/W

120V / 60Hz

Class 2 N.a.  
 Ada N.a.  
 Installation methods BACKPLATE  
 MUD KIT INSTALLATION

Weight: 1.3 LBS  
 Protection level: IP53 - suitable for damp locations  
 Minimum distance: n.a.

Remarks: For other voltages or dimming options, contact factory.

Accessories: BOXY HONEYCOMB  
 BOXY SOFTENING LENS  
 BOXY GLASS SBL

**Requirements :**  
 MUD KIT 2  
 COVERPLATE R 117

For detailed installation instructions, please consult the manual. [6\\_251\\_70\\_811\\_XXX\\_ED8\\_HAND.pdf](#)



Bell Auditorium Expansion

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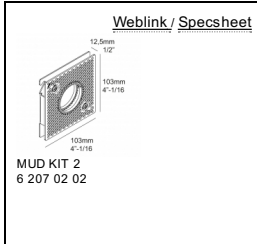
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**FB11**

Page 1 of 1

**BOXY R 93033 DIM8**  
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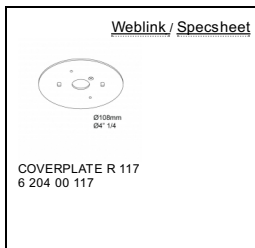
**Related references**

**MUD KITS**



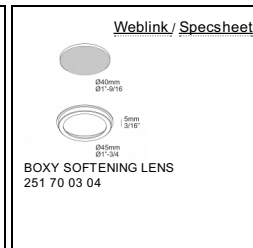
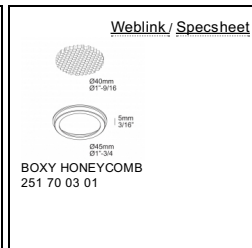
**Related references**

**COVER PLATES**



**Related references**

**LIGHT ALTERING DEVICES**



Bell Auditorium Expansion

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Type:  
**FB11**

BOXY R 93033 DIM8  
6 251 70 811 932 ED8

Related project picture of product family:



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# Custom Metal Chandelier - 24" Square

SKU: m5-14mp-1-r10n1041-54  
Project: James Brown Arena: Bell Expansion  
Type: Commercial  
QTY: 5  
Created By: hgruneisen@hlblighting.com

### Fixture Details

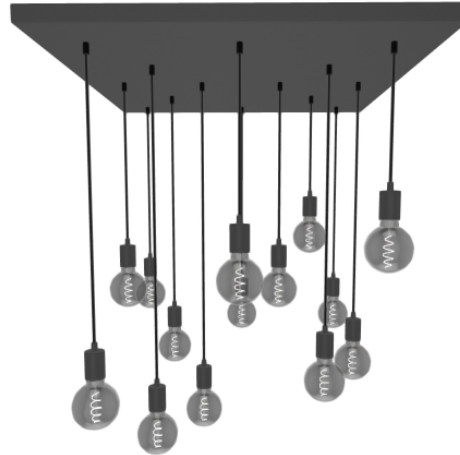
Pendant Length: 20-35 Staggered  
Voltage: 90V - 240V  
Weight: <50lbs

### Parts and Finishes

Metal Base: Black  
Cord Type/Color: Round Black  
Socket: Modern Black  
Shade/Cage: None

### Bulb

Name: LED Smoke 3" Globe  
Quantity: 14  
Base: E26  
Type: LED  
Wattage: 4w  
Lumens: 275  
Temp: 3500K  
Dimensions: 5" x 3"  
Voltage: 120



Certification: C-UL-US DRY  
Warranty: 1 Year Parts Repair or Replace



[www.MixMatchLighting.com](http://www.MixMatchLighting.com)  
450 N. Leavitt St. Chicago IL 60612  
[info@MixMatchLighting.com](mailto:info@MixMatchLighting.com) (312) 569 - 0992



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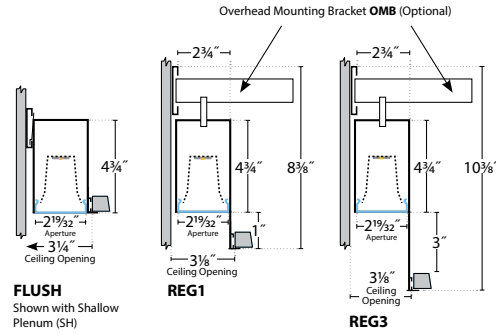
# P23 | Cove & Perimeter

## 2" Perimeter



PRUDENTIAL LTG.

PRULITE.COM 213.746.0360



### Open office illumination, wall washing or grazing.

Slimmer 2.5" aperture partner to our award-winning Bionic and P40 Series with the same industry-best combination of optics, efficacy and aesthetics. Batwing with 1.6 spacing criteria. Wall washing and grazing with no mechanical kicker or open cavity.

### BIO2 AND P23 SERIES OPTICS:

- Direct/Indirect:** Satin Acrylic, Batwing, Wash, Graze, Perimeter Fill, Ceiling Wash & Indirect Symmetric Glow.
- Recessed Linear:** Satin Acrylic, Batwing, Wash and Graze.
- Perimeter:** Satin Acrylic, Wash, Graze and Perimeter Fill.

**P23-PER-FLSH-LED35-LO-SAL-D1**  
1601 Delivered Lumens  
16 Watts  
100 Lm/W  
3500 CCT

UP TO **103** LPW

FLUSH:	LO	MO	SO	HO
<b>SAL-D1</b> Lm/Ft	400	600	800	900
<b>MMG-D1G</b> Lm/Ft	400	600	800	900
<b>MWW-D1R</b> Lm/Ft	400	600	800	900
REGRESS 3:				
<b>REG3-SAL</b> Lm/Ft	350	500	700	800
<b>REG3-D1G</b> Lm/Ft	350	500	700	800
W/Ft	4.6	6.5	9.5	11

HO - NA for Lutron

Lumen output may vary +/- 5%  
3500K used for lm/ft estimates above  
4000K +2% llf, 3000K -2%, 2700K -4%  
-10% LLF for 90 CRI (4K, 3500K and 3K)

See **LED Details PDF** for more info

Declare.



Made in the USA

SE-RIES	LENS-POSITION	LED-COLOR	OUT-PUT	NOMINAL-LENGTH	TRIM-COLOR	SHIELDING	DISTRI-BUTION	MOUNT-ING	CIRCU-ITING	VOLT-AGE	CEILING-SYSTEMS	DRIVERS	OPTIONS, SENSORS & CORNERS
P23-PER									SC				
Perimeter	<b>FLSH</b> Flush Lens <b>REG1</b> 1" Regressed Lens <b>REG3</b> 3" Regressed Lens (NA with wall wash) NOTE: Specify shallow plenum under options to install without overhead mounting brackets	<b>LED27</b> 2700K (90CRI) <b>LED3</b> 3000K <b>LED35</b> 3500K <b>LED4</b> 4000K <b>LED3-90</b> 90CRI <b>LED4-90</b> 90CRI	<b>LO</b> Low <b>MO</b> Medium <b>SO</b> Standard <b>HO</b> High (NA with Lutron) <b>PROG</b> Programmable Light Output (Specify desired lm/ft or w/ft)	2' 3' 4' 6' 8' R (row length)	<b>TMW</b> Textured Matte White (Standard) <b>YGW</b> Gloss White <b>Y</b> Premium Color <b>CC</b> Custom Color	<b>SAL</b> Satin Acrylic Lens (D1 only) <b>MWG</b> Acrylic Wall Grazer Lens (D1G only) <b>MWW</b> Acrylic Wall Wash Lens (D1R only)	<b>D1</b> Direct (SAL only) <b>D1G</b> Wall Grazer (MWG only) <b>D1R</b> Perimeter Fill (MWW only, NA with REG3)	<b>WTW</b> Wall to Wall (Any row length) <b>LP</b> Light Pocket (Typically 1" increments, fixture stops before wall)	SC Single Circuit	<b>UNV</b> (120-277) <b>347</b> (Emergency battery requires a Step Down transformer)	<b>X1</b> T-Bar 1 1/2" Exposed <b>X1M</b> T-Bar 1/2" Exposed <b>X2</b> Dimensional T-Bar Arm-Strong Interlude® <b>X6</b> Slot Grid <b>X3B</b> Hard Ceiling (Flange trim with overhead mounting brackets) <b>X7</b> Hard Ceiling (Trimless Mud-over Concealed Flange)	<b>ND</b> Non-Dimming <b>DM01</b> 0-10v, 1% Dimming (Standard) <b>LDE1</b> Lutron Hi-lume 1% EcoSystem LED (Soft fade on, fade-to-black dimming, NA-HO) <b>ECO</b> 1% 0-10v, EldoLED (Logarithmic dimming std) <b>ECDA</b> 1% DALI, EldoLED (Logarithmic dimming std) <b>SOLO</b> 0.1% 0-10v, EldoLED (Dim-to-dark, Logarithmic dimming std) <b>SODA</b> 0.1% DALI, EldoLED (Dim-to-dark, Logarithmic dimming std)	<b>EMHE</b> CAT20 Emergency Battery (D1, D1R-950, D1G-675 delivered lumens; CA Title 20 compliant; 4' or longer (remote for < 4')) <b>CP</b> Chicago Plenum <b>SH</b> Shallow Plenum <b>PRUBIN</b> Meticulous Binning and Labeling every LED Board within a 2-Step MacAdams Ellipse <b>SENSORS:</b> <b>205-ON/OFF</b> WattStopper PIR Occupancy <b>205-STEP:</b> Dim to 50% <b>205-DM:</b> Dim to 1% <b>LUX</b> Phillips DLH <b>ENL</b> Enlighted 2-Wire DLH & Environmental <b>CORNERS:</b> <b>C2I</b> Lit 90° 2-Way Inside <b>C2O</b> Lit 90° 2-Way Outside <b>C2X</b> Special Angled Connector (Consult factory)

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Cove & Perimeter 1  
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## Bell Auditorium Expansion

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# P23 | Cove & Perimeter

## 2" Perimeter

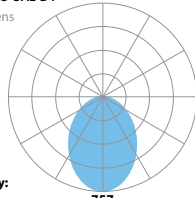


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### DIRECT

**LOW OUTPUT:**  
**P23-PER-FLSH-LED35-LO-SAL-D1**  
 1601 Delivered Lumens  
 16 Watts  
 100 Lm/W  
 3500 CCT



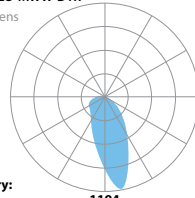
**Zonal Lumen Summary:**  
 0-90 = 100%

Vertical Angle	0°	22.5°	45°	67.5°	90°
0°	757	757	757	757	757
5°	755	748	750	751	747
15°	684	682	694	706	708
25°	564	568	595	625	634
35°	430	438	474	514	527
45°	308	319	353	397	410
55°	212	219	245	280	294
65°	133	138	155	177	187
75°	68	70	78	89	93
85°	18	19	20	22	22
90°	1	2	3	3	3

UPTO	100 LM/W				
	LO	MO	SO	HO	
	Lm/Ft	400	600	800	900
	W/Ft	4	6	8.3	10

### PERIMETER FILL

**LOW OUTPUT:**  
**P23-PER-FLSH-LED35-LO-MWW-D1R**  
 1648 Delivered Lumens  
 16 Watts  
 103 Lm/W  
 3500 CCT



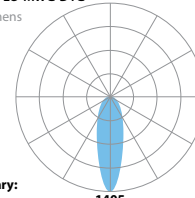
**Zonal Lumen Summary:**  
 0-90 = 100%

Vertical Angle	0°	22.5°	45°	67.5°	90°
0°	801	801	801	801	801
5°	1027	1009	946	873	803
15°	1149	1194	1183	1003	751
25°	807	843	995	1047	653
35°	579	598	716	993	519
45°	423	429	488	773	374
55°	298	302	322	522	241
65°	134	177	197	292	129
75°	46	61	101	123	49
85°	7	9	21	18	4
90°	0	0	0	0	0

UPTO	103 LM/W				
	LO	MO	SO	HO	
	Lm/Ft	400	600	800	900
	W/Ft	4	6	8.3	10

### WALL GRAZER

**LOW OUTPUT:**  
**P23-PER-FLSH-LED35-LO-MWG-D1G**  
 1530 Delivered Lumens  
 16 Watts  
 96 Lm/W  
 4000 CCT



**Zonal Lumen Summary:**  
 0-90 = 100%

Vertical Angle	0°	22.5°	45°	67.5°	90°
0°	1405	1405	1405	1405	1405
5°	1183	1204	1266	1359	1400
15°	634	665	784	1060	1360
25°	375	398	495	748	1268
35°	253	261	315	517	1081
45°	195	194	209	338	795
55°	143	142	140	206	485
65°	88	92	88	114	240
75°	41	45	44	50	90
85°	9	9	9	9	14
90°	2	1	1	1	1

UPTO	96 LM/W				
	LO	MO	SO	HO	
	Lm/Ft	400	600	800	900
	W/Ft	4	6	8.3	10

10% LLF for REG3 SAL

### LUMEN MAINTENANCE

Designed to last with cool running mid-power LEDs projected to maintain 90% (L90) of their initial output for 100,000 hours (at HO), and L70 exceeding 150,000 hours.

### LED SYSTEM

LED modules and drivers are field replaceable.

### PROG

(OPTIONAL)

Programmable light output. Specify desired lumens or watts per linear foot. Min: 2½ w/ft, consult factory for requests above 12 w/ft.

### BINNING

Standard binning (all Prudential LED boards) includes testing at the chip level and board integration to provide consistent color temperature within a 3-step MacAdams ellipse, with +/- 5% lumen output range and +/- .004 Duv.

### PRUBIN\*

(OPTIONAL)

Prudential Ltg's exclusive 'job binning' method that ensures color temperature consistency across all luminaires on a project. Meticulously testing and labeling **EVERY LED BOARD** to +/- 25 lumens, +/- 50k CCT and +/- .004 Duv — while also separating positive from negative — allows us to match color, hue and intensity throughout a project and provides a consistent color temperature within a 2-step MacAdams ellipse.

### LABELS

#### ELECTRICAL

CSA and ETL damp labeled and I.B.E.W. manufactured.

Must specify LED dimming controls. LED fixtures have constant current driver(s) with less than 20% THD when loaded to a minimum of 60%. Drivers sink a maximum of 6mA per driver. DM10 LED drivers are 0-10V dimmable and are compatible with most 0-10V wall slide dimmers and direct 0-10V analog signal dimmers. Max driver size 1.625" w x 1.25" h.

#### CONSTRUCTION

Housing	20-gauge steel, >20% PC recycled, 100% recyclable.
Lens	Acrylic, 100% recyclable.
X1, X2, X6 Trim	Steel.
X3, X7 Trim	Extruded aluminum.
Weight	<b>FLUSH</b> 4 lbs/ft. <b>3" REGRESS</b> 6 lbs/ft.

#### MOUNTING

Recessed into drywall or T-bar ceilings.

#### WARRANTY

Single-source, 5 year limited warranty covers standard components and construction.

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Cove & Perimeter

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## Bell Auditorium Expansion

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# P23 | Cove & Perimeter

## 2" Perimeter

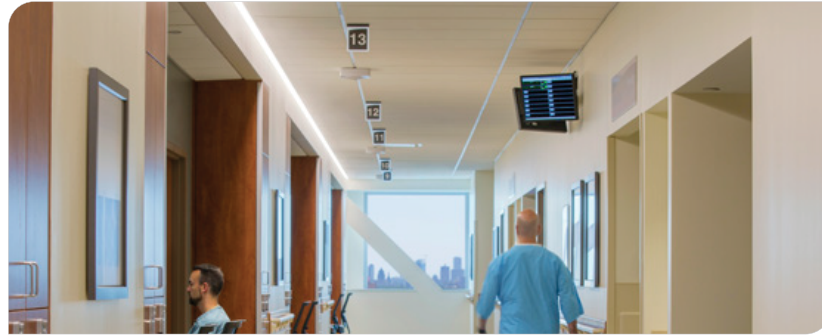


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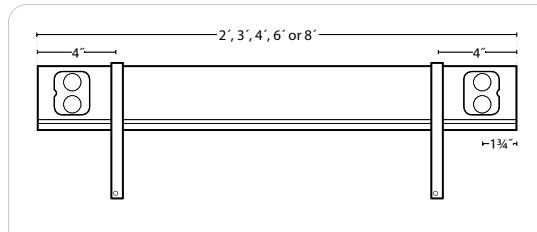
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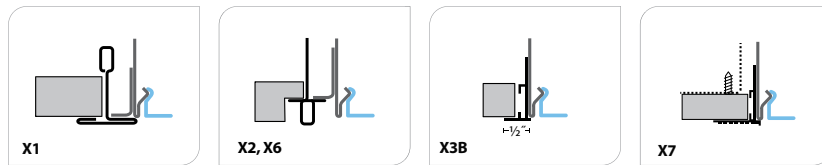
Choose from one of our Premium Colors with no set-up fee.  
For paint chip samples, please email: [info@prulite.com](mailto:info@prulite.com)



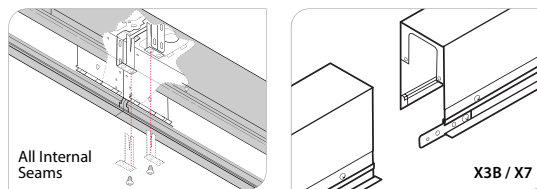
### MOUNTING LOCATIONS



### CEILING SYSTEMS



### ADJOINING DETAILS



### INTEGRATED SENSORS



**NOTE:** Sensor plate will match fixture trim color

Consult factory for other sensors, please email: [info@prulite.com](mailto:info@prulite.com)

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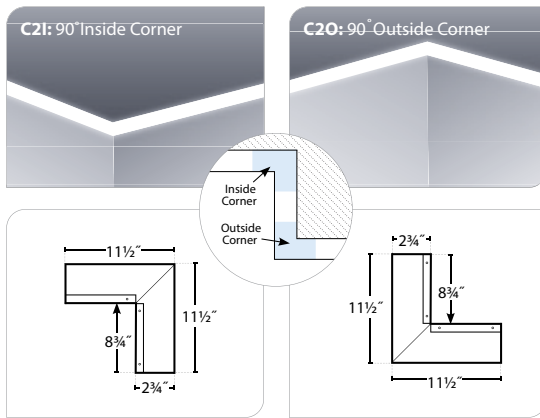
## 2" Perimeter



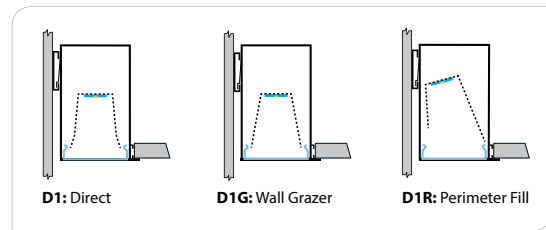
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### CORNERS



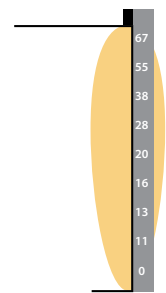
### DISTRIBUTION CROSS SECTIONS



## Smooth Wall Grazing.

A tight, focused beam grazes wall textures evenly, accenting and highlighting details to elevate the visual drama.

	Watts/Ft	9'	40fc	76fc	16fc	4.75
Standard Output - 750 lm/ft	10	9'	40fc	76fc	16fc	4.75



## Perimeter Fill.

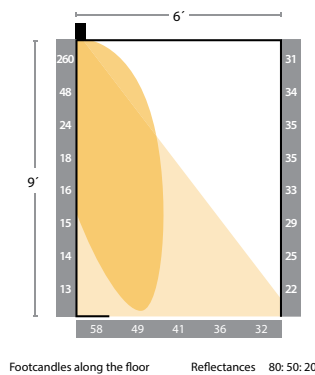
**Fill a Corridor with Light — from the Perimeter.**

It's a perimeter optic that washes corridors in light, offering outstanding light distribution, far more energy efficient than typical soft glow solutions and significantly reduces installation cost. Ideal for corridors where budget and energy efficiency conflict with strict IES requirements for high footcandles.

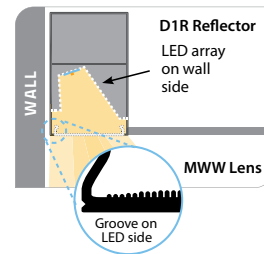
Suspended, surface mounted or recessed, perimeter lighting system.

**4" Aperture P43 & Bionic are ideal for 8' wide corridors.**

	Watts/Sq. Ft.	9'	43fc	1.9:1
High Output - 885 lm/ft	2	9'	43fc	1.9:1



### PERIMETER FILL ORIENTATION



Prudential Ltg. reserves the right to change design specifications or materials without notice. Please visit prulite.com for most current data.  
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Cove & Perimeter

4

04-12-2022



## Bell Auditorium Expansion

Issue for Permit / Bid  
**16 January 2023**

Type:  
**FB13**

Page 4 of 1

JOB NAME \_\_\_\_\_  
CONTACT \_\_\_\_\_  
ORDERING CODE \_\_\_\_\_

**THETA750 SNAP** Recessed Module - Snap In Standard White or RGBW



**DESCRIPTION**  
Theta750 Snap features a patented design with a collapsible thread. With one easy push, the module snaps securely into the rail. Removal is only possible with a unique extraction tool. Most cost effective rail solution on the market. Field or OEM handrail installation. Series shunt bypass ensures remaining operate if single puck failure (exception: RGBW).

**HOUSING**  
Extremely durable 316 stainless steel marine grade electro-polished housing, with 3.5" (90mm) 20AWG wire leads.

**MOUNTING**

- Install in metallic surface only for proper thermal dissipation. Luminaire is for use in non-insulated recessed surfaces
- Rail Size - min. D 1-3/8", 35mm
- Rail Wall Thickness - min. 1/16", 1.5mm
- Curved or flat mounting surfaces
- Aperture for Flat face - 15mm or 15mm + (16mm x 0.5mm) counterbore (required for flush finish)
- Aperture for Curved face - 15mm or 15mm + (16mm x 1.5mm) counterbore (required for flush finish)

**ELECTRICAL/LED Driver**

- 3Vdc, 500mA, 1.5W (Remote Driver Required)
- RGBW 500mA single emitter or total system 4 x 125mA
- Cool splice connector included
- Ambient operating temperature: -40°C to + 55°C
- Series shunt bypass ensures remaining operate if single puck failure (exception: RGBW)

**LISTINGS**

- ETLus Listed to UL2108 (suitable for wet locations)
- cETL Listed to CSA C22.2 #250.0
- Impact tested to IK10 (EN62262) PC lens only
- IP65 rated with PC lens
- IP67 rated with Borosilicate glass lens
- IP68 rated to 6.5ft at 24hrs (NOT FOR PERMANENT SUBMERSION)
- ADA Compliant when using handrail diameter 1-7/16" (36mm) to 2" (50.8mm) O.D
- 3000k or warmer must be selected for International Dark-Sky Association approval.

**LED INFO**

- LED: Cree Xlamp® XP-G3 (applicable for Standard White)  
Cree Xlamp® XM-L Color (applicable for RGBW)  
Cree Xlamp® XP-GA (Amber-590nm \*Dominant Wavelength\* complies with Wildlife and Marine Turtle safe-lighting requirements)
- Duv: 0.001
- CCT: 2700K, 3000K, 3500K, 4000K, RGBW, amber
- CRI: >80
- Lumen Maintenance: L<sub>90</sub>> 90,700 hrs (Standard White)
- Warranty: 5 year limited warranty

ORDERING CODE		
SERIES	750S	snap puck
CCT	27K	2700K
	30K	3000K
	35K	3500K
	40K	4000K
	RGBW <sup>1,3</sup> AMB	RGBW amber
BEAM	ST <sup>2</sup>	70° standard
	VA <sup>2</sup>	75° asymmetric
	WD <sup>3</sup>	105° wide
	HYP <sup>3</sup>	75° hyperbolic
LENS	PC	polycarbonate - IP65
	BG	borosilicate glass - IP67
	IP68	optically clear polyurethane - IP68
FACE TYPE	CF	curved face
	FF	flat face

ORDERING CODE \_\_\_\_\_

Follow the steps to specify your fixture, example:

750S - 27K - ST - PC - FF

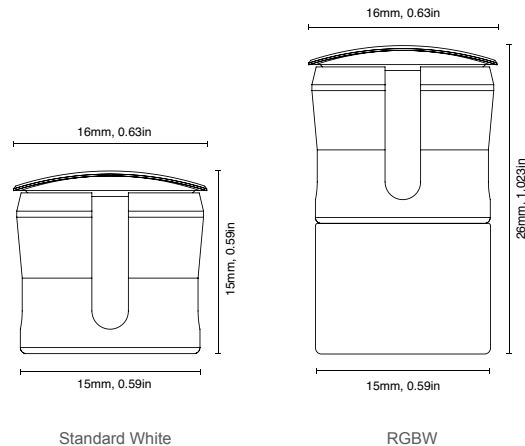
LUMENS FOR ST/VA/WD BEAM OPTION	
LUMENS (LM)	CCT (K)
165	2700
170	3000
175	3500
180	4000
145	amber

LUMENS FOR HYP BEAM OPTION	
LUMENS (LM)	CCT (K)
85	2700
90	3000
95	3500
100	4000
77	amber

LUMENS FOR IP68 LENS OPTION	
LUMENS (LM)	CCT (K)
115	2700
120	3000
125	3500
130	4000
102	amber

See page 7 for Design Guide.

**NOTES**  
1. RGBW only available in ST beam option. W CCT at 4000K.  
2. ST 60° and VA 85° when using IP68 Lens.  
3. Not Available in IP68.



Bell Auditorium Expansion

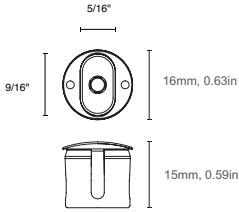
Issue for Permit / Bid  
16 January 2023

Type:  
FS3 Series

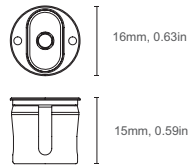
**STANDARD WHITE - STANDARD BEAM**

THETA750 Snap Standard has an elliptical symmetric distribution. For installation in handrail, mounting is typically at 30° from the vertical axis of the handrail underside. Snap is available in a range of distributions and special angles on request. Asymmetrical beam, see page 3.

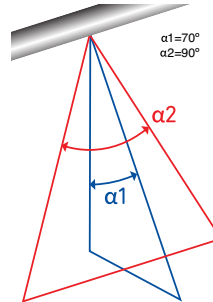
THETA750 SNAP ST - STANDARD WHITE  
CURVED FACE DETAIL



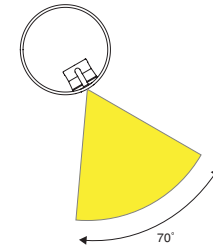
THETA750 SNAP ST - STANDARD WHITE  
FLAT FACE DETAIL



THETA750 SNAP ST - STANDARD WHITE  
BEAM ALPHA 3000K

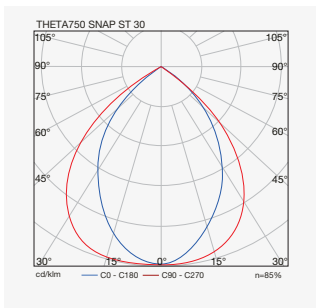


THETA750 SNAP ST - STANDARD WHITE  
STANDARD BEAM

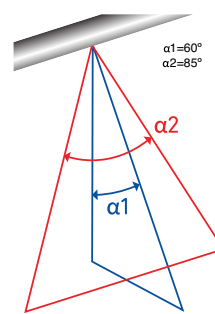


Elliptical symmetric distribution for typical mounting at 30° from vertical.

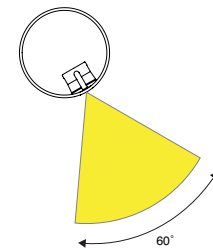
THETA750 SNAP ST 30  
STANDARD SYMMETRICAL BEAM 3000K



THETA750 SNAP ST - STANDARD WHITE IP68  
BEAM ALPHA 3000K

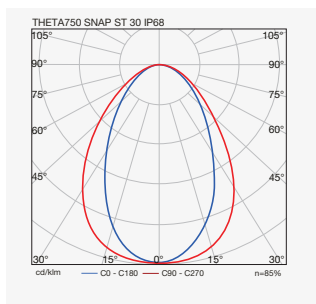


THETA750 SNAP ST - STANDARD WHITE  
STANDARD BEAM IP68



Elliptical symmetric distribution for typical mounting at 30° from vertical.

THETA750 SNAP ST 30 IP68  
STANDARD SYMMETRICAL BEAM 3000K



In a continuing effort to offer the best product possible we reserve the right to change, without notice, specifications or materials that in our opinion will not alter the function of the product. v12.19.22 | Theta750 Snap | Page 2 of 8



Bell Auditorium Expansion

Issue for Permit / Bid  
16 January 2023

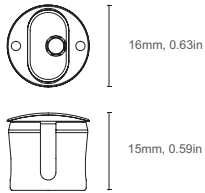
Type:  
FS3 Series

Page 2 of 1

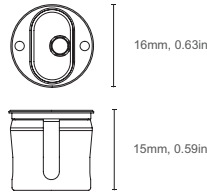
**STANDARD WHITE - ASYMMETRICAL BEAM**

THETA750 Snap Asymmetric has an elliptical asymmetric distribution. Designed for insertion at 0-10 degrees from the vertical axis of the handrail underside. The asymmetric beam illuminates the path but keeps the light source out of sight. Snap is available in a range of standard distributions and special angles on request.

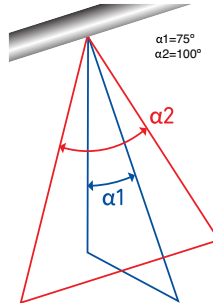
THETA750 SNAP VA - STANDARD WHITE  
CURVED FACE DETAIL



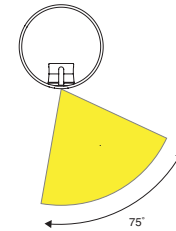
THETA750 SNAP VA - STANDARD WHITE  
FLAT FACE DETAIL



THETA750 SNAP VA - STANDARD WHITE  
BEAM ALPHA 3000K

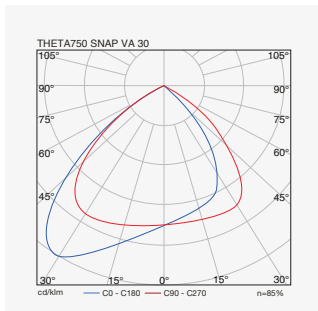


THETA750 SNAP VA - STANDARD WHITE  
ASYMMETRICAL BEAM

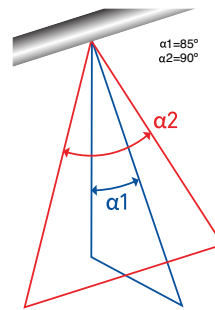


Elliptical asymmetric distribution displayed here with a vertical mount.

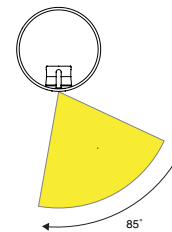
THETA750 SNAP VA 30  
ASYMMETRICAL BEAM 3000K



THETA750 SNAP VA - STANDARD WHITE IP68  
BEAM ALPHA 3000K

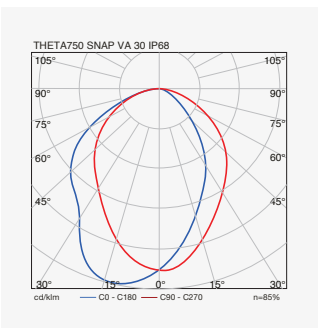


THETA750 SNAP VA - STANDARD WHITE  
ASYMMETRICAL BEAM IP68



Elliptical asymmetric distribution displayed here with a vertical mount.

THETA750 SNAP VA 30 IP68  
ASYMMETRICAL BEAM 3000K



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Bell Auditorium Expansion

Issue for Permit / Bid  
**16 January 2023**

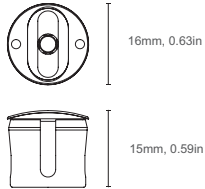
Type:  
**FS3 Series**

Page 3 of 8

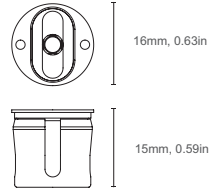
**STANDARD WHITE - WIDE BEAM**

THETA750 Snap Wide has a specially designed very wide elliptical distribution with no sharp cut off. Typical for mounting in the underside of a handrail at vertical down position.

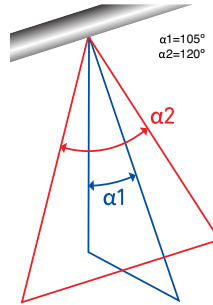
THETA750 SNAP WD - STANDARD WHITE  
CURVED FACE DETAIL



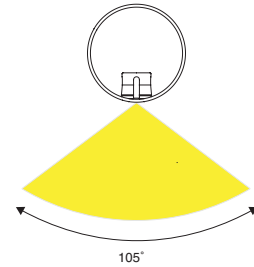
THETA750 SNAP WD - STANDARD WHITE  
FLAT FACE DETAIL



THETA750 SNAP WD - STANDARD WHITE  
BEAM ALPHA 3000K

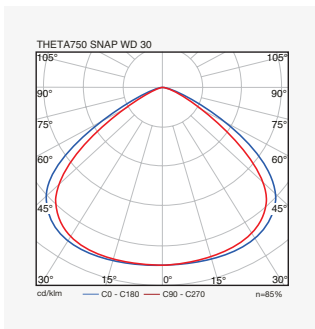


THETA750 SNAP WD - STANDARD WHITE  
WIDE BEAM



Wide elliptical distribution displayed here with a vertical mount

THETA750 SNAP WD 30  
WIDE BEAM 3000K



Bell Auditorium Expansion

Issue for Permit / Bid  
**16 January 2023**

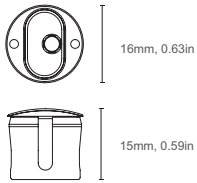
Type:  
**FS3 Series**



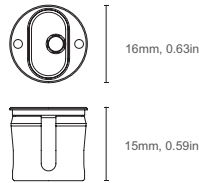
**STANDARD WHITE - HYPERBOLIC BEAM**

THETA750 Snap Hyperbolic has an elliptical asymmetric distribution. Designed for insertion at 0-10 degrees from the vertical axis of the handrail underside. The asymmetric beam illuminates the path but keeps the light source out of sight. Hyperbolic is available in a range of standard distributions and special angles on request.

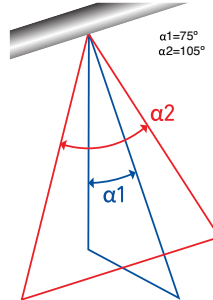
THETA750 SNAP HYP - STANDARD WHITE  
CURVED FACE DETAIL



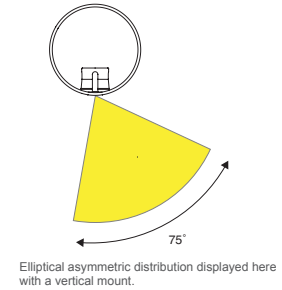
THETA750 SNAP HYP - STANDARD WHITE  
FLAT FACE DETAIL



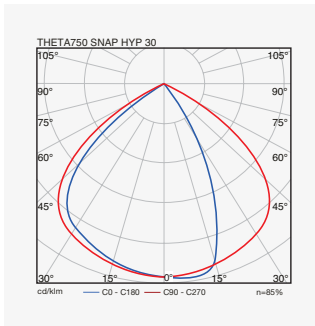
THETA750 SNAP HYP - STANDARD WHITE  
BEAM ALPHA 3000K



THETA750 SNAP HYP - STANDARD WHITE  
HYPERBOLIC BEAM



THETA750 SNAP HYP 30  
HYPERBOLIC BEAM 3000K



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10007



Bell Auditorium Expansion

Issue for Permit / Bid  
**16 January 2023**

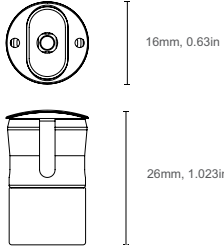
Type:  
**FS3 Series**

Page 5 of 1

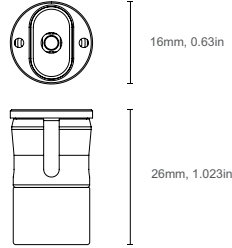
**RGBW - STANDARD BEAM**

RGBW has an elliptical symmetric distribution. For installation in handrail, mounting is typically at 30° from the vertical axis of the handrail underside. RGBW is available in a range of distributions and special angles on request.

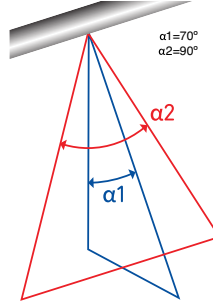
THETA750 SNAP ST - RGBW  
CURVED FACE DETAIL



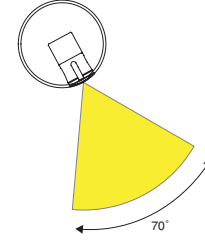
THETA750 SNAP ST - RGBW  
FLAT FACE DETAIL



THETA750 SNAP ST - RGBW  
BEAM ALPHA 3000K

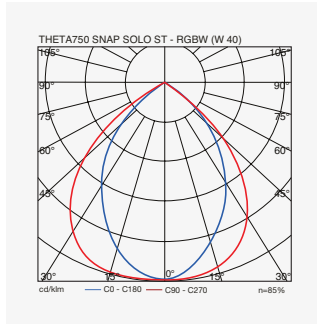


THETA750 SNAP ST - RGBW  
STANDARD BEAM



Elliptical symmetric distribution for typical mounting at 30° from vertical.

THETA750 SNAP SOLO ST - RGBW (W 40)  
STANDARD SYMMETRICAL BEAM 4000K  
(Results displayed were obtained using white chip at 500mA)



Bell Auditorium Expansion

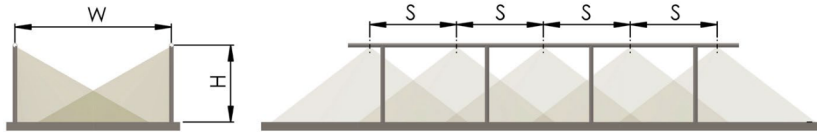
Issue for Permit / Bid  
**16 January 2023**

Type:  
**FS3 Series**

**SPACING GUIDE**

The following guide is intended to help designers and engineers with desired foot-candles levels. The drawing to the right shows a typical installation into a handrail. The tables list the average foot-candles at a variety of path widths and LED spacings

TYPICAL INSTALLATION



Height (H) is at 3'-1/4"

**STANDARD WHITE - STANDARD BEAM IP65-67/IP68: LIGHT FROM BOTH SIDES**

PATH WIDTH (W)	4ft	6.5ft	10ft	13ft
LED SPACING (S)	fc	fc	fc	fc
1.5ft	32/18	19/11	13/7	10/5
3ft	16/9	10/5	6/3.5	5/2.7
6.5ft	8/4.5	5/2.7	3/1.8	2/1.3

fc = average foot-candles  
CCT = 3000K  
NOTE: Calculations indicated are with LED module installed at 30° offset from vertical down axis.

**STANDARD WHITE - ASYMMETRICAL BEAM IP65-67/IP68: LIGHT FROM BOTH SIDES**

PATH WIDTH (W)	4ft	6.5ft	10ft	13ft
LED SPACING (S)	fc	fc	fc	fc
1.5ft	27/16	16/9.5	11/6.3	8/4.7
3ft	14/8	8/4.7	5/3	4/2.4
6.5ft	7/4	4/2.4	3/1.5	2/1.2

fc = average foot-candles  
CCT = 3000K  
NOTE: Calculations indicated are with LED module in vertical down position.

**STANDARD WHITE - WIDE BEAM: LIGHT FROM BOTH SIDES**

PATH WIDTH (W)	4ft	6.5ft	10ft	13ft
LED SPACING (S)	fc	fc	fc	fc
1.5ft	21	12	8	6
3ft	10	6	4	3
6.5ft	5	3	2	1.5

fc = average foot-candles  
CCT = 3000K  
NOTE: Calculations indicated are with LED module in vertical down position.

**STANDARD WHITE - HYPERBOLIC BEAM: LIGHT FROM BOTH SIDES**

PATH WIDTH (W)	4ft	6.5ft	10ft	13ft
LED SPACING (S)	fc	fc	fc	fc
1.5ft	15	9	6	4.5
3ft	8	4.5	3	2.3
6.5ft	4	2.3	1.5	1

fc = average foot-candles  
CCT = 3000K  
NOTE: Calculations indicated are with LED module in vertical down position.

**RGBW (W CCT at 4000K) - STANDARD BEAM: LIGHT FROM BOTH SIDES**

PATH WIDTH (W)	4ft	6.5ft	10ft	13ft
LED SPACING (S)	fc	fc	fc	fc
1.5ft	35	21	14	11
3ft	18	11	7	5
6.5ft	9	5	4	3

fc = average foot-candles  
CCT = 4000K  
NOTE: Calculations indicated are with LED module installed at 30° offset from vertical down axis and obtained using white chip at 500mA

In a continuing effort to offer the best product possible we reserve the right to change, without notice, specifications or materials that in our opinion will not alter the function of the product. v12.19.22 | Theta750 Snap | Page 7 of 8



Bell Auditorium Expansion

Issue for Permit / Bid  
16 January 2023

Type:  
FS3 Series

### THETA750 SNAP TOOL KIT - FOR ROUND OR SQUARE HANDRAIL



Product Number: 750-TOOL KIT THETA SNAP

- 1 1 x Drill Jig unit pre-installed with 1 x 15 and 16mm cutters
- 2 1 x Flat Face Spacer (for use ONLY with Flat face / Square Pipe).  
Not Shown.
- 3 1 x Drilling manual (this guide)
- 4 2 x 15mm cutters (spares)
- 5 1 x 16mm cutter (spare)
- 6 1 x Cutter removal tool (double-sided)
- 7 1 x 2mm Allen (hex) key
- 8 2 x cutting lubricant
- 9 1 x AF 10mm nut driver
- 10 1 x 10mm wrench
- 11 1 x Insertion pliers
- 12 1 x File

\* Not shown, wire crimping pliers.

#### Purchases

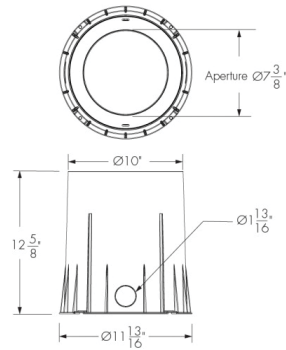
- It is strongly recommended to purchase a kit or multiple kits for larger projects or projects with several phases.
- Additional drill bits jig assemblies can be purchased at nominal cost to replace worn or ineffective parts. CONSULT FACTORY.

### NO TOOL KIT REQUIRED - FOR FLAT SURFACES

- Drill 15mm hole in mounting surface

Project Name \_\_\_\_\_ Qty \_\_\_\_\_

Type \_\_\_\_\_ Catalog / Part Number \_\_\_\_\_



Top view

Front view

Shown with FLN trim type

**Photometric Summary**

**Symmetric**

	Delivered output (lm)	Intensity (peak cd)	Power <sup>[1]</sup> (120V) [W]
<b>VN (6°)</b>	1695	83,330	30 <sup>[4]</sup>
<b>NS (10°)</b>	4371 <sup>[3]</sup>	63,536	60 <sup>[2]</sup>
<b>M (30°)</b>	4929 <sup>[3]</sup>	21,162	60 <sup>[2]</sup>
<b>FL (40°)</b>	4442 <sup>[3]</sup>	10,611	60 <sup>[2]</sup>
<b>WFL (60°)</b>	4118 <sup>[3]</sup>	4157	60 <sup>[2]</sup>

**Bi-symmetric**

	Delivered output (lm)	Intensity (peak cd)	Power <sup>[1]</sup> (120V) [W]
<b>6°x90°</b>	1585	8136	30 <sup>[4]</sup>
<b>90°x6°</b>			
<b>15°x90°</b>	3670 <sup>[3]</sup>	9152	60 <sup>[2]</sup>
<b>90°x15°</b>			
<b>25°x90°</b>	3836 <sup>[3]</sup>	5471	60 <sup>[2]</sup>
<b>90°x25°</b>			
<b>35°x90°</b>	3396 <sup>[3]</sup>	3536	60 <sup>[2]</sup>
<b>90°x35°</b>			

**Asymmetric**

	Delivered output (lm)	Intensity (peak cd)	Power <sup>[1]</sup> (120V) [W]
<b>NAS</b>	1713	26,491	30 <sup>[4]</sup>
<b>WW</b>	2182	3250	36 <sup>[2]</sup>

Based on 4000K, On/Off configuration. Tested with IFR lens for VN optic, SFR lens for NAS, WW optics and CL lens for all other optics.

Photometric performance is measured in compliance with IESNA LM 79-08. Consult photometric files for static color information.

- [1] Add 5 W per fixture when specifying DMX/RDM.
- [2] Use 39 W when specifying lumentalk for white light.
- [3] 70% output for lumentalk, 80% output for DALI when specifying white light.
- [4] Use 32 W when specifying lumentalk for VN, 6°x90°, 90°x6° and NAS.

**Description**

The Lumenbeam Inground Large is a high-performance, ground-recessed LED projector designed to solve a range of inground lighting challenges with a choice of optics, trim, lenses and control options. The plug and play design simplifies installation, protecting the system from water infiltration and ensuring long-lasting performance. Built with robust, high-quality materials that are resistant to harsh environments, the Lumenbeam Inground Large delivers L70 LED lifetimes from 79,000 up to 370,000 hours, has a Drive-Over rating of 5000kg, IK10 glass lens and an IP68 factory-sealed optical chamber.

**Features**

<b>Construction</b>	Walk over compliant up to 1000 kg in any type of ground, Drive over compliant up to 5000 kg in concrete
<b>Color and Color Temperature</b>	2200K, 2700K, 3000K, 3500K, 4000K, 5700K, Red, Green, Blue
<b>Optics (nominal distribution)</b>	VN (6°), NS (10°), M (30°), FL (40°), WFL (60°), 6° x 90°, 15° x 90°, 25° x 90°, 35° x 90°, 90° x 6°, 90° x 15°, 90° x 25°, 90° x 35°, NAS (Narrow Asymmetric), WW (Asymmetric Wallwash)
<b>Lens</b>	Clear lens, Small frosted ring, Large frosted ring, Softening lens, (lens type will vary according to optic, see optics and lens section)
<b>Optical Option (factory installed)</b>	Internal louver
<b>Trim Type</b>	Flush trim with hardware, Flush trim no hardware, Bevel edge trim with hardware, Bevel edge trim no hardware
<b>Blockout</b>	Recessed blockout, Recessed blockout with mounting brackets
<b>Options</b>	Anti-slip lens
<b>Adjustment</b>	-3° to +15° tilt, 360° rotation
<b>Power Consumption</b>	30 W to 60 W
<b>Warranty</b>	5-year limited warranty

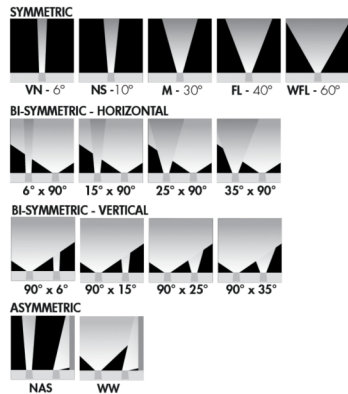


Bell Auditorium Expansion

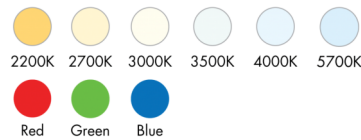
Issue for Permit / Bid  
**16 January 2023**

Type:  
**FS6 Series**

**Optics**



**Colors and Color Temperatures**



**Controls**

ON/OFF 0-10V DALI

lumen talk DMXRdm

**Construction**



WO - Walk over



DO - Drive over

**Trim Finishes**



SSB - Brushed Stainless Steel



SSP - Polished Stainless Steel

**Options**



Anti-slip lens

**Ratings**

IP68 IK10

**Performance**

<b>Maximum Delivered Output</b>	4929 lm (4000K, M30°, CL lens, On/Off control)
<b>Maximum Delivered Intensity</b>	83,330 cd at nadir (4000K, VN 6°, LFR lens, On/Off control)
<b>Illuminance at Distance</b>	Minimum 1 fc at 288 ft (4000K, VN 6°, LFR lens, On/Off control)
<b>Color Consistency</b>	2 SDCM, 3 SDCM (2200K and 5700K)
<b>Color Rendering</b>	Minimum CRI 80
<b>Lumen Maintenance</b>	L70 79,000 to 370,000 hrs (Ta 25 °C), L70 77,000 to 90,500 hrs (Ta 40 °C)

**Physical**

<b>Optical Chamber Material</b>	Brass for walk-over and drive-over construction in harsh environments
<b>Blockout Material</b>	Fiberglass reinforced polymer
<b>Lens Material</b>	Tempered glass
<b>Hardware Material</b>	Stainless steel
<b>Gasket Material</b>	Silicone
<b>Trim Finish</b>	Brushed stainless steel, Polished stainless steel
<b>Weight</b>	23 lbs

**Electrical and control**

<b>Voltage</b>	120-277 volts, 220-240 volts
<b>Leader Cable Conductor</b>	6C #14-3/ #24-3
<b>Leader Cable Connector</b>	IP68 6-pin push-lock
<b>Control</b>	On/Off control, Lumentalk, 0-10V dimming, DALI dimming, DMX/RDM enabled
<b>Resolution (DMX/RDM)</b>	Per fixture, 8-bit or 16-bit

**Environmental**

<b>Storage Temperature</b>	-40 °F to 185 °F (device must reach start-up temperature value before operating)
<b>Start-up Temperature</b>	-13 °F to 104 °F
<b>Operating Temperature</b>	-40 °F to 104 °F, Consult factory for -40 °F to 122 °F temperature range
<b>Ingress Protection Rating</b>	IP68 (submerged up to 3.3 ft for up to 24 hours), not suitable for permanent immersion applications
<b>Impact Resistance Rating</b>	IK10
<b>Environment</b>	Wet location

**Accessories (order separately)**

<b>Cables</b>	3 Conductor Power and 3 Conductor Data Leader Cable with Connector, 3 Conductor Power and 3 Conductor Data Cable
<b>Electrical Accessories</b>	Large Junction Box for Lumenbeam Inground



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**Certifications**



<b>Control Boxes</b>	DMX/RDM enabled (daisy chain or star configuration), Ethernet enabled (daisy chain or star configuration)
<b>Control Systems</b>	Lumentone™ 2, Pharos® kit
<b>Diagnostic and Addressing Tools</b>	LumenID, LumentalkID



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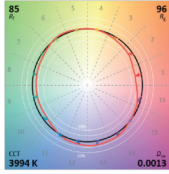
Issue for Permit / Bid  
**16 January 2023**

Type:  
FS6 Series

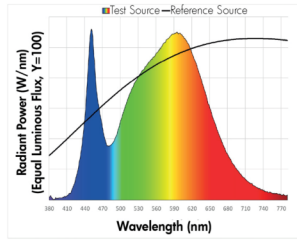
**Chromaticity Data**

TM-30 - 4000K

CCT	CIE		TM-30	
4000K	R <sub>a</sub>	83	R <sub>1</sub>	85
	R <sub>2</sub>	14	R <sub>2</sub>	96



**Spectral Power Distribution**



**Construction details**

**WO - Walk over**  
compliant up to 1000kg

**DO - Drive over**  
compliant up to 5000kg

**Trim type** All trim options are suitable (FLH, FLN, BVH and BVN)

**Trim type** Only trim options with visible hardware are suitable (FLH and BVH)

**Ground type** Installed in sand, soft soil, compacted soil, pavement or concrete

**Ground type** Installed in concrete

**Optics and lens options**

22K, 27K, 30K, 35K, 40K and 57K static colors



Optics / Lens	Clear	Small frosted ring	Large frosted ring	Softening	Anti-slip
VN			<input checked="" type="checkbox"/>		
NS/M/FL/WFL	<input checked="" type="checkbox"/>			Optional	Optional (can be combined with all lenses and optics)
6° /15°/25°/35° x 90°	<input checked="" type="checkbox"/>				
NAS/WW		<input checked="" type="checkbox"/>			

Recommended for optimal performance, may be replaced by a softening lens. A softening lens will affect beam distribution and output. Consult factory for application support.



Bell Auditorium Expansion

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Type:  
**FS6 Series**



**Specification Sheet**

**lumenbeam**  
Inground Large  
LBIL

WHITE AND STATIC COLORS

**RD, GR and BL static colors**

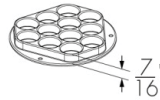
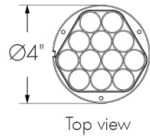
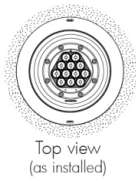


Optics / Lens	Clear	Small frosted ring	Large frosted ring	Softening	Anti-slip
VN			☑		
NS	☑			Optional	
M/FL/WFL				☑	Optional (can be combined with all lenses and optics)
6° /15°/25°/35° x 90°	☑			Optional	
NAS		☑			
WW				☑	

☑ Recommended for optimal performance, may be replaced by a softening lens. A softening lens will affect beam distribution and output. Consult factory for application support.

**Optical accessories (factory installed)**

**INTL - Internal louver**



- The internal louver is factory installed and not adjustable in the field.
- Not available for NAS, WW optics.
- The addition of an internal louver will affect beam distribution, consult factory for application support.

**lumenpulse™**

1220 Marie-Victorin Blvd., Longueuil, QC J4G 2H9 CA  
info@lumenpulse.com [www.lumenpulse.com](http://www.lumenpulse.com)

United States 617.307.5700 | Canada 1.877.937.3003 | 514.937.3003 F 514.937.6289  
[www.lumenpulse.com/products/2061](http://www.lumenpulse.com/products/2061)

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MS - R10

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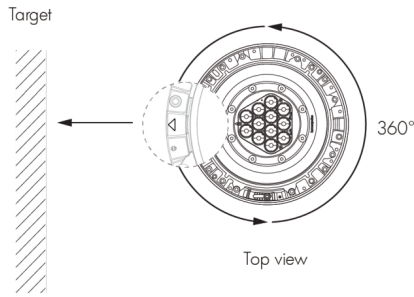
Issue for Permit / Bid  
**16 January 2023**

Type:  
**FS6 Series**

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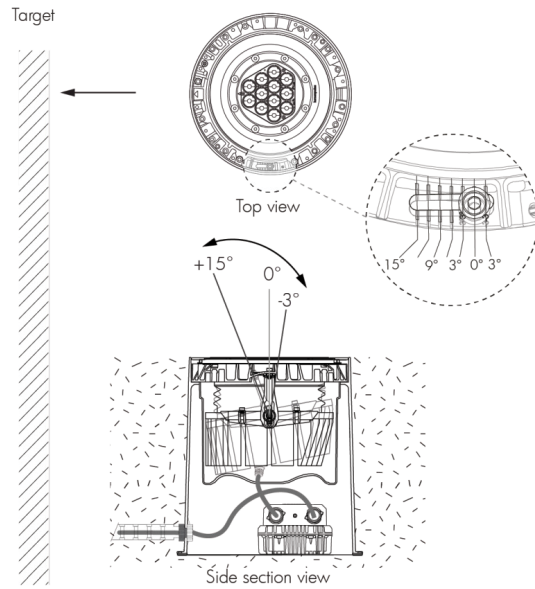
**Adjustment**

**360° Orientation**



The optical chamber can be rotated until the arrow faces the target. Refer to the installation instructions for details.

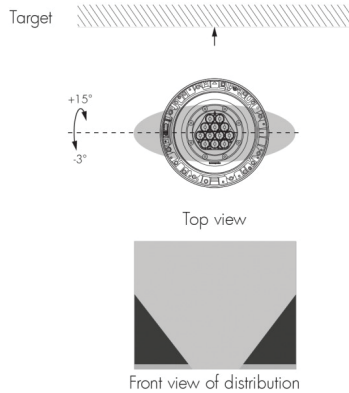
**-3° to +15° Tilt adjustment**



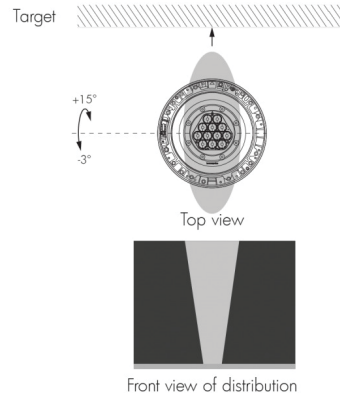
- Tilt can be adjusted on site without opening the factory sealed optical chamber.
- **Asymmetrical optics:** Tilt set in factory for optimal results (WW at 5° and NAS at 3°).

**Bi-symmetrical distributions**

**Horizontal distribution : 6°x90°, 15°x90°, 25°x90°, 35°x90°**

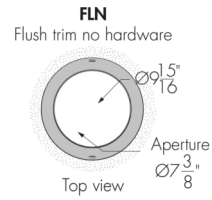
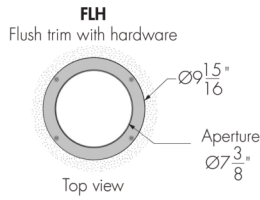
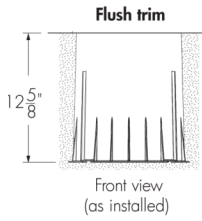


**Vertical distribution : 90°x6°, 90°x15°, 90°x25°, 90°x35°**



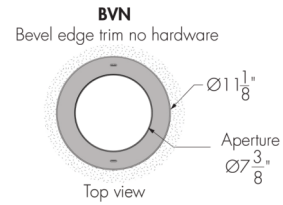
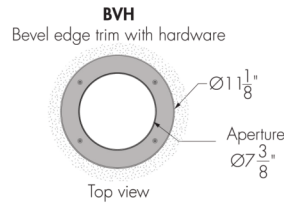
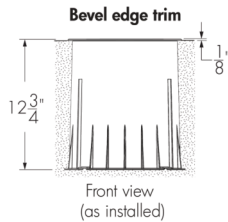
**Trim type**

**Flush trim**



Only trims with hardware are drive-over compliant.

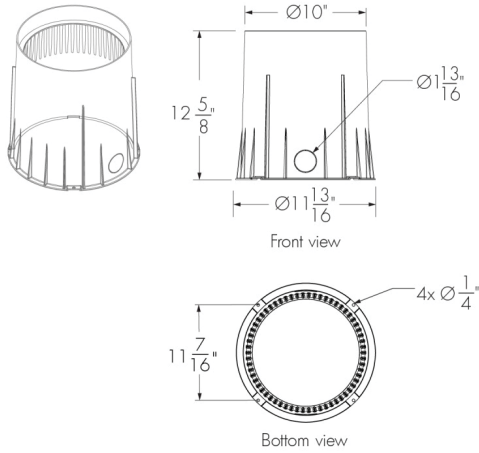
**Bevel edge trim**



**Blockout**

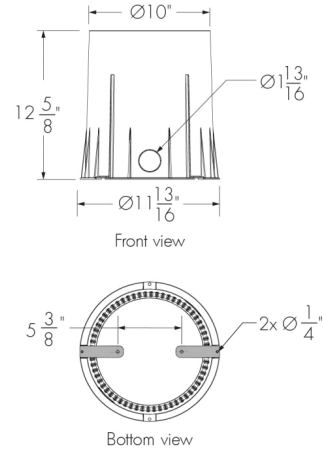
**RBO - Recessed Blockout**

**RBO - Recessed blockout**

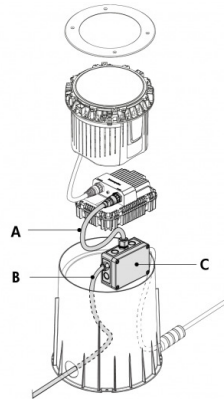


**RBM - Recessed Blockout with Mounting Brackets**

**RBM - Recessed blockout with mounting brackets**



**Overview - cables and accessories**



- A - 3P3DLC:** 3 Conductor Power and 3 Conductor Data Leader Cable with Connector
  - B - 3P3DC:** 3 Conductor Power and 3 Conductor Data Cable
  - C - LBI-JBOX-L:** Large Junction Box for Lumenbeam Inground (required for continuous runs and DMX/RDM daisy chain layouts)
- Refer to typical wiring diagrams for details.

**Cables (order separately)**

**3P3DLC - 3 Conductor Power and 3 Conductor Data Leader Cable with Connector**



**CERTIFICATION:** UL or CE  
**LENGTH:** 10 ft, 25 ft or 50 ft

- Sealing endcap is mandatory for all unused connectors. One (1) included with every leader cable.
- Consult 3P3DLC specification sheet for details.

**3P3DC - 3 Conductor Power and 3 Conductor Data Cable**



**CERTIFICATION:** UL or CE  
**LENGTH:** 50 ft, 100 ft, 150 ft, 200 ft or complete spool of cable 250 ft

**Electrical accessories (order separately)**

**LBI-JBOX-L - Large Junction Box for Lumenbeam Inground (required for continuous runs and DMX/RDM daisy chain layouts)**



Refer to LBI-JBOX-L installation instructions for details.

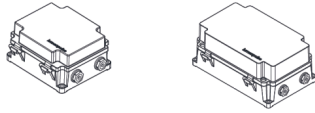
**Included**

- 1x Junction box with 16 in 3P3DLC cable whip
- 4x Strain reliefs
- 1x IP68 insulating resin
- 1x Sealing cap



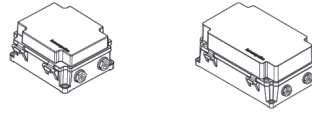
**Control boxes (order separately)**

**CBX-DMX/RDM - DMX/RDM enabled (daisy chain or star configuration)**



DMX/RDM control box. Up to six power and data outputs to fixtures or fixture runs. Consult CBX specification sheet and installation instructions for details. Lumenterminators provided with CBX (2x for daisy chain configuration, 6x for star configuration), consult factory to order spares.

**CBX-ENET - Ethernet enabled (daisy chain or star configuration)**



Ethernet control box. Up to four power and data outputs to fixture or fixture runs. Consult Ethernet CBX specification sheet and installation instructions for details.

**Control systems (order separately)**

**LTN2 - Lumentone™ 2**



Lumentone 2 is a simple pre-programmed DMX 512 controller with a push button rotary dial and live feedback.

**PHAROS - Pharos® kit**



The Pharos kit, available for 1 or 2 DMX universes, allows for complete control of large lighting installations. 2 DMX universes kit shown.

**Diagnostic and addressing tools (order separately)**

**LID - LumenID**



LumenID is a diagnostic and addressing DMX/RDM tool. It must be specified on all DMX applications. Consult LID specification sheet for details.

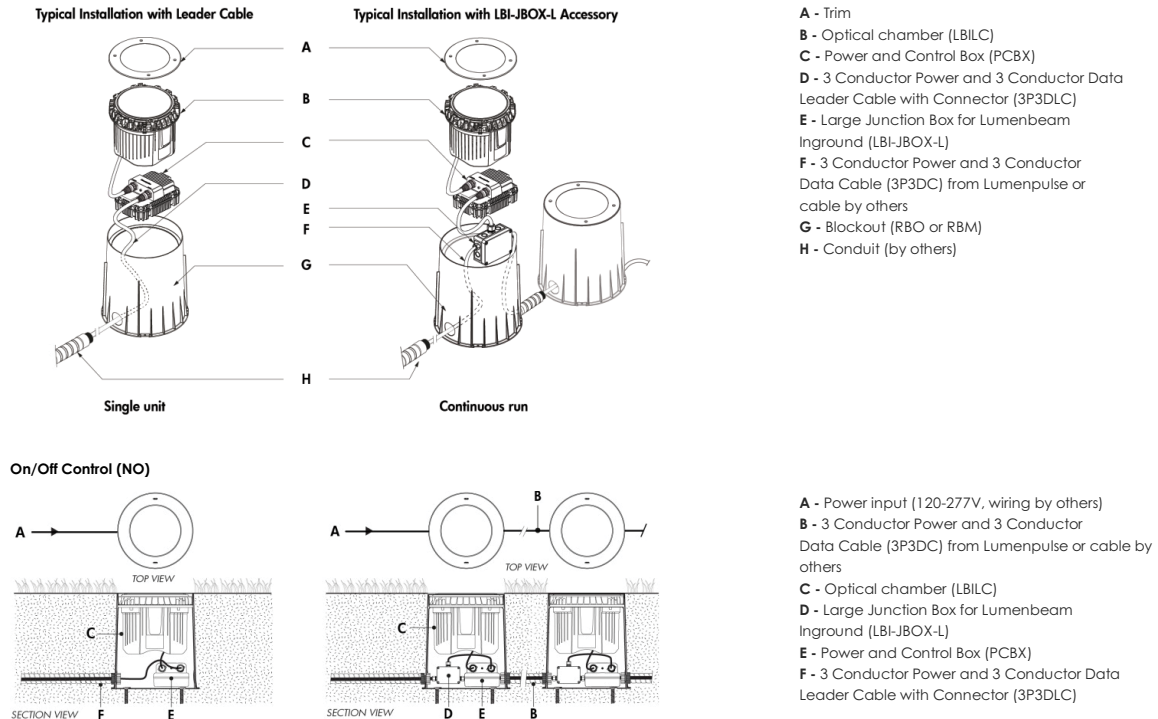
**LID-LT - LumentalkID**



LumentalkID is a diagnostic and addressing tool. It must be specified for all Lumentalk (LT) applications. Consult LID-LT specification sheet for details.



**Typical wiring diagrams**



- Consult factory for specific applications and maximum fixture count/cable length recommendations.
- Refer to Photometric Summary table for wattage information.

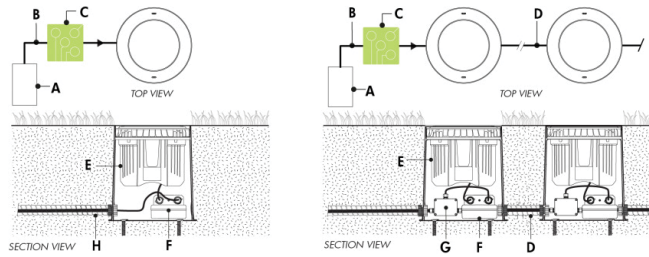


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**16 January 2023**

Type:  
**FS6 Series**

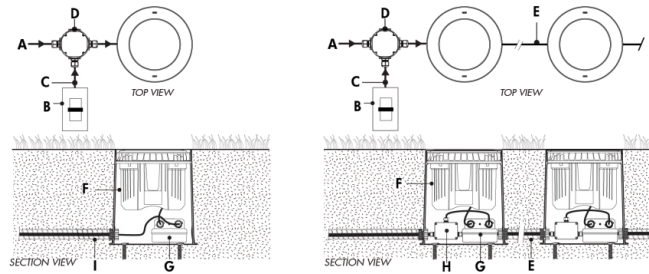
**Lumentalk (LT)**



- A - Dimmer/controller (order separately from Lumenpulse, or by others)
- B - Data wiring (by others)
- C - Lumentranslator 2 (LTL2 -DIM, -DMX, -TRIAC, -DALI)
- D - 3 Conductor Power and 3 Conductor Data Cable (3P3DC) from Lumenpulse or cable by others
- E - Optical chamber (LBILC)
- F - Power and Control Box (PCBX)
- G - Large Junction Box for Lumenbeam Inground (LBI-JBOX-L)
- H - 3 Conductor Power and 3 Conductor Data Leader Cable with Connector (3P3DLC)

- Consult factory for specific applications and maximum fixture count/cable length recommendations.
- Lumentalk enabled fixtures must be commissioned using LumentalkID software and a LID-LT. Consult factory for details.
- Maximum of 1 transmitter (Lumentranslator or Lumenlink) per system. No third party fixtures allowed on the same circuit.
- For DMX applications: 1 DMX controller per Lumentalk network, maximum of 48 DMX channels per Lumentalk network (minimum step transition update rate is 1 second, minimum fade time between two colors is 1 minute). Consult factory for applications that require additional capabilities.
- Consult factory for DALI Lumentalk applications.
- 1% minimum dimming value. Refer to Photometric Summary table for wattage information.

**0-10V dimming (DIM)**

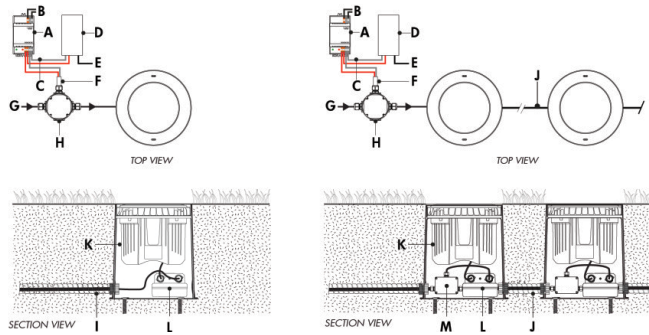


- A - Power input (120-277V, wiring by others)
- B - Dimmer (by others)
- C - Data wiring (by others)
- D - Junction box (by others)
- E - 3 Conductor Power and 3 Conductor Data Cable (3P3DC) from Lumenpulse or cable by others
- F - Optical chamber (LBILC)
- G - Power and Control Box (PCBX)
- H - Large Junction Box for Lumenbeam Inground (LBI-JBOX-L)
- I - 3 Conductor Power and 3 Conductor Data Leader Cable with Connector (3P3DLC)

- Consult factory for specific applications and maximum fixture count/cable length recommendations.
- 0-10V mA ratings: passive dimmer (Current Sink): 3mA per fixture, active dimmer (Current Source): 0.5mA per fixture.
- 1% minimum dimming value. Refer to Photometric Summary table for wattage information.



**DAU dimming (DALI)**



- A - DALI bus power supply (by others)
- B - Power input for DALI bus power supply (wiring by others)
- C - To DALI controller (by others)
- D - DALI controller (by others)
- E - Power input for DALI controller (wiring by others)
- F - To fixture
- G - Power input (120-277V, wiring by others)
- H - Junction box (by others)
- I - 3 Conductor Power and 3 Conductor Data Leader Cable with Connector (3P3DLC)
- J - 3 Conductor Power and 3 Conductor Data Cable (3P3DC) from Lumenpulse or cable by others
- K - Optical chamber (LBILC)
- L - Power and Control Box (PCBX)
- M - Large Junction Box for Lumenbeam Inground (LBI-JBOX-L)

- Consult factory for specific applications and maximum fixture count/cable length recommendations.
- Maximum of 64 DALI fixtures per DALI loop.
- Commissioning may be required based on the selection of 3rd party DALI controller. Controller and commissioning provided by others.
- Refer to Photometric Summary table for wattage information.



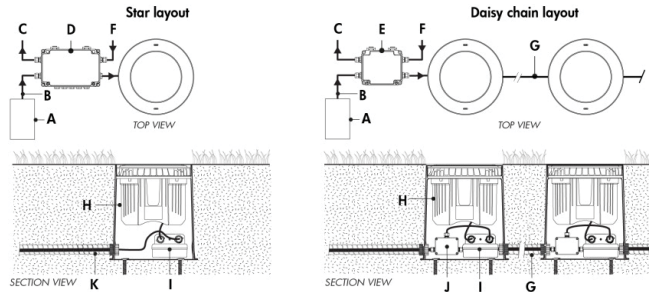
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**DMX/RDM enabled (DMX/RDM)**



- A** - DMX/RDM controller (order separately from Lumenpulse, or by others)
- B** - Data input (Belden 9841 or equivalent, by others)
- C** - Data output to next CBX (optional, not isolated/not boosted)
- D** - CBX-ST
- E** - CBX-DS
- F** - Power input (120-277V, wiring by others)
- G** - 3 Conductor Power and 3 Conductor Data Cable (3P3DC) from Lumenpulse or cable by others
- H** - Optical chamber (LBILC)
- I** - Power and Control Box (PCBX)
- J** - Large Junction Box for Lumenbeam Inground (LBI-JBOX-L)
- K** - 3 Conductor Power and 3 Conductor Data Leader Cable with Connector (3P3DLC)

**Maximum fixture count**

Configuration/Voltage	120V	208V	240V	277V
<b>LBIL</b> (Maximum number of fixtures per run)	18*	32	32	32

Based on 15A maximum, 14AWG cable, fixtures spaced 10 ft on center, first fixture 50 ft from CBX.

\*28 fixtures maximum for VN, 6"x90", 90"x6", NAS and WW optics.

- Refer to CBX installation instructions for additional wiring details.
- Consult factory for specific applications and maximum fixture count/cable length recommendations.
- The DMX/RDM protocol states a maximum of 32 DMX/RDM enabled fixtures on any single run. Maximum of 4 DMX/RDM repeaters/CBX cascading in line. Each fixture requires 1 DMX address. Maximum of 1 output per CBX-DS. Maximum of 6 outputs per CBX-ST.
- Refer to Photometric Summary table for wattage information.
- DMX terminator is required at the end of each run to maintain data integrity. (2x) DMX lumenterminators included per CBX-DS, (6x) included per CBX-ST. See installation instructions for details.



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**FS6 Series**

**How to order**

Housing <sup>(1)</sup>	Construction	Voltage	Color and Color Temperature <sup>(5)</sup>	Optics	Lens <sup>(8)</sup>	Optical Options	Control <sup>(14)</sup>
LBIL Lumenbeam Inground Large	<b>WO</b> Walk over  <b>DO</b> Drive over <sup>(2)</sup>	<b>120/277</b> 120-277 volts <sup>(3)</sup>  <b>220/240</b> 220-240 volts <sup>(4)</sup>	<b>22K</b> 2200K  <b>27K</b> 2700K  <b>30K</b> 3000K  <b>35K</b> 3500K  <b>40K</b> 4000K  <b>57K</b> 5700K  <b>RD</b> Red <sup>(4)</sup>  <b>GR</b> Green <sup>(4)</sup>  <b>BL</b> Blue <sup>(4)</sup>	<b>VN</b> Very Narrow 6° <sup>(7)</sup>  <b>NS</b> Narrow Spot 10° <sup>(7)</sup>  <b>M</b> Medium 30° <sup>(7)</sup>  <b>FL</b> Flood 40° <sup>(7)</sup>  <b>WFL</b> Wide Flood 60° <sup>(7)</sup>  <b>6x90</b> 6° vertical x 90° horizontal <sup>(7)</sup>  <b>15x90</b> 15° vertical x 90° horizontal <sup>(7)</sup>  <b>25x90</b> 25° vertical x 90° horizontal <sup>(7)</sup>  <b>35x90</b> 35° vertical x 90° horizontal <sup>(7)</sup>  <b>90x6</b> 90° vertical x 6° horizontal <sup>(7)</sup>  <b>90x15</b> 90° vertical x 15° horizontal <sup>(7)</sup>  <b>90x25</b> 90° vertical x 25° horizontal <sup>(7)</sup>  <b>90x35</b> 90° vertical x 35° horizontal <sup>(7)</sup>  <b>NAS</b> Narrow Asymmetric <sup>(7)</sup>  <b>WW</b> Asymmetric Wallwash <sup>(7)</sup>	<b>CL</b> Clear lens <sup>(9)</sup>  <b>SFR</b> Small frosted ring <sup>(10)</sup>  <b>LFR</b> Large frosted ring <sup>(11)</sup>  <b>SL</b> Softening lens <sup>(12)</sup>	<b>INTL</b> Internal louver <sup>(13)</sup>	<b>NO</b> On/Off control  <b>LT</b> Lumentalk <sup>(15)</sup>  <b>DIM</b> 0-10V dimming  <b>DALI</b> DALI dimming  <b>DMX/RDM</b> DMX/RDM enabled <sup>(16)</sup>

**Notes:**

- 1. A Lumenbeam Inground fixture includes one optical chamber (LBLC), one Power and Control Box (PCBX), one recessed blackout with temporary blackout cover (RBO or RBM) and one trim (FLH, FLN, BVH or BVN). The LBLC and PCBX are provided according to the optic and control configuration.
- 2. A trim option with hardware (FLH or BVH) must be specified for DO construction.
- 3. Available for UL certification only.
- 4. Available for CE certification only.
- 5. Consult factory for availability of static Royal Blue, Amber, 6500K and 90+ CRI.
- 6. Static colors made to order 8-10 weeks.
- 7. Factory installed, not interchangeable on site.
- 8. Consult Optics and Lens Options section for details.
- 9. Available for all optics except VN, NAS and WW.
- 10. Available for NAS and WW optics only.
- 11. Available for VN optic only.
- 12. Available as an alternate lens choice for all optics. A softening lens will affect beam distribution and output. Consult factory for application support.
- 13. Not available for NAS and WW optics.
- 14. Wattage and output may vary according to control option. Refer to Photometric Summary table for details.
- 15. A Lumentranslator 2 (LT2) and LumentalkID (LID2) must be specified for Lumentalk applications. Consult Lumentranslator 2 and Lumentalk pages and specification sheets for details.
- 16. A control box (CBX) and LumenID (LID) must be specified.



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Bell Auditorium Expansion

Issue for Permit / Bid  
**16 January 2023**

Type:  
**FS6 Series**

**How to order**

Trim Type	Trim Finish	Blockout	Options	Environment	Certification
<b>FLH</b> Flush trim with hardware  <b>FLN</b> Flush trim no hardware <sup>(17)</sup>  <b>BVH</b> Bevel edge trim with hardware  <b>BVN</b> Bevel edge trim no hardware <sup>(17)</sup>	<b>SSB</b> Brushed stainless steel  <b>SSP</b> Polished stainless steel	<b>RBO</b> Recessed blockout  <b>RBM</b> Recessed blockout with mounting brackets	<b>ASL</b> Anti-slip lens	<b>HRS</b> Standard brass material suitable for harsh environments	<b>UL</b> UL compliant  <b>CE</b> CE compliant <sup>(18)</sup>

**Notes:**

17. Not available for DO construction.

18. Consult European specification sheet and installation instructions for CE wiring information.



Bell Auditorium Expansion

Issue for Permit / Bid  
**16 January 2023**

Type:  
FS6 Series



# D-Series Size 0 LED Area Luminaire



d"series

## Specifications

<b>EPA:</b>	0.75 ft <sup>2</sup> (.07 m <sup>2</sup> )
<b>Length:</b>	26.18" (66.5 cm)
<b>Width:</b>	14.06" (35.7 cm)
<b>Height<sub>1</sub>:</b>	2.26" (5.7 cm)
<b>Height<sub>2</sub>:</b>	7.46" (18.9 cm)
<b>Weight (max):</b>	18 lbs (8.2 kg)

**PRELIMINARY**

Catalog Number
Notes
Type

Hit the Tab key or mouse over the page to see all interactive elements.

## Introduction

The modern styling of the D-Series features a highly refined aesthetic that blends seamlessly with its environment. The D-Series offers the benefits of the latest in LED technology into a high performance, high efficacy, long-life luminaire.

The outstanding photometric performance results in sites with excellent uniformity, greater pole spacing and lower power density. It is ideal for replacing up to 400W metal halide in pedestrian and area lighting applications, with typical energy savings of 70% and expected service life of over 100,000 hours.

## Ordering Information EXAMPLE: DSX0 LED P6 40K 70CRI T3M MVOLT SPA NLTAIR2 PIRHN DDBXD

DSX0 LED		Color temperature		Color Rendering Index	Distribution		Voltage	Mounting				
DSX0 LED	<b>Forward optics</b>	(this section 70CRI only)		70CRI	AFR	Automotive front row	T5M	Type V medium <sup>3</sup>	MVOLT	(120V-277V) <sup>5</sup>	<b>Shipped included</b>	
	P1 P5	30K 3000K	70CRI		T1S	Type I short	T5LG	Type V low glare <sup>3</sup>	HVOLT	(347V-480V) <sup>6</sup>		SPA
	P2 P6	40K 4000K	70CRI	T2M	Type II medium	T5W	Type V wide <sup>3</sup>	XVOLT	(277V - 480V) <sup>7</sup>	RPA	Round pole mounting (#8 drilling)	
	P3 P7	50K 5000K	70CRI	T3M	Type III medium	BLC3	Type III backlight control <sup>4</sup>			WBA	Wall bracket <sup>2</sup>	
	P4		(this section 80CRI only, extended lead times apply)		T3LG	Type III low glare <sup>4</sup>	BLC4	Type IV backlight control <sup>4</sup>			SPA5	Square pole mounting #5 drilling <sup>11</sup>
	<b>Rotated optics</b>				T4M	Type IV medium					RPA5	Round pole mounting #5 drilling <sup>11</sup>
	P10 <sup>2</sup> P12 <sup>2</sup>	27K 2700K	80CRI	T4LG	Type IV low glare <sup>4</sup>	LCCO	Left corner cutoff <sup>4</sup>				SPA8N	Square narrow pole mounting #8 drilling
	P11 <sup>2</sup> P13 <sup>2</sup>	30K 3000K	80CRI	TFTM	Forward throw medium	RCCO	Right corner cutoff <sup>4</sup>				<b>Shipped separately</b>	
		35K 3500K	80CRI								MA	Mast arm mounting bracket adapter (field install required) <sup>12</sup>
		40K 4000K	80CRI									
		50K 5000K	80CRI									
<b>Control options</b>			<b>Other options</b>			<b>Finish (required)</b>						
<b>Shipped installed</b>	NLTAIR2 PIRHN nLight AIR gen 2 enabled with bi-level motion / ambient sensor, 8-40" mounting height, ambient sensor enabled at 2fc. <sup>13,14,15,19,20</sup>			PER7	Seven-pin receptacle only (controls ordered separate) <sup>16,20</sup>	<b>Shipped installed</b>	HS	Houseside shield (black finish standard) <sup>22</sup>	DDBXD	Dark Bronze		
PIR	High/low, motion/ambient sensor, 8-40" mounting height, ambient sensor enabled at 2fc. <sup>15,20,21</sup>			FAO	Field adjustable output. <sup>20,21</sup>	L90	Left rotated optics <sup>2</sup>	DNAXD	Natural Aluminum			
PER	NEMA twist-lock receptacle only (controls ordered separate) <sup>16</sup>			BL30	Bi-level switched dimming, 30%. <sup>17,20</sup>	R90	Right rotated optics <sup>2</sup>	DWHXD	White			
PERS	Five-pin receptacle only (controls ordered separate) <sup>16,20</sup>			BL50	Bi-level switched dimming, 50%. <sup>17,20</sup>	CCE	Construction Coastal Environment	DDBTXD	Textured dark bronze			
				DMG	0-10v dimming wires pulled outside fixture (for use with an external control, ordered separately) <sup>18</sup>	<b>Shipped separately</b>	EGS	External Glare Shield (reversible, field install required, matches housing finish)	DBLXBD	Textured black		
						BS	Bird Spikes (field install required)	DNATXD	Textured natural aluminum			
								DWHGXD	Textured white			



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## Bell Auditorium Expansion

Issue for Permit / Bid  
**16 January 2023**

Type:  
**FS10 Series**

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## Ordering Information

### Accessories

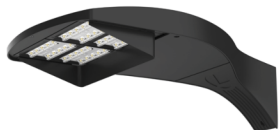
Ordered and shipped separately.

DLL127F 1.5 JU	Photocell - SSL twist-lock (120-277V) <sup>21</sup>
DLL347F 1.5 CULJU	Photocell - SSL twist-lock (347V) <sup>21</sup>
DLL480F 1.5 CULJU	Photocell - SSL twist-lock (480V) <sup>21</sup>
DSHORT SBK U	Shorting cap <sup>21</sup>
DSX0HS 20C U	House-side shield for P1, P2, P3 and P4 <sup>22</sup>
DSX0HS 30C U	House-side shield for P10, P11, P12 and P13 <sup>22</sup>
DSX0HS 40C U	House-side shield for P5, P6 and P7 <sup>22</sup>
DSXRPA (FINISH) U	Round pole adapter (#8 drilling, specify finish)
DSXRPA5 (FINISH) U	Round pole adapter #5 drilling (specify finish)
DSXSPA5 (FINISH) U	Square pole adapter #5 drilling (specify finish)
DSXMA (FINISH) U	Mast arm mounting bracket adaptor (specify finish) <sup>22</sup>
DSX0EGS (FINISH) U	External glare shield

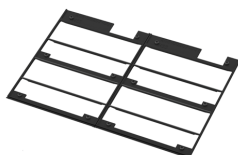
### NOTES

- 1
- 2 Must be combined with option L90 or R90. Rotated optics only available with packages P10, P11, P12 and P13.
- 3 Any type 5 distribution with photocell, is not available with WBA.
- 4 Not available with HS.
- 5 MVOLT driver operates on any line voltage from 120-277V (50/60 Hz).
- 6 HVOLT driver operates on any line voltage from 347-480V (50/60 Hz).
- 7 XVOLT operates with any voltage between 277V and 480V (50/60 Hz).
- 8 -
- 9 -
- 10 -
- 11 SPA5 and RPA5 for use with #5 drilling only (Not for use with #8 drilling).
- 12 Must order fixture with SPA mounting. Mast arm (MA) adapter bracket shipped separately. May also be ordered as an accessory. See Accessories information. For use with 2-3/8" diameter mast arm (not included).
- 13 NLTAIR2 and PIRHN must be ordered together. For more information on nLight Air 2 visit [this link](#).
- 14 NLTAIR2 PIRHN not available with other controls including PIR, PER, PER5, PER7, FAO, BL30, BL50 and DMG.
- 15 PIR not available with NLTAIR2, PER, PER5, PER7, FAO BL30, BL50 and DMG.
- 16 PER/PER5/PER7 not available with NLTAIR2, PIR, BL30, BL50. Photocell ordered and shipped as a separate line item from Acuity Brands Controls. See accessories. Shorting Cap included.
- 17 BL30 and BL50 are not available with NLTAIR2 PIRHN, PIR, PER5, PER7, FAO and DMG.
- 18 DMG not available with NLTAIR2 PIRHN, PIR, PER5, PER7 and FAO.
- 19 Reference Motion Sensor Default Settings table on page 4 to see functionality.
- 20 Reference Controls Options table on page 4.
- 21 FAO not available with other dimming controls options.
- 22 Not available with T3LG, T4LG, BLCS, BLCA, LCCO and RCCO distribution. Also available as a separate accessory; see Accessories information.
- 23 Requires luminaire to be specified with PER, PER5 or PER7 option. See Controls Table on page 4.

## Shield Accessories



External Glare Shield (EGS)

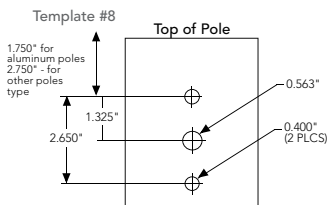
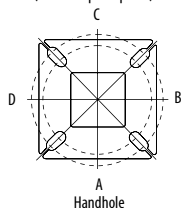


House Side Shield (HS)

## Drilling

### HANDHOLE ORIENTATION

(from top of pole)



### Tenon Mounting Slipfitter

Tenon O.D.	Mounting	Single Unit	2 @ 180	2 @ 90	3 @ 90	3 @ 120	4 @ 90
2-3/8"	RPA	AS3-5190	AS3-5280	AS3-5290	AS3-5390	AS3-5320	AS3-5490
2-7/8"	RPA	AST25-190	AST25-280	AST25-290	AST25-390	AST25-320	AST25-490
4"	RPA	AST35-190	AST35-280	AST35-290	AST35-390	AST35-320	AST35-490

Mounting Option	Drilling Template	Single	2 @ 180	2 @ 90	3 @ 90	3 @ 120	4 @ 90
Head Location		Side B	Side B & D	Side B & C	Side B, C & D	Round Pole Only	Side A, B, C & D
Drill Nomenclature	#8	DM19AS	DM28AS	DM29AS	DM39AS	DM32AS	DM49AS
<b>Minimum Acceptable Outside Pole Dimension</b>							
SPA	#8	3"	3"	3.2"	3.2"		3.2"
RPA	#8	3"	3"	3.2"	3.2"	3"	3.2"
SPA5	#5	3"	3"	3.2"	3.2"		3.2"
RPA5	#5	3"	3"	3.2"	3.2"	3"	3.2"

### DSX0 Area Luminaire - EPA

\*Includes luminaire and integral mounting arm. Other tenons, arms, brackets or other accessories are not included in this EPA data.

Fixture Quantity & Mounting Configuration	Single DM19	2 @ 180 DM28	2 @ 90 DM29	3 @ 90 DM39	3 @ 120 DM32	4 @ 90 DM49
Mounting Type						
DSX0 LED	0.750	1.500	1.430	2.250	2.250	2.798



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FS10 Series

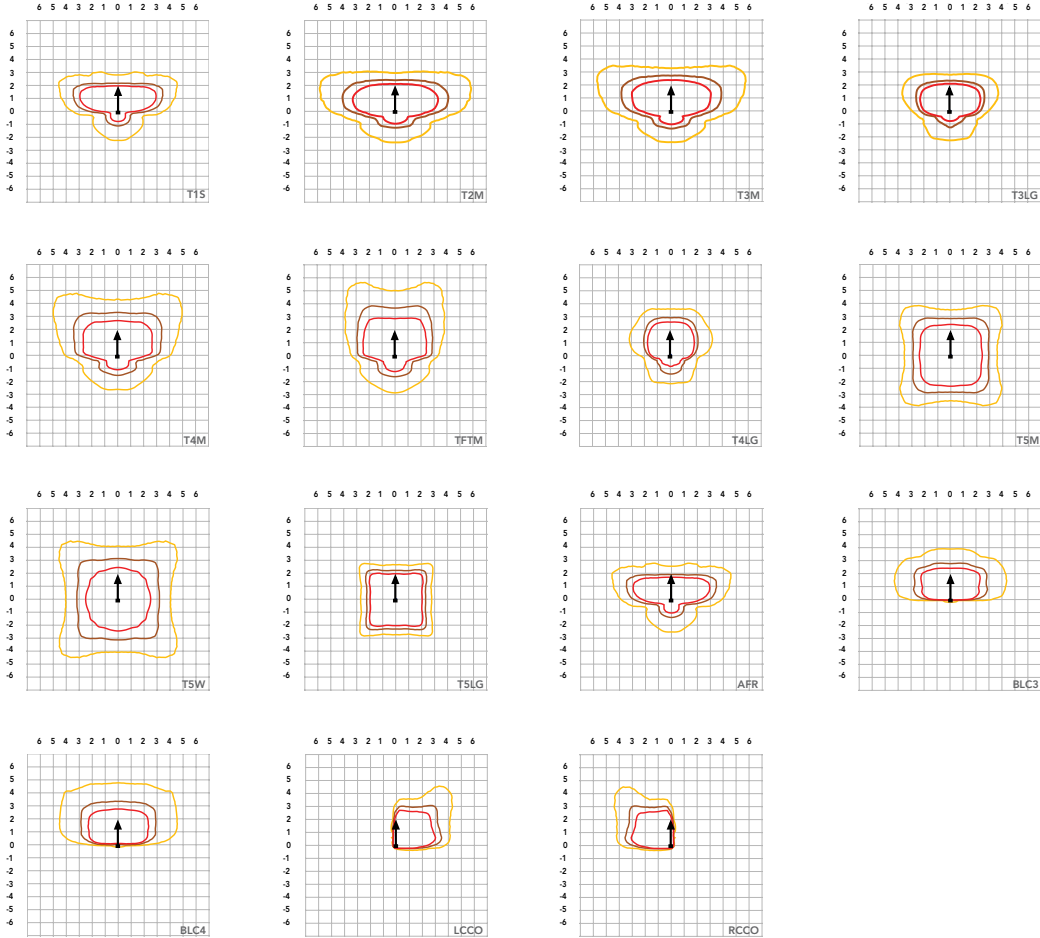
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Photometric Diagrams

To see complete photometric reports or download .ies files for this product, visit Lithonia Lighting's [homepage](#).

Isofootcandle plots for the DSX0 LED P7 40K 70CRI. Distances are in units of mounting height (20').

LEGEND  
■ 0.1 fc  
■ 0.5 fc  
■ 1.0 fc



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## Performance Data

### Lumen Ambient Temperature (LAT) Multipliers

Use these factors to determine relative lumen output for average ambient temperatures from 0-40°C (32-104°F).

Ambient		Lumen Multiplier
0°C	32°F	1.04
5°C	41°F	1.04
10°C	50°F	1.03
15°C	59°F	1.02
20°C	68°F	1.01
<b>25°C</b>	<b>77°F</b>	<b>1.00</b>
30°C	86°F	0.99
35°C	95°F	0.98
40°C	104°F	0.97

### Projected LED Lumen Maintenance

Data references the extrapolated performance projections for the platforms noted in a **25°C ambient**, based on 10,000 hours of LED testing (tested per IESNA LM-80-08 and projected per IESNA TM-21-11).

To calculate LLF, use the lumen maintenance factor that corresponds to the desired number of operating hours below. For other lumen maintenance values, contact factory.

Operating Hours	Lumen Maintenance Factor
0	1.00
25,000	0.94
50,000	0.89
100,000	0.80

### Electrical Load

	Performance Package	LED Count	Drive Current (mA)	Wattage	Current (A)					
					120V	208V	240V	277V	347V	480V
Forward Optics (Non-Rotated)	P1	20	530	34	0.28	0.16	0.14	0.12	0.10	0.07
	P2	20	700	45	0.38	0.22	0.19	0.16	0.13	0.09
	P3	20	1050	69	0.57	0.33	0.29	0.25	0.20	0.14
	P4	20	1400	94	0.78	0.45	0.39	0.34	0.27	0.19
	P5	40	700	89	0.75	0.43	0.38	0.33	0.26	0.19
	P6	40	1050	136	1.14	0.66	0.57	0.49	0.39	0.29
	P7	40	1300	170	1.42	0.82	0.71	0.62	0.49	0.36
Rotated Optics (Requires L90 or R90)	P10	30	530	51	0.42	0.24	0.21	0.18	0.15	0.11
	P11	30	700	67	0.57	0.33	0.28	0.25	0.20	0.14
	P12	30	1050	103	0.86	0.50	0.43	0.37	0.30	0.22
	P13	30	1300	129	1.07	0.62	0.54	0.46	0.37	0.27

### Motion Sensor Default Settings

Option	Unoccupied Dimmed Level	High Level (when occupied)	Photocell Operation	Dwell Time	Ramp-up Time	Dimming Fade Rate
PIR	30%	100%	Enabled @ 2FC	7.5 min	3 sec	5 min
NLTAIR2 PIRHN	30%	100%	Enabled @ 2FC	7.5 min	3 sec	5 min

### Controls Options

Nomenclature	Description	Functionality	Primary control device	Notes
FAO	Field adjustable output device installed inside the luminaire; wired to the driver dimming leads.	Allows the luminaire to be manually dimmed, effectively trimming the light output.	FAO device	Cannot be used with other controls options that need the 0-10V leads
DS (not available on DSX0)	Drivers wired independently for 50/50 luminaire operation	The luminaire is wired to two separate circuits, allowing for 50/50 operation.	Independently wired drivers	Requires two separately switched circuits. Consider nLight AIR as a more cost effective alternative.
PER5 or PER7	Twist-lock photocell receptacle	Compatible with standard twist-lock photocells for dusk to dawn operation, or advanced control nodes that provide 0-10V dimming signals.	Twist-lock photocells such as DLL Elite or advanced control nodes such as ROAM.	Pins 4 & 5 to dimming leads on driver, Pins 6 & 7 are capped inside luminaire. Cannot be used with other controls options that need the 0-10V leads.
PIR	Motion sensor with integral photocell. PIR covers 8-40' mounting.	Luminaires dim when no occupancy is detected.	Acuity Controls r5BG	Cannot be used with other controls options that need the 0-10V leads.
NLTAIR2 PIRHN	nLight AIR enabled luminaire for motion sensing, photocell and wireless communication. PIRHN covers 8' to 40' mounting	Motion and ambient light sensing with group response. Scheduled dimming with motion sensor over-ride when wirelessly connected to the nLight Eclipse.	nLight Air r5BG	nLight AIR sensors can be programmed and commissioned from the ground using the CLAIRity Pro app. Cannot be used with other controls options that need the 0-10V leads.
BL30 or BL50	Integrated bi-level device that allows a second control circuit to switch all light engines to either 30% or 50% light output	BLC device provides input to 0-10V dimming leads on all drivers providing either 100% or dimmed (30% or 50%) control by a secondary circuit	BLC UVOLT1	BLC device is powered off the 0-10V dimming leads, thus can be used with any input voltage from 120 to 480V



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## Performance Data

### Lumen Output

Lumen values are from photometric tests performed in accordance with IESNA LM-79-08. Data is considered to be representative of configurations shown within the tolerances described within LM-79. Contact factory for performance data on any configurations not shown here.

Forward Optics																							
LED Count	Drive Current (mA)	Performance Package	System Watts	Distribution Type	30K (3000K, 70 CRI)					40K (4000K, 70 CRI)					50K (5000K, 70 CRI)								
					Lumens	B	U	G	LPW	Lumens	B	U	G	LPW	Lumens	B	U	G	LPW				
20	530	P1	33W	TIS	4,906	1	0	1	148	5,113	1	0	1	154	5,213	1	0	1	157				
				T2M	4,545	1	0	2	137	4,736	1	0	2	143	4,829	1	0	2	145				
				T3M	4,597	1	0	2	138	4,791	1	0	2	144	4,885	1	0	2	147				
				T3LG	4,107	1	0	1	124	4,280	1	0	1	129	4,363	1	0	1	131				
				T4M	4,666	1	0	2	141	4,863	1	0	2	146	4,957	1	0	2	149				
				T4LG	4,244	1	0	1	128	4,423	1	0	1	133	4,509	1	0	1	136				
				TFIM	4,698	1	0	2	141	4,896	1	0	2	147	4,992	1	0	2	150				
				T5M	4,801	3	0	1	145	5,003	3	0	1	151	5,101	3	0	1	154				
				T5W	4,878	3	0	1	147	5,084	3	0	2	153	5,183	3	0	2	156				
				TSLG	4,814	2	0	1	145	5,018	2	0	1	151	5,115	2	0	1	154				
				BLC3	3,344	0	0	1	101	3,485	0	0	1	105	3,553	0	0	1	107				
				BLC4	3,454	0	0	2	104	3,599	0	0	2	108	3,670	0	0	2	111				
				RCCO	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---			
				LCCO	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---			
				AFR	4,906	1	0	1	148	5,113	1	0	1	154	5,213	1	0	1	157				
				20	700	P2	45W	TIS	6,328	1	0	1	140	6,595	1	0	1	146	6,724	1	0	1	149
								T2M	5,862	1	0	2	130	6,109	1	0	2	135	6,228	1	0	2	138
								T3M	5,930	1	0	3	131	6,180	1	0	3	137	6,301	1	0	3	140
T3LG	5,297	1	0					1	117	5,521	1	0	1	122	5,628	1	0	1	125				
T4M	6,018	1	0					3	133	6,272	1	0	3	139	6,395	1	0	3	142				
T4LG	5,474	1	0					1	121	5,705	1	0	1	126	5,816	1	0	1	129				
TFIM	6,060	1	0					3	134	6,316	1	0	3	140	6,439	1	0	3	143				
T5M	6,192	3	0					1	137	6,453	3	0	2	143	6,579	3	0	2	146				
T5W	6,293	3	0					2	139	6,558	3	0	2	145	6,686	3	0	2	148				
TSLG	6,210	2	0					1	138	6,472	3	0	1	143	6,598	3	0	1	146				
BLC3	4,313	0	0					2	96	4,495	0	0	2	100	4,583	0	0	2	102				
BLC4	4,455	0	0					2	99	4,643	0	0	2	103	4,733	0	0	2	105				
RCCO	---	---	---					---	---	---	---	---	---	---	---	---	---	---	---	---			
LCCO	---	---	---					---	---	---	---	---	---	---	---	---	---	---	---	---			
AFR	6,328	1	0					1	140	6,595	1	0	1	146	6,724	1	0	1	149				
20	1050	P3	69W					TIS	9,006	1	0	2	131	9,386	1	0	2	136	9,569	1	0	2	139
								T2M	8,343	2	0	3	121	8,694	2	0	3	126	8,864	2	0	3	129
								T3M	8,439	2	0	3	122	8,795	2	0	3	128	8,967	2	0	3	130
				T3LG	7,539	1	0	2	109	7,857	1	0	2	114	8,010	1	0	2	116				
				T4M	8,565	2	0	3	124	8,926	2	0	3	129	9,100	2	0	3	132				
				T4LG	7,790	1	0	2	113	8,119	1	0	2	118	8,277	1	0	2	120				
				TFIM	8,624	1	0	3	125	8,988	1	0	3	130	9,163	2	0	3	133				
				T5M	8,812	3	0	2	128	9,184	4	0	2	133	9,363	4	0	2	136				
				T5W	8,955	4	0	2	130	9,333	4	0	2	135	9,515	4	0	2	138				
				TSLG	8,838	3	0	1	128	9,211	3	0	1	134	9,390	3	0	1	136				
				BLC3	6,139	0	0	2	89	6,398	0	0	2	93	6,522	0	0	2	95				
				BLC4	6,340	0	0	3	92	6,607	0	0	3	96	6,736	0	0	3	98				
				RCCO	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---			
				LCCO	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---			
				AFR	9,006	1	0	2	131	9,386	1	0	2	136	9,569	1	0	2	139				
				20	1400	P4	93W	TIS	11,396	1	0	2	122	11,877	1	0	2	128	12,109	2	0	2	130
								T2M	10,557	2	0	3	113	11,003	2	0	3	118	11,217	2	0	3	121
								T3M	10,680	2	0	3	115	11,130	2	0	3	120	11,347	2	0	3	122
T3LG	9,540	1	0					2	103	9,942	1	0	2	107	10,136	1	0	2	109				
T4M	10,839	2	0					3	117	11,296	2	0	3	121	11,516	2	0	4	124				
T4LG	9,858	1	0					2	106	10,274	1	0	2	110	10,474	1	0	2	113				
TFIM	10,914	2	0					3	117	11,374	2	0	3	122	11,596	2	0	3	125				
T5M	11,152	4	0					2	120	11,622	4	0	2	125	11,849	4	0	2	127				
T5W	11,332	4	0					3	122	11,811	4	0	3	127	12,041	4	0	3	129				
TSLG	11,184	3	0					1	120	11,656	3	0	2	125	11,883	3	0	2	128				
BLC3	7,768	0	0					2	83	8,096	0	0	2	87	8,254	0	0	2	89				
BLC4	8,023	0	0					3	86	8,362	0	0	3	90	8,524	0	0	3	92				
RCCO	---	---	---					---	---	---	---	---	---	---	---	---	---	---	---	---			
LCCO	---	---	---					---	---	---	---	---	---	---	---	---	---	---	---	---			
AFR	11,396	1	0					2	122	11,877	1	0	2	128	12,109	2	0	2	130				



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# Performance Data

## Lumen Output

Lumen values are from photometric tests performed in accordance with IESNA LM-79-08. Data is considered to be representative of configurations shown within the tolerances described within LM-79. Contact factory for performance data on any configurations not shown here.

Forward Optics																							
LED Count	Drive Current (mA)	Performance Package	System Watts	Distribution Type	30K (3000K, 70 CRI)					40K (4000K, 70 CRI)					50K (5000K, 70 CRI)								
					Lumens	B	U	G	LPW	Lumens	B	U	G	LPW	Lumens	B	U	G	LPW				
40	700	P5	90W	T1S	12,380	2	0	2	137	12,902	2	0	2	143	13,154	2	0	2	146				
				T2M	11,468	2	0	3	127	11,952	2	0	3	133	12,185	2	0	3	135				
				T3M	11,601	2	0	3	129	12,091	2	0	3	134	12,326	2	0	4	137				
				T3LG	10,363	2	0	2	115	10,800	2	0	2	120	11,011	2	0	2	122				
				T4M	11,774	2	0	4	131	12,271	2	0	4	136	12,510	2	0	4	139				
				T4LG	10,709	1	0	2	119	11,160	2	0	2	124	11,378	2	0	2	126				
				TFTM	11,856	2	0	3	132	12,356	2	0	4	137	12,596	2	0	4	140				
				T5M	12,114	4	0	2	134	12,625	4	0	2	140	12,871	4	0	2	143				
				TSW	12,310	4	0	3	137	12,830	4	0	3	142	13,080	4	0	3	145				
				TSLG	12,149	3	0	2	135	12,662	3	0	2	141	12,908	3	0	2	143				
				BLC3	8,438	0	0	2	94	8,794	0	0	2	98	8,966	0	0	2	99				
				BLC4	8,715	0	0	3	97	9,083	0	0	3	101	9,260	0	0	3	103				
				RCCO	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
				LCCO	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
				AFR	12,380	2	0	2	137	12,902	2	0	2	143	13,154	2	0	2	146				
				40	1050	P6	137W	T1S	17,545	2	0	3	128	18,285	2	0	3	133	18,642	2	0	3	136
								T2M	16,253	3	0	4	119	16,939	3	0	4	124	17,269	3	0	4	126
								T3M	16,442	2	0	4	120	17,135	3	0	4	125	17,469	3	0	4	128
T3LG	14,687	2	0					2	107	15,306	2	0	2	112	15,605	2	0	2	114				
T4M	16,687	2	0					4	122	17,391	3	0	5	127	17,730	3	0	5	129				
T4LG	15,177	2	0					2	111	15,817	2	0	2	115	16,125	2	0	2	118				
TFTM	16,802	2	0					4	123	17,511	2	0	4	128	17,852	2	0	5	130				
T5M	17,168	4	0					2	125	17,893	5	0	3	131	18,241	5	0	3	133				
TSW	17,447	5	0					3	127	18,183	5	0	3	133	18,537	5	0	3	135				
TSLG	17,218	4	0					2	126	17,944	4	0	2	131	18,294	4	0	2	134				
BLC3	11,959	0	0					3	87	12,464	0	0	3	91	12,707	0	0	3	93				
BLC4	12,352	0	0					4	90	12,873	0	0	4	94	13,124	0	0	4	96				
RCCO	---	---	---					---	---	---	---	---	---	---	---	---	---	---	---	---	---		
LCCO	---	---	---					---	---	---	---	---	---	---	---	---	---	---	---	---	---		
AFR	17,545	2	0					3	128	18,285	2	0	3	133	18,642	2	0	3	136				
40	1300	P7	171W					T1S	20,806	2	0	3	122	21,683	2	0	3	127	22,106	2	0	3	129
								T2M	19,273	3	0	4	113	20,086	3	0	4	118	20,478	3	0	4	120
								T3M	19,497	3	0	5	114	20,319	3	0	5	119	20,715	3	0	5	121
				T3LG	17,416	2	0	2	102	18,151	2	0	2	106	18,504	2	0	2	108				
				T4M	19,787	3	0	5	116	20,622	3	0	5	121	21,024	3	0	5	123				
				T4LG	17,997	2	0	2	105	18,756	2	0	2	110	19,121	2	0	2	112				
				TFTM	19,924	3	0	5	117	20,765	3	0	5	122	21,170	3	0	5	124				
				T5M	20,359	5	0	3	119	21,217	5	0	3	124	21,631	5	0	3	127				
				TSW	20,689	5	0	3	121	21,561	5	0	3	126	21,982	5	0	3	129				
				TSLG	20,418	4	0	2	120	21,279	4	0	2	125	21,694	4	0	2	127				
				BLC3	14,182	0	0	3	83	14,780	0	0	3	87	15,068	0	0	3	88				
				BLC4	14,647	0	0	4	86	15,265	0	0	4	89	15,562	0	0	4	91				
				RCCO	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
				LCCO	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
				AFR	20,806	2	0	3	122	21,683	2	0	3	127	22,106	2	0	3	129				



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## Performance Data

### Lumen Output

Lumen values are from photometric tests performed in accordance with IESNA LM-79-08. Data is considered to be representative of configurations shown within the tolerances described within LM-79. Contact factory for performance data on any configurations not shown here.

Rotated Optics																							
LED Count	Drive Current (mA)	Performance Package	System Watts	Distribution Type	30K (3000K, 70 CRI)					40K (4000K, 70 CRI)					50K (5000K, 70 CRI)								
					Lumens	B	U	G	LPW	Lumens	B	U	G	LPW	Lumens	B	U	G	LPW				
30	530	P10	51W	T1S	7,399	3	0	3	145	7,711	3	0	3	151	7,862	3	0	3	154				
				T2M	6,854	3	0	3	135	7,144	3	0	3	140	7,283	3	0	3	143				
				T3M	6,933	3	0	3	136	7,225	3	0	3	142	7,366	3	0	3	145				
				T3LG	6,194	2	0	2	122	6,455	2	0	2	127	6,581	2	0	2	129				
				T4M	7,036	3	0	3	138	7,333	3	0	3	144	7,476	3	0	3	147				
				T4LG	6,399	2	0	2	126	6,669	2	0	2	131	6,799	2	0	2	134				
				TF1M	7,086	3	0	3	139	7,385	3	0	3	145	7,529	3	0	3	148				
				T5M	7,239	3	0	2	142	7,545	3	0	2	148	7,692	3	0	2	151				
				TSW	7,357	3	0	2	145	7,667	3	0	2	151	7,816	4	0	2	154				
				TS1G	7,260	3	0	1	143	7,567	3	0	1	149	7,714	3	0	1	152				
				BLC3	5,043	3	0	3	99	5,256	3	0	3	103	5,358	3	0	3	105				
				BLC4	5,208	3	0	3	102	5,428	3	0	3	107	5,534	3	0	3	109				
				RCCO	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
				LCCO	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
				AFR	7,399	3	0	3	145	7,711	3	0	3	151	7,862	3	0	3	154				
				30	700	P11	68W	T1S	9,358	3	0	3	138	9,753	3	0	3	143	9,943	3	0	3	146
								T2M	8,669	3	0	3	127	9,034	3	0	3	133	9,211	3	0	3	135
T3M	8,768	3	0					3	129	9,138	3	0	3	134	9,316	3	0	3	137				
T3LG	7,833	3	0					3	115	8,164	3	0	3	120	8,323	3	0	3	122				
T4M	8,899	3	0					3	131	9,274	3	0	3	136	9,455	3	0	3	139				
T4LG	8,093	3	0					3	119	8,435	3	0	3	124	8,599	3	0	3	126				
TF1M	8,962	3	0					3	132	9,340	3	0	3	137	9,522	3	0	3	140				
T5M	9,156	4	0					2	135	9,542	4	0	2	140	9,728	4	0	2	143				
TSW	9,304	4	0					2	137	9,696	4	0	2	143	9,885	4	0	2	145				
TS1G	9,182	3	0					1	135	9,569	3	0	1	141	9,756	3	0	1	143				
BLC3	6,378	3	0					3	94	6,647	3	0	3	98	6,777	3	0	3	100				
BLC4	6,587	3	0					3	97	6,865	3	0	3	101	6,999	3	0	3	103				
RCCO	---	---	---					---	---	---	---	---	---	---	---	---	---	---	---	---	---		
LCCO	---	---	---					---	---	---	---	---	---	---	---	---	---	---	---	---	---		
AFR	9,358	3	0					3	138	9,753	3	0	3	143	9,943	3	0	3	146				
30	1050	P12	103W					T1S	13,247	3	0	3	128	13,806	3	0	3	134	14,075	3	0	3	136
								T2M	12,271	4	0	4	119	12,789	4	0	4	124	13,038	4	0	4	126
				T3M	12,412	4	0	4	120	12,935	4	0	4	125	13,187	4	0	4	128				
				T3LG	11,089	3	0	3	107	11,556	3	0	3	112	11,782	3	0	3	114				
				T4M	12,597	4	0	4	122	13,128	4	0	4	127	13,384	4	0	4	129				
				T4LG	11,457	3	0	3	111	11,940	3	0	3	116	12,173	3	0	3	118				
				TF1M	12,686	4	0	4	123	13,221	4	0	4	128	13,479	4	0	4	130				
				T5M	12,960	4	0	2	125	13,507	4	0	2	131	13,770	4	0	2	133				
				TSW	13,170	4	0	3	127	13,726	4	0	3	133	13,994	4	0	3	135				
				TS1G	12,998	3	0	2	126	13,546	3	0	2	131	13,810	3	0	2	134				
				BLC3	9,029	3	0	3	87	9,409	3	0	3	91	9,593	3	0	3	93				
				BLC4	9,324	4	0	4	90	9,718	4	0	4	94	9,907	4	0	4	96				
				RCCO	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
				LCCO	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
				AFR	13,247	3	0	3	128	13,806	3	0	3	134	14,075	3	0	3	136				
				30	1300	P13	129W	T1S	15,704	3	0	3	122	16,366	3	0	3	127	16,685	4	0	4	130
								T2M	14,547	4	0	4	113	15,161	4	0	4	118	15,457	4	0	4	120
T3M	14,714	4	0					4	114	15,335	4	0	4	119	15,634	4	0	4	121				
T3LG	13,145	3	0					3	102	13,700	3	0	3	106	13,967	3	0	3	108				
T4M	14,933	4	0					4	116	15,563	4	0	4	121	15,867	4	0	4	123				
T4LG	13,582	3	0					3	105	14,155	3	0	3	110	14,431	3	0	3	112				
TF1M	15,039	4	0					4	117	15,673	4	0	4	122	15,979	4	0	4	124				
T5M	15,364	4	0					2	119	16,013	4	0	2	124	16,325	4	0	2	127				
TSW	15,613	5	0					3	121	16,272	5	0	3	126	16,589	5	0	3	129				
TS1G	15,409	3	0					2	120	16,059	3	0	2	125	16,372	4	0	2	127				
BLC3	10,703	4	0					4	83	11,155	4	0	4	87	11,372	4	0	4	88				
BLC4	11,054	4	0					4	86	11,520	4	0	4	89	11,745	4	0	4	91				
RCCO	---	---	---					---	---	---	---	---	---	---	---	---	---	---	---	---	---		
LCCO	---	---	---					---	---	---	---	---	---	---	---	---	---	---	---	---	---		
AFR	15,704	3	0					3	122	16,366	3	0	3	127	16,685	4	0	4	130				



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## FEATURES & SPECIFICATIONS

### INTENDED USE

The sleek design of the D-Series Size 0 reflects the embedded high performance LED technology. It is ideal for many commercial and municipal applications, such as parking lots, plazas, campuses, and pedestrian areas.

### CONSTRUCTION

Single-piece die-cast aluminum housing has integral heat sink fins to optimize thermal management through conductive and convective cooling. Modular design allows for ease of maintenance and future light engine upgrades. The LED driver is mounted in direct contact with the casting to promote low operating temperature and long life. Housing driver compartment is completely sealed against moisture and environmental contaminants (IP66). Low EPA (0.95 ft<sup>2</sup>) for optimized pole wind loading.

### FINISH

Exterior parts are protected by a zinc-infused Super Durable TGIC thermostat powder coat finish that provides superior resistance to corrosion and weathering. A tightly controlled multi-stage process ensures a minimum 3 mils thickness for a finish that can withstand extreme climate changes without cracking or peeling. Available in both textured and non-textured finishes.

### COASTAL CONSTRUCTION (CCE)

Optional corrosion resistant construction is engineered with added corrosion protection in materials and/or pre-treatment of base material under super durable paint. Provides additional corrosion protection for applications near coastal areas. Finish is salt spray tested to over 5,000 hours per ASTM B117 with scribe rating of 10. Additional lead-times may apply.

### OPTICS

Precision-molded proprietary silicone lenses are engineered for superior area lighting distribution, uniformity, and pole spacing. Light engines are available in 3000 K, 4000 K or 5000 K (70 CRI) configurations. 80CRI configurations are also available. The D-Series Size 0 has zero uplight and qualifies as a Nighttime Friendly™ product, meaning it is consistent with the LEED® and Green Globes™ criteria for eliminating wasteful uplight.

### ELECTRICAL

Light engine(s) configurations consist of high-efficacy LEDs mounted to metal-core circuit boards to maximize heat dissipation and promote long life (up to L80/100,000 hours at 25°C). Fixture ships standard with 0-10V dimming driver. Class 1 electronic drivers are designed to have a power factor >90%, THD <20%, and an expected life of 100,000 hours with <1% failure rate. Easily serviceable 10kV surge protection device meets a minimum Category C Low operation (per ANSI/IEEE C62.41.2).

### STANDARD CONTROLS

The DSX0 LED area luminaire has a number of control options. DSX Size 0, comes standard with 0-10V dimming driver. Dusk to dawn controls can be utilized via optional NEMA twist-lock photocell receptacles. PIR integrated motion sensor with on-board photocell feature field-adjustable programming and are suitable for mounting heights up to 40 feet. Control option BL features a bi-level device that allows a second control circuit to switch all light engines to either 30% or 50% light output.

### nLIGHT AIR CONTROLS

The DSX0 LED area luminaire is also available with nLight® AIR for the ultimate in wireless control. This powerful controls platform provides out-of-the-box basic motion sensing and photocontrol functionality and is suitable for mounting heights up to 40 feet. Once commissioned using a smartphone and the easy-to-use CLAIRITY app, nLight AIR equipped luminaires can be grouped, resulting in motion sensor and photocell group response without the need for additional equipment. Scheduled dimming with motion sensor over-ride can be achieved when used with the nLight Eclipse. Additional information about nLight Air can be found [here](#).

### INSTALLATION

Integral mounting arm allows for fast, easy mounting using Lithonia standard #8 drilling. The standard "SPA" option for square poles and the "RPA" option for round poles offers universal mounting for drillings 2.41" through 3.16". For #5 pole drillings, use SPA5 or RPA5. Additional mountings are available including a wall bracket (WBA) and mast arm (MA) option that allows luminaire attachment to a 2 3/8" horizontal mast arm.

### LISTINGS

UL listed to meet U.S. and Canadian standards. UL Listed for wet locations. Light engines are IP66 rated; luminaire is IP66 rated. Rated for -40°C minimum ambient.

International Dark-Sky Association (IDA) Fixture Seal of Approval (FSA) is available for all products on this page utilizing 3000K color temperature only.

### WARRANTY

5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: [www.acuitybrands.com/support/warranty/terms-and-conditions](http://www.acuitybrands.com/support/warranty/terms-and-conditions)

**Note:** Actual performance may differ as a result of end-user environment and application.

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.



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**Application**

As an individual luminaire with low mounting heights, it can be used for marking danger areas or in rows for illuminating corridors and passageways. With high mounting heights it can be used as a wall luminaire next to doors or for lighting small wall areas.

**Materials**

Luminaire housing constructed of die-cast marine grade, copper free ( $\leq 0.3\%$  copper content) A360.0 aluminum alloy  
 Matte safety glass  
 High temperature silicone gasket  
 Mechanically captive stainless steel fasteners

**NRTL** listed to North American Standards, suitable for wet locations  
 Protection class IP 64  
 Weight: 1.5 lbs

**Electrical**

Operating voltage 120-277VAC  
 Minimum start temperature  $-30^{\circ}\text{C}$   
 LED module wattage 4.2W  
 System wattage 5.8W  
 Controllability 0-10V dimmable  
 Color rendering index  $Ra > 90$   
 Luminaire lumens 362 lumens (3000K)  
 Lifetime at  $Ta = 15^{\circ}\text{C}$   $> 500,000$  h (L70)  
 Lifetime at  $Ta = 35^{\circ}\text{C}$  434,000 h (L70)

**LED color temperature**

- 4000K - Product number + **K4**
- 3500K - Product number + **K35**
- 3000K - Product number + **K3 (EXPRESS)**
- 2700K - Product number + **K27**

**BEGA** can supply you with suitable LED replacement modules for up to 20 years after the purchase of LED luminaires - see website for details

**Finish**

All BEGA standard finishes are matte, textured polyester powder coat with minimum 3 mil thickness.

- Available colors  Black (BLK)  White (WHT)  RAL:  
 Bronze (BRZ)  Silver (SLV)  CUS:

Type:  
 BEGA Product:  
 Project:  
 Modified:



LED wall luminaire - directed light				
	LED	A	B	C
<b>22261</b>	<b>ADA</b> 4.2W	6 7/8	3 3/4	2 3/8



**BEGA** 1000 BEGA Way, Carpinteria, CA 93013 (805) 684-0533 info@bega-us.com

Due to the dynamic nature of lighting products and the associated technologies, luminaire data on this sheet is subject to change at the discretion of BEGA North America. For the most current technical data, please refer to bega-us.com Updated 08/24/18 © copyright BEGA 2018



Bell Auditorium Expansion

Issue for Permit / Bid  
**16 January 2023**

Type:  
**FS12**

#### 4.4 APPENDIX C – LIGHTING CONTROL INTENT DIAGRAM

- A. Contractor shall provide the lighting control system to meet the complete performance descriptions in this Appendix. Provide Manufacturer’s written confirmation that the performance of the control intent diagram has been met or provide sequence of operation for all spaces described in this Appendix during the submittal process. If there are any discrepancies between the performance of the submitted system and the specified system identify these differences and why the specified performance cannot be met.

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**CAMACHO**  
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FACILITY

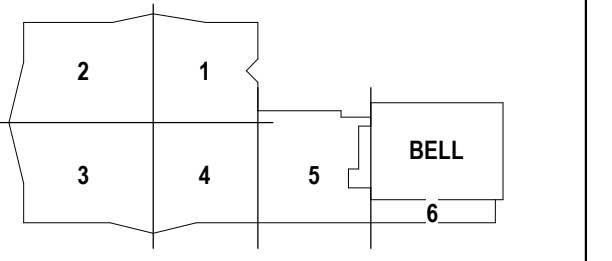
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150 ROUSE BLVD, 3RD FLOOR  
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**KEYPLAN**



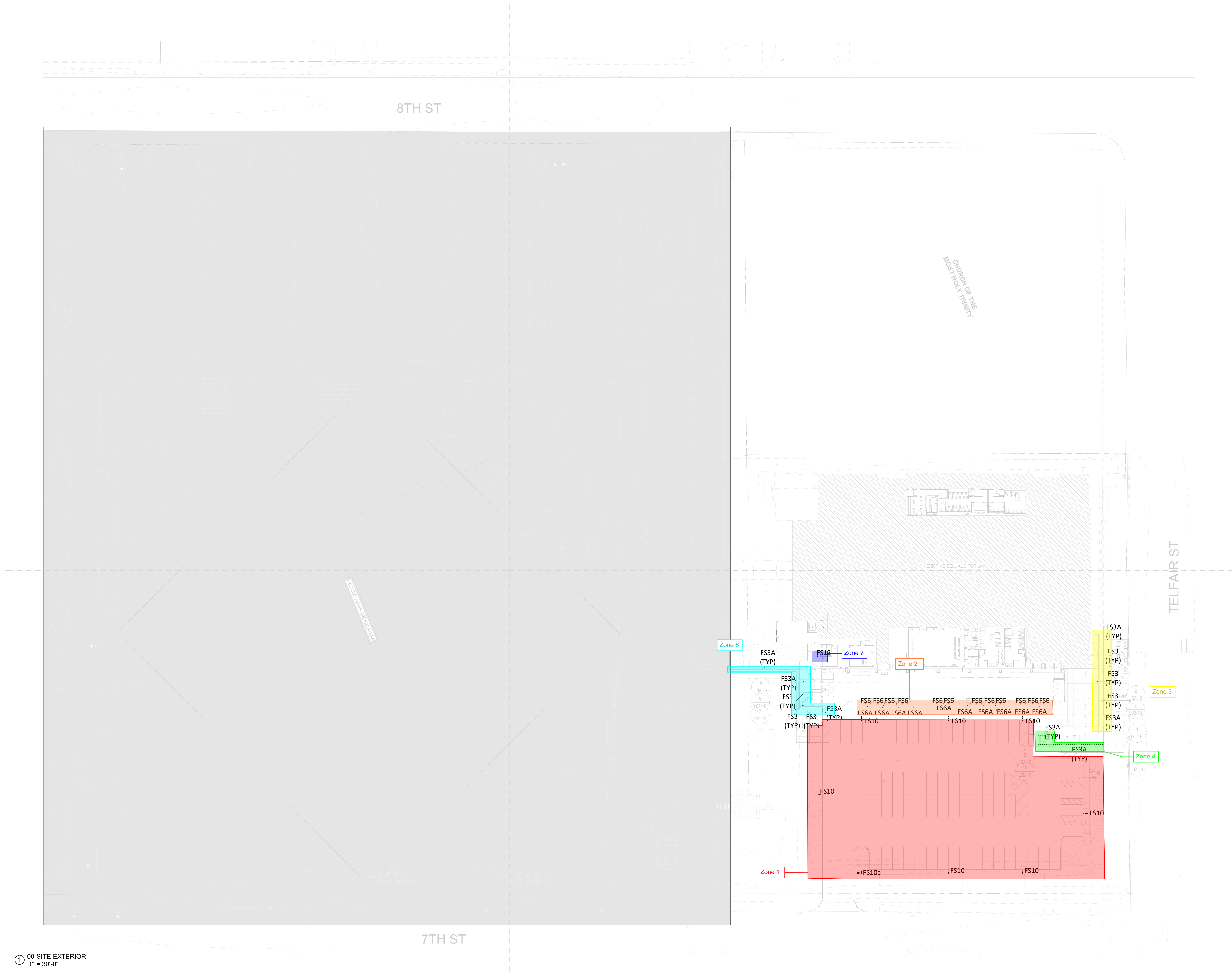
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**SITE LIGHTING PLAN**

**LD10-02**



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① 00-SITE EXTERIOR  
1" = 30'-0"

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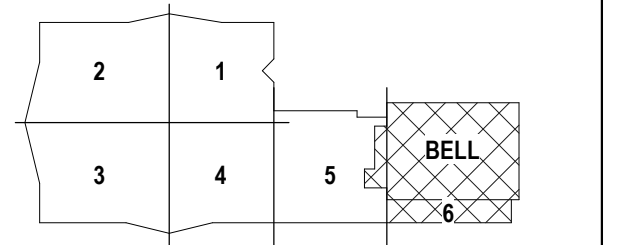
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**ENLARGED LIGHTING  
FLOOR PLAN - SECTOR  
06 - EVENT LEVEL 01**

**LD10-16**

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(1) FB5B LOCATED AT  
TOP AND BOTTOM OF  
BAR WALL

(1) FB5D LOCATED AT  
BACK OF EACH SHELF

① 01-EVENT LEVEL LTG FP - SECTOR 6  
1" = 10'-0"



**CONSULTANTS**

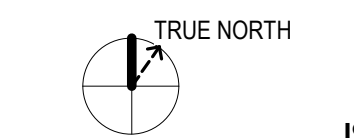
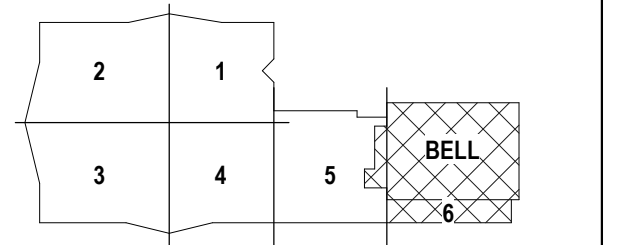
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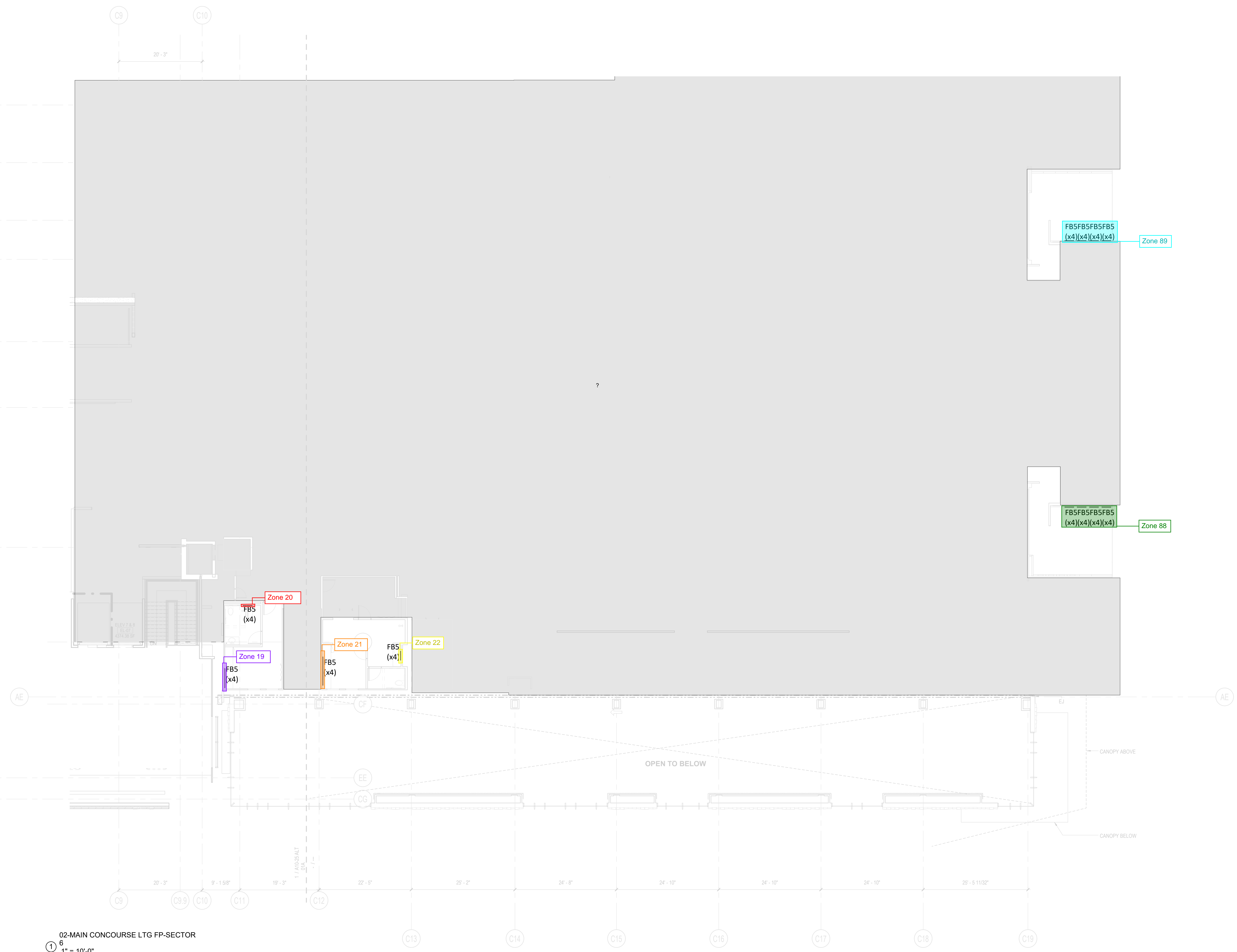
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**ENLARGED LIGHTING  
 FLOOR PLAN- SECTOR 06  
 - MAIN CONCOURSE  
 LEVEL 02**

**LD10-26**



02-MAIN CONCOURSE LTG FP-SECTOR  
 ① 6  
 1" = 10'-0"

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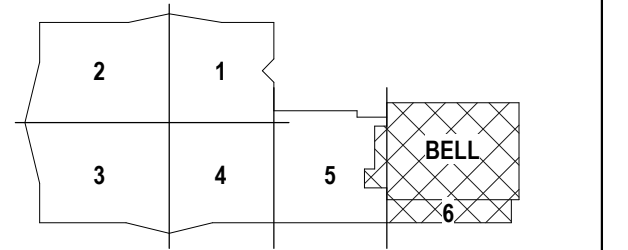
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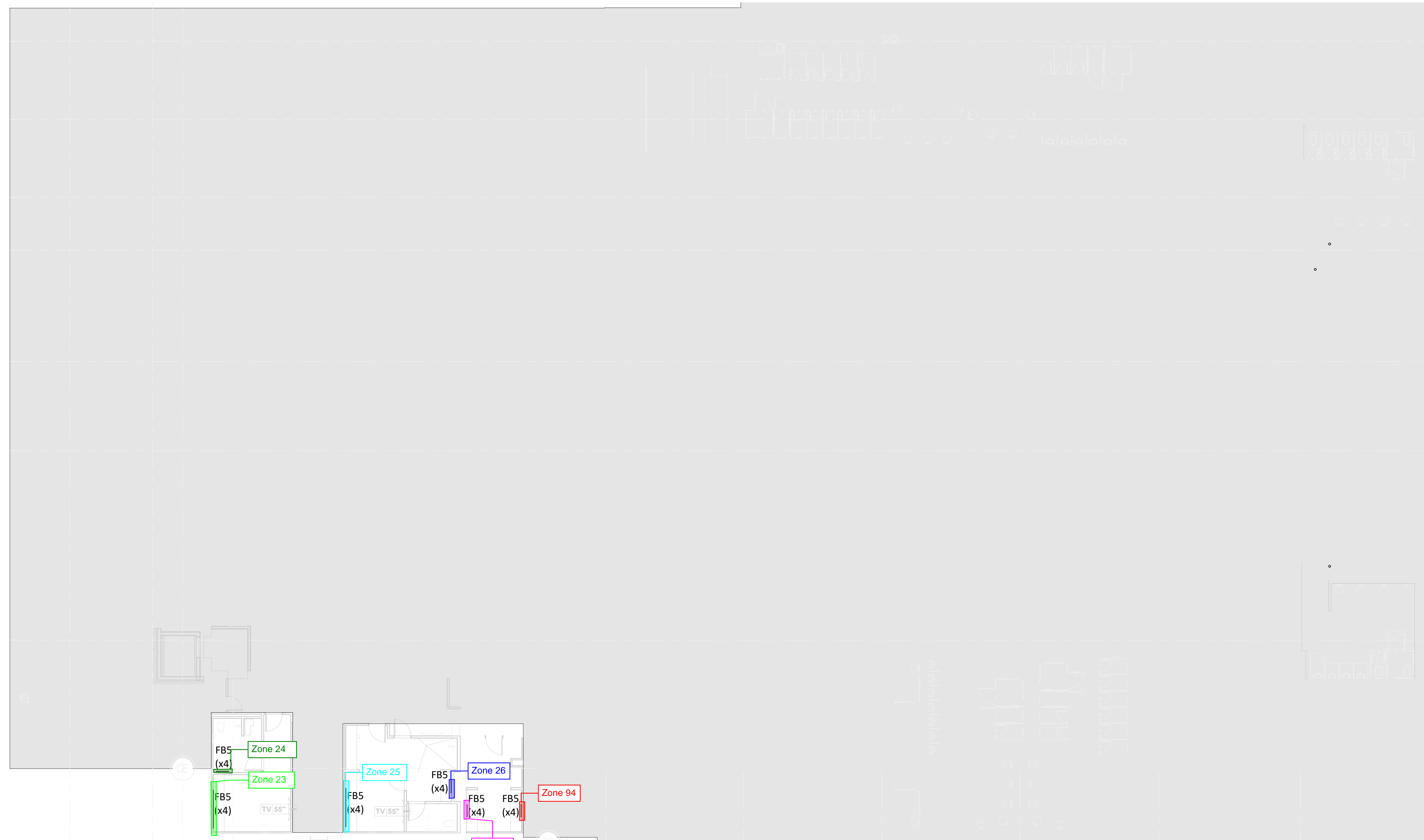
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**ENLARGE LIGHTING  
FLOOR PLAN - SECTOR  
06 - SUITE LEVEL 03**

**LD10-36**



① 03-SUITE LEVEL LTG FP - SECTOR 6  
1" = 10'-0"

**CONSULTANTS**

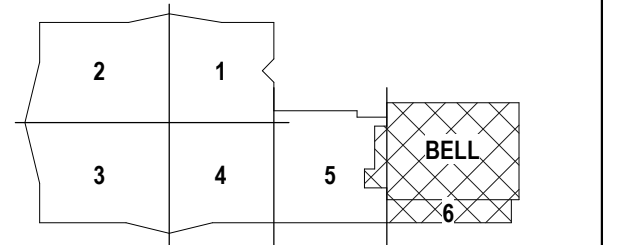
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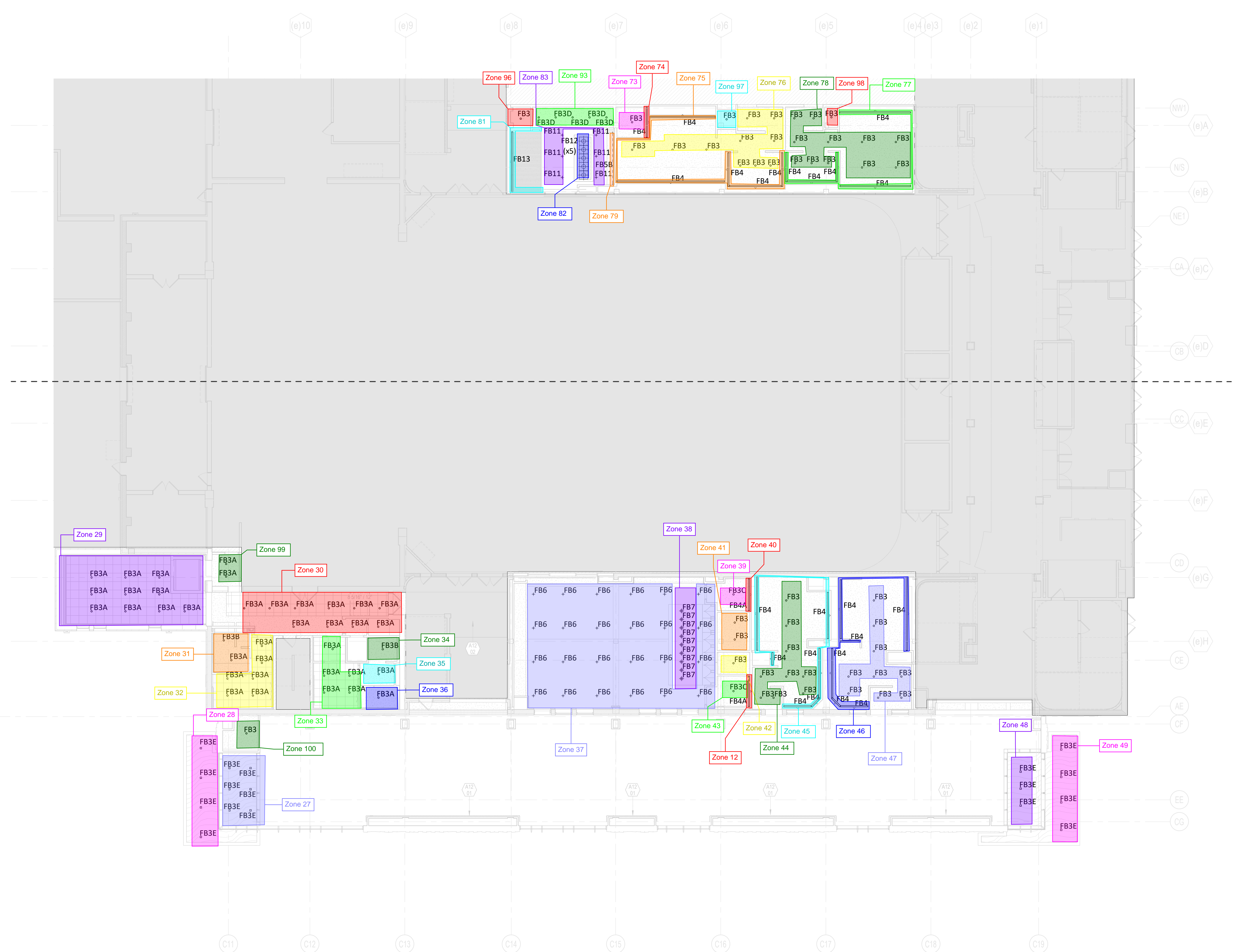


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**ENLARGED LIGHTING  
 REFLECTED CEILING  
 PLAN - SECTOR 06 -  
 EVENT LEVEL 01**

**LD12-16**



01-EVENT LEVEL LTG RCP- SECTOR 6  
 1" = 10'-0"

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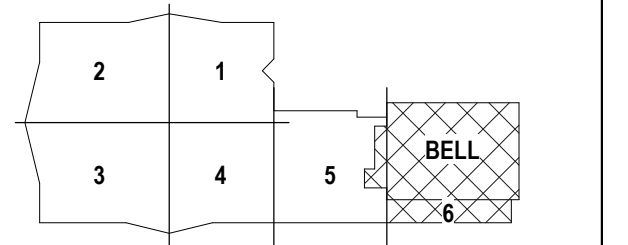
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- RUSSELL SPACE**  
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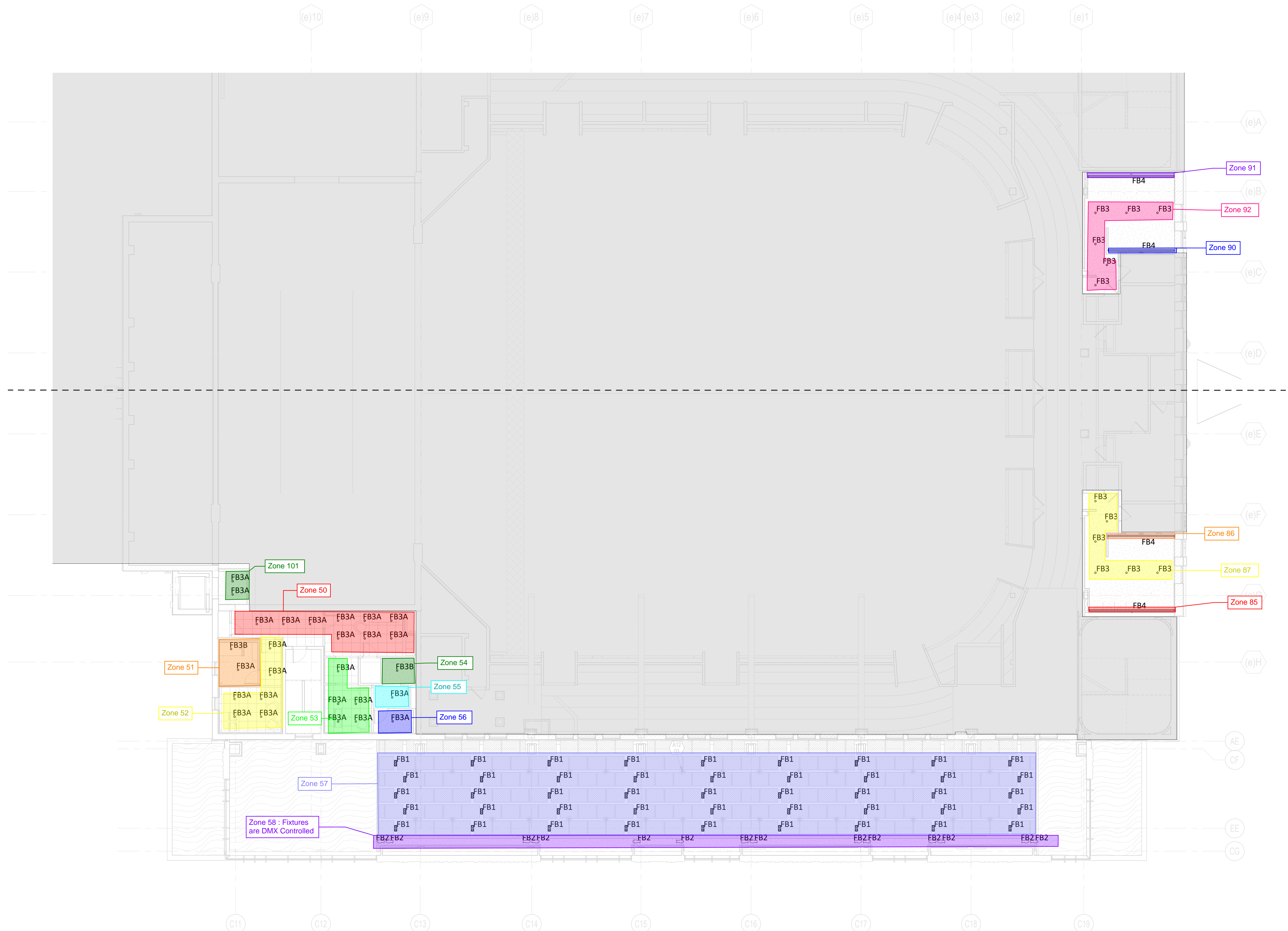


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**ENLARGED LIGHTING  
REFLECTED CEILING  
PLAN - SECTOR 06 - MAIN  
CONCOURSE LEVEL 02**

**LD12-26**



02-MAIN CONCOURSE LTG RCP-  
SECTOR 06  
1" = 10'-0"

**CONSULTANTS**

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**DICKINSON ARCHITECTS**  
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3424 MIDDICOURT ROAD, SUITE 124,  
CARROLTON, TEXAS 75006  
FIRE AND CODE CONSULTANT

**FP&C**  
1330 BURLINGTON ST., SUITE 200, NORTH  
KANSAS CITY, MISSOURI 64116  
LIGHTING DESIGN CONSULTANT

**HLB**  
3455 RINGSBY COURT, SUITE 148,  
DENVER, COLORADO 80216  
OWNER'S REP

**RUSSELLS P A C E**  
171 17th STREET NW SUITE 1600,  
ATLANTA, GEORGIA 30363  
FACILITY

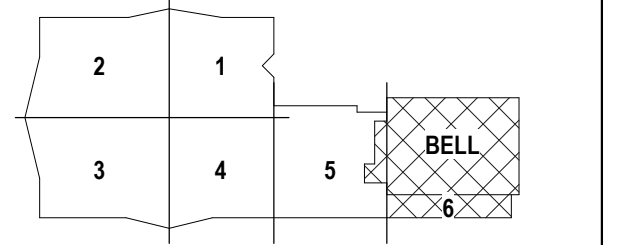
**SPECTRA VENUE MANAGEMENT**  
150 ROUSE BLVD, 3RD FLOOR  
PHILADELPHIA, PENNSYLVANIA 19112



**BELL AUDITORIUM  
EXPANSION &  
RENOVATIONS**  
712 Telfair St, Augusta, GA 30901  
STAMP

ISSUE FOR PERMIT / BID 1.16.2022

**KEYPLAN**



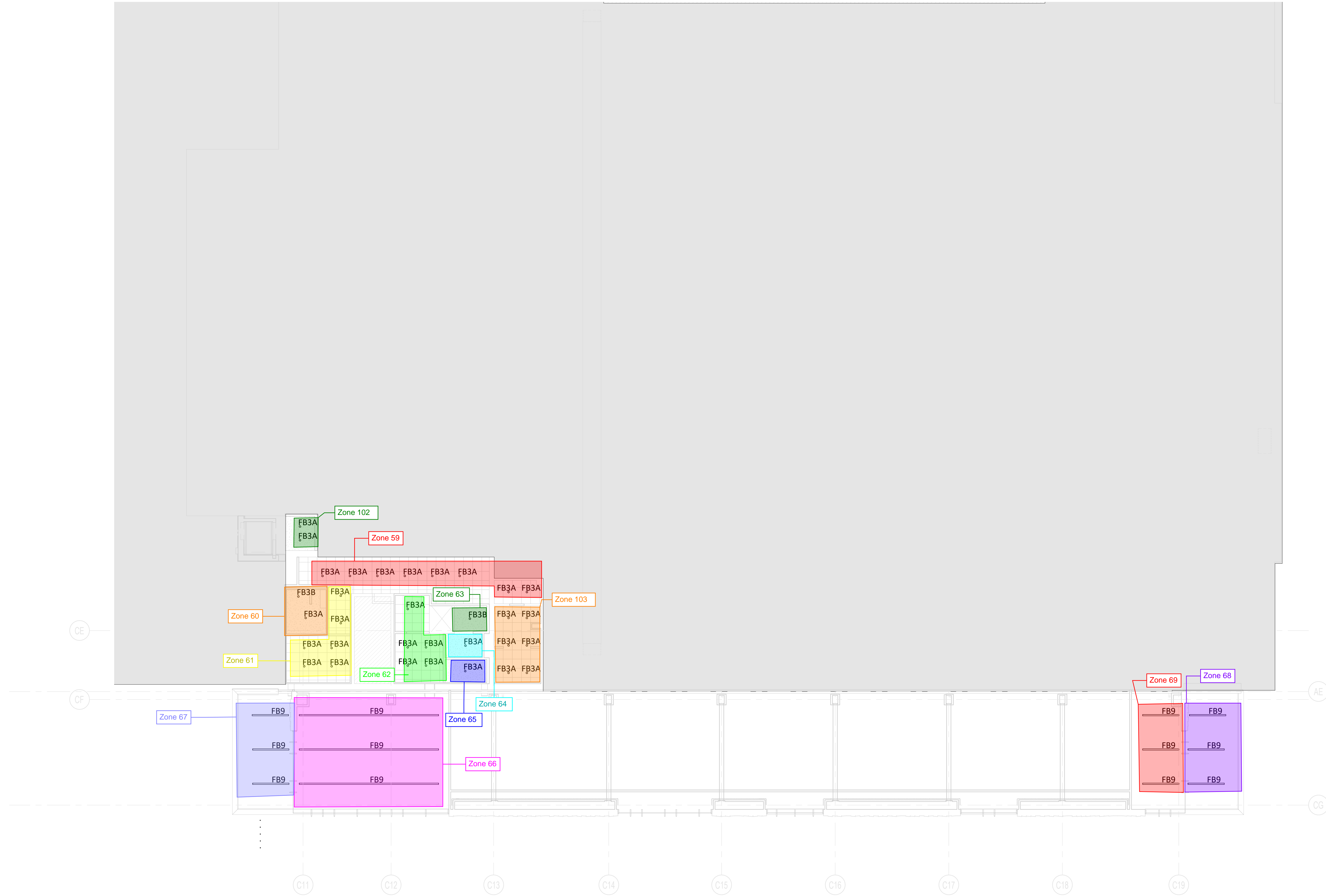
**ISSUE CHART**

Sheet Responsibility Author

100% CONSTRUCTION DOCUMENTS	01/16/23
90% CONSTRUCTION DOCUMENTS	12/19/22
50% CONSTRUCTION DOCUMENTS	10/31/22
ISSUE	DATE
Job Number	222028.00

**ENLARGED LIGHTING  
REFLECTED CEILING  
PLAN - SECTOR 06 -  
SUITE LEVEL 03**

**LD12-36**



① 03-SUITE LEVEL LTG RCP- SECTOR 6  
1" = 10'-0"

**END OF SECTION 26 51 13**

## **SECTION 27 13 43**

### **DISTRIBUTED TELEVISION SYSTEM**

#### **PART 1 - GENERAL**

##### 1.1 SECTION INCLUDES

- A. Work under this Contract includes all labor, supervision, coordination, materials, equipment, installation, tools, inspection, transportation services, commissioning, testing, instruction, and warranties etc., necessary to complete the installation of the HFC Distribution System as described in these specifications and illustrated on the associated drawings.
- B. Also includes:
  - 1. Required licenses and permits including payment of charges and fees.
  - 2. Verification of dimensions and conditions at the job site.
  - 3. Preparation of submittal information.
  - 4. Coordination with other trades.
  - 5. Installation in accordance with the contract documents, manufacturer's recommendations, and in conformity with applicable codes and authority having jurisdiction.
  - 6. Extension of electrical service, including ground, to equipment locations.
  - 7. Installer's commissioning.
  - 8. Initial tests and adjustments, written report and documentation.
  - 9. Instruction of operating personnel and provision of manuals.
  - 10. Maintenance services and warranty.

##### 1.2 REFERENCES

- A. Published specification standards, tests or recommended methods of trade, industry or governmental organizations apply to work in this section were cited below:
  - 1. American National Safety Institute (ANSI).
  - 2. American Society of Testing and Materials (ASTM).
  - 3. Building Industry Consulting Service International (BICSI).
  - 4. BICSI's Telecommunications Distribution Methods Manual (TDMM).
  - 5. Electronics Industries Association (EIA).
  - 6. Federal Communications Commission (FCC).
  - 7. Institute of Electrical and Electronic Engineers (IEEE).
  - 8. National Cable Television Association (NCTA).
  - 9. National Electrical Manufacturer's Association (NEMA).
  - 10. National Electrical Code (NEC).
  - 11. Society of Cable Television Engineers (SCTE).
  - 12. Telecommunications Industries Association (TIA).
  - 13. Underwriters Laboratories (UL).

### 1.3 RESPONSIBILITY AND RELATED WORK

- A. Drawings and general provisions of the Contract, Division 01 Specification Sections, and agreement between Owner and Construction Manager apply to this Section.
- B. Division 16: Electrical Work
  - 1. Power is provided for this work at locations shown on the electrical riser diagram and or other drawings/information in electrical drawings and specifications. Power will be terminated to a panel near the equipment enclosure. Contractor shall be responsible for termination and distribution of electrical power from the panel to the equipment as required.
  - 2. A Ground point will be provided in each equipment room or enclosure electrical panel. Contractor shall be responsible for connecting ground point to all equipment in accordance with NEC Code, local codes and standards specified herein.

### 1.4 DESCRIPTIONS AND REQUIREMENTS

- A. The following is intended to further describe the Work and clarify design intent and is not an exhaustive description of the Television Distribution System. Refer to the Electronic Systems ("AV" series) drawings for further information relating to this Section.
- B. Televisions distribution system to be provided for distribution throughout the renovated areas as indicated on the drawings. Systems will require interconnection with existing cable system and arranged with facility owners.
- C. Provide service to all AV equipment rack locations as shown on drawings.
- D. Determine actual channel selection and assignments during project submittal phase. Coordinate the channel lineup with the owner for a complete and coherent operational interface.
- E. Provide an active forward path 1000 MHz bandwidth, hybrid fiber optic/coaxial cable distribution system, to distribute broadband RF signals within the facility. Provide feeder line from Demarc, and dedicated drop cable scheme for RF signal distribution.
- F. Provide a homerun zone system. Provide spare service ports at each node distribution point. Refer to the documents for spare ports required.
- G. Provide signal level amplification, connectors, cable, hardware, material, and labor as required for drop lines and outlets to locations as specified in drawings. It is anticipated that additional drop service outlets will be added and will be no more than 250 feet from the distribution point. Signal level for additional drops must be configured to be within specified levels. Levels for the system must be adjusted for maximum levels for additional and future outlets. Notify architect of conflicts of signal level when additional drops are placed.
- H. System performance criteria:



1. Digital carrier level: at 499.31 MHz (Channel 70), +5 dBmV  $\pm$  3 dBmV measured at the drop outlet.
  2. Satellite signal criteria: -35 dBmV for DBS receivers measured at the drop service outlet.
  3. Modulation Error Ratio (MER)
    - a. At headend:  $\geq$  40dB
    - b. At drop tap:  $\geq$  32dB
  4. Bit Error Rate (BER)
    - a. At headend:  $\geq 10^9$
    - b. At drop tap:  $\geq 10^7$
  5. Provide signal pads to adjust the drop service outlets levels not to exceed 10 dBmV.
  6. Digital carrier level difference between adjacent channels: less than 1 dB.
  7. Digital carrier level difference between non-adjacent channels: less than 3 dB.
  8. Carrier-to-noise ratio, insofar as it is due to the contribution of noise by the System: greater than 46 dB.
  9. Ratio, after demodulation, between the maximum level of the desired signal and the interference resulting from cross modulation from other signals on the System: greater than 50 dB.
  10. Isolation between spaces: greater than 30 dB. Isolation value of devices separating any two given outlets will be used for the purpose of this calculation as well as the return loss attributed to interconnecting cabling.
  11. Reflections: greater than 40 dB below the respective digital carrier.
  12. Verify visible components of interference do not appear when receivers are tuned to each of the distributed channels.
- I. Provide a forward path fiber optic system (HFC) to distribute Cable TV signals between the Existing DTV cabling and the new telecom/AV rooms located in the West renovation project. Provide a dedicated HFC Node to each AV room to distribute Cable TV signals within the West renovation project from the main DTV Node on the Field Level.
1. All fiber strands are to be terminated, labeled, and tested. All fiber connections are to be Angled Physical Contact (APC) connectors. Connector type is to be consistent from origination to destination without patch points and must be coordinated with the manufacturer of the equipment for fit and style.
  2. Terminate all spare fibers to patch panels located in the DTV headend equipment rack.
  3. Fusion splice breakout fiber cables (pigtails) will be required to allow for cables to be connected to the patch termination boxes in the nodes and at patch panels in the headend while allowing dedicated patch free connections to the HFC transmitter and fiber splitters at the headend and the HFC receivers at the node.
- J. Provide J-Hook pathways for routing television cables and trunk. The J-hooks must be sized for 50% spare capacity after cable calculations for installed cable. The J-hook pathways are to have conduits routed to the pathway from the service

outlets. J-Hook pathways are to be installed on horizontal lines of the building and accessible for service and future additions. Coordination with all trades mounting material above the ceiling is critical. This will include mechanical, plumbing, electrical etc.

1. Provide a minimum spacing of 3' between J-hooks.
  2. At contractors option, wire basket may be provided in lieu of J-hooks, however all conditions, capacities, and routing remains the same as J-hook pathways.
- K. All cable drops and J-Hook pathways are to be concealed from view. Any cable in view of the public must be coordinated with the architect.
- L. Provide the required minimum RG6 quad shield drop cables from the multi-tap at to the appropriate TV outlet. Provide plenum rated cable as required.
- M. Provide termination for all unused multitaps, couplers and splitter ports with a termination resistor.
1. Terminate distribution amplifiers and extenders as recommend by manufacturer.

#### 1.5 RESPONSIBILITY AND RELATED WORK

- A. Coordinate and schedule work with other trades.
- B. Prior to final installation of antenna's conduct an electrical and physical antenna survey after building construction has progressed far enough for reasonably accurate results and prior to installation of antenna. Prior to conducting this survey, submit the methods and means to be employed for approval and do not undertake the survey until such approval is obtained. Conduct survey in compliance with NCTA recommendations and FCC requirements.
- C. Conduit, wireways, wall boxes, pull boxes, junction boxes, sleeves, conduit interconnects between J-Hook pathways and inaccessible ceiling areas and AC power circuits and ground wiring to the HFC Distribution System are specified under the electrical & telecommunications divisions. This does not relieve this Installer from responsibility for a complete working system. Coordination with the Electrical Contractor is required to achieve proper conduit and power systems.
- D. Supply accessories and minor equipment items needed for a complete system, even if not specifically mentioned in these Specifications or on the associated Drawings, without claim for additional payment.
- E. Notwithstanding any detailed information in the Contract Documents, it is the responsibility of this Installer to supply systems in full working order. Notify the Architect of any discrepancies in part numbers or quantities before bid. Failing to provide such notification requires this Installer to supply items and quantities according to the intent of the Specifications and associated Drawings without claim for additional payment.

- F. Obtain permits necessary for the execution of any work pertaining to the installation, or any operation by the Owner including any associated charges or fees.
- G. Execute work in accordance with the National Electrical Code, the National Electrical Safety Code, and applicable State and Local codes, ordinances, and regulations. If a conflict develops between the contract document and the appropriate codes and is reported to the Architect prior to bid opening, the Architect will prepare the necessary clarification. Where a conflict is reported after contract award, propose a resolution of the conflict and, upon approval, perform work.
- H. Coordinate exact location and installation of equipment, power, grounding, and raceway requirements with the Architect.
- I. Provide a separation of at least 18" when running signal cables parallel with electrical power. This will include any power installed in cable trays or conduit. Good engineering practices and field conditions must be taken into consideration when encountering these situations.

#### 1.6 QUALITY ASSURANCE

- A. Contractor's Qualifications: Firm experienced in the provision of systems similar in complexity to those required for this project; and meet the following:
  - 1. No less than three years' experience with equipment and systems of the specified types.
  - 2. Experience with at least three comparable scale projects within the last two years.
  - 3. Be a franchised dealer and service facility for the manufacturer's products furnished.
  - 4. Provide manufacturer-certified installer for passive LAN components. Submit copies of certification.
  - 5. Maintain a fully staffed and equipped service facility.
  - 6. At the request of the Architect, demonstrate that:
    - a. Adequate plant and equipment is available to complete the work.
    - b. Adequate staff with commensurate technical experience is available.
- B. Manufacturer's Qualifications: No less than five years continuous experience in the production of specified types of product. Production per applicable NEMA standards.
- C. Work: Perform Work in compliance with the applicable standards listed herein and governing codes and regulations of the authorities having jurisdiction and the Contract Documents.
  - 1. Drawings and specification requirements govern where they exceed Code and Regulation requirements.
  - 2. Where requirements between governing codes and regulations vary, the more restrictive provision applies.
  - 3. Nothing in the Contract Documents grants authority or permission to disregard or violate any legal requirements.

## 1.7 SUBMITTALS

- A. The submittal information required by the specification is to be presented complete. Cost for the Owner's consultant to review secondary and re-submittals due to the Installer's failure to include required submittal information, or rejection of incomplete or improperly prepared submittal information will be the responsibility of the Contractor.
- B. Provide for approval not later than thirty (30) days after issuance of Notice to Proceed and prior to commencement of Work:
  - 1. A complete schedule of submittals.
  - 2. A chronological schedule of Work in bar chart form. Revise and resubmit schedule as required to reflect construction progress.
- C. Provide for approval no later than sixty (60) days after issuance of notice to proceed and in accordance with previously submitted submittal schedule.
  - 1. Section 1: Complete list of products to be incorporated within the Work.
  - 2. Section 2: Manufacturer's data sheets for each product. Provide original manufacturer's data sheets in order as they appear in the specification. These data sheets are submitted for each product in sufficient detail to facilitate proper evaluation to the products suitability for incorporation within the Work. Television antenna cut sheets may be omitted. If they are included at this time, it is for information purposes only. Television antenna approval will be subject to site survey results.
  - 3. Section 3: Samples of wall plates to include all connector components, blank inserts, sub-chassis, and cover plate,
  - 4. Section 4: Samples of cable types proposed with representative labeling. Each cable sample must have the manufacturers factory printed rating on the jacket of each wire sample.
- D. Provide for approval no later than ninety (90) days after notice to proceed:
  - 1. Provide drawings created with CAD software such as AutoCAD using standard industry graphic standards.
  - 2. Provide installing drawings showing special details depicting methods and means specific to each product, assembly and each product manufacturer's recommended installation methods and means. Provide no less than:
    - a. Antenna farm layout dimensioned at no less than 3/8" scale,
    - b. Headend floor plan with dimensioned equipment rack and elevated wall lining at no less than 3/8" scale, and
    - c. Dimensioned elevation layout of wall lining in distribution amplifier rooms at no less than 3/8" scale.
  - 3. Provide point-to-point schematic drawings detailing inter-component and intra-component, on contractor assembled components or fabricated products, wiring and cabling diagram-depicting cable types, designator, and color codes. Give each component a unique designator and use this designator consistently throughout the project. Provide no less than:

- a. Headend rack layout to include cable routing and cable support.
  - b. Amplifier distribution riser with each television service drop location.
  - c. Node Room locations and layouts.
    - 1) Elevations
    - 2) Termination cabinets.
    - 3) Fiber and coax routing.
    - 4) Demarc locations and layout.
    - 5) Panel & plate details.
4. Provide equipment drawings showing location of equipment in racks, or consoles, with dimensions; wire routing and cabling within housings; AC power outlet and terminal strip locations.
- a. Coordinate with the electrical contractor and provide the designated power circuits servicing the HFC equipment.
5. Inputs and outputs of active components and multi-taps, multi-tap port levels and drop service signal levels for each location. Indicate physical location (e.g., room number, column line, etc.) of each component.
6. Patch Panel Drawings. Provide detailed drawing of patch panel layouts and designation (labeling) strips, including color schemes, connector types etc.
7. Custom Enclosures and Millwork Drawings. Provide full fabrication detail drawings indicating size, material, finish, and openings for equipment.
8. Fabricated Plates and Panels Drawings. Provide complete drawings on custom fabricated plates or panels. Drawings to include dimensioned locations of components, component types, engraving information, plate material and color, and bill of material.
9. Provide representative equipment and cabling labeling scheme. Include font sizes and styles, explanation of scheme, and descriptor and designator schedule.
10. Provide detail drawings depicting any unique installation methods specific to each product.
11. Provide the coordinated channel lineup.
12. Any other pertinent data generated which is necessary to provide the work described in this specification.
- E. Submittal Format:
1. Each submittal shall be bound in a three-ring D style binder sized for 150% of the material with a maximum size being a three-inch spine. Use multiple volumes if necessary.
  2. Provide each submittal with a unique number and be numbered in consecutive order.
  3. Provide each submittal binder with a cover and a spine reflecting the project title and submittal number.
  4. Provide each submittal with a complete table of contents with the following information:
    - a. Project title and number.

- b. Submittal number. In the case of a re-submittal, use the original submittal number immediately followed by the suffix "R" immediately followed by a unique number and be numbered in consecutive order.
  - c. Date of submission.
  - d. Referenced addendum or change-order number as applicable.
  - e. Referenced specification Section, Part, Article, Paragraph, and page number or drawing reference as applicable.
  - f. Index Product Data sheets by manufacturer and model or part number.
5. Separate major grouping with labeled binder tabs.
  6. Each submission page stamped with Contractor's certification stamp, initialed, or signed certifying:
    - a. Review, approval, and acceptance of submission.
    - b. Certification of product compliance to specification.
    - c. Verification product may be incorporated within the work.
  7. Arrange product data list in specification order followed by unspecified product arranged by manufacturer and model or part number. Follow list by manufacturer's data sheets, arranged in the same order. Where a data sheet shows more than one product, indicate the model being proposed with an arrow or other appropriate symbol. Arrows are preferred over highlighters so that documents may be copied by reviewers if required.
  8. Drawings executed at an appropriate scale, not smaller than 3/8"=1'.

F. Submittal Copies:

1. These requirements represent minimum project requirements; a project's general conditions may require additional copies for project distribution.
2. Submit one (1) unbound reproducible drawing set and two (2) bound prints of all drawings. The processed reproducible shall be returned to Contractor. Additional prints will not be reviewed they will be returned un-marked.
3. Submit four binders of bound materials (e.g., product submittals).
4. Submit three copies of product or sample finishes as required within this specification.

G. Electronic Submittals:

1. If electronic files are submitted, they must still be scaled drawings and legible. All electronic submittals must be coordinated with the architect.

H. Resubmission Requirements:

1. Make any requested corrections or change in submittals required. Resubmit for review until no exceptions are taken.
2. Indicate any changes that have been made other than those requested.

## 1.8 PROJECT RECORD MANUAL

- A. Submit three bound original sets (this is a minimum of two for the Owner and one for the Architect's consultant; additional copies may be required by the project's general conditions) after substantial completion and prior to final inspection.
- B. The Project Record Manual shall be segregated into three separate bindings as follows:
  1. Operations Manual:
    - a. Product Data: Product incorporated within the Work:
      - 1) Manufacturer's data for each type of product conforming to the scheme above. The list shall include manufacturer's serial numbers.
      - 2) Each product Owner/Instruction Manual.
      - 3) For custom circuits or modifications, a description of the purpose, capabilities, and operation of each item.
      - 4) Manufacturer's wiring diagram for each type of product incorporated.
      - 5) Separately bound list by manufacturer and model or part number of all products incorporated within the Work arranged in alphanumeric order.
    - b. Record drawings: Final rendition of that specified depicting what is incorporated within the Work.
    - c. Test Reports: Recorded findings of testing specification of this specification.
    - d. System Operation and Instructions: Prepare a complete and typical procedure for the operation of the equipment as a system, organized by subsystem or activity.
      - 1) This procedure should describe the operation of all system capabilities.
      - 2) Assume the intended reader of the manual to be technically experienced but unfamiliar with the components and the facility.
  2. Service & Maintenance Manual:
    - a. Provide an original copy of the service manual on every piece of equipment for which the manufacturer offers a service manual. Arrange manuals in the same order as the operations manual.
    - b. Manufacturer's maintenance and care instructions.
    - c. Maintenance Instructions, including maintenance phone number(s) and hours; maintenance schedule; description of products recommended or provided for maintenance purposes, and instructions for the proper use of these products.
  3. Warranty Manual:
    - a. Manufacturer's warranty statements on each product.
    - b. Date of substantial completion and ending dates for warranties for each group of products.

c. Software registration and licenses.

- C. Include any other pertinent data generated during the Project or required for future service.
  - 1. Appropriately duplicate data within the separate bindings when it will reasonably clarify procedures, e.g., operational data in maintenance binding.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Ship product in its original container, to prevent damaging or entrance of foreign matter.
- B. Handling and shipping in accordance with manufacturer's recommendation.
- C. Provide protective covering during construction, to prevent damaging or entrance of foreign matter.
- D. Replace at no expense to Owner, product damaged during storage, handling, or the course of construction.

1.10 PROJECT CONDITIONS

- A. Verify conditions on the job site applicable to this work. Notify Architect in writing of discrepancies, conflicts, or omissions promptly upon discovery.
- B. The Drawings diagrammatically show cabling and arrangements of equipment fitting the space available without interference. If conditions exist which make it impossible to install work as shown, recommend solutions and/or submit drawings to the Architect for approval, showing how the work may be installed.

1.11 FINAL INSPECTION AND TEST

- A. Upon completion of installation, initial adjustments, tests, and measurements specified in Part 3, and submission and review of the results, a final inspection and test will be observed by the Architect no earlier than two weeks after receipt of the written results.
- B. Provide a minimum of one (1) person for inspection and two (2) persons for testing familiar with aspects of the System to assist the Owner.
- C. The process of testing the System may necessitate moving and adjusting certain components such as antennas or signal processors.
- D. Testing includes operation of each major system and any other components deemed necessary. Perform tests and provide required test equipment, tools and material required to make any necessary repairs, corrections, or adjustments.
- E. The following procedures will be performed on each System:



1. Inspection of the methods and means employed to incorporate the System within the facility.
  2. Verification of proper operation, from controlling devices to controlled devices.
  3. Verification of proper adjustment, balance, and alignment of equipment for optimum quality and to meet the manufacturer's published specifications. Establish and mark normal settings for each level control, and appropriately record these settings within the Record Documents.
  4. Other tests on equipment or systems deemed appropriate.
- F. In the event the need for further adjustment or work becomes evident during testing, the Contractor is to continue his work until the System is acceptable at no addition to the contract price. If approval is delayed because of defective equipment, or failure of equipment or installation to meet the requirements of these specifications and any extension of the inspection and testing period is required, the contract price will be reduced for the additional time and expenses of the Owner, at the standard rate in effect at that time.

#### 1.12 WARRANTY

- A. Warrant labor and product for one (1) year following the date of substantial completion to be free of defects and deficiencies, and to conform to the drawings and specifications as to kind, quality, function, and characteristics. Repair or replace defects occurring in labor or product within the Warranty period without charge.
- B. This warranty is in addition to any specific warranties issued by manufacturers for greater periods of time.
- C. Within the warranty period, answer service calls within eight hours, and correct the deficiency within twenty-four (24) hours.

#### 1.13 INSTRUCTION OF OWNER PERSONNEL

- A. After final completion, provide four (4) hours of instruction to Owner designated personnel on the operation and maintenance of the System. If any component is not operational at the time of testing or training, the vendor shall return to complete the testing or training on the component.
- B. Develop instructional course based on the use of the system and manufacturer's recommendations. Provide a minimum of forty hours of instruction. Arrange course so that operational and maintenance training seminars are separate.
- C. Training Submittals:
  1. All Operations and Maintenance manuals, as well as as-built drawings must be on site for all sessions of training.
  2. Following discussions with Owner, formally submit a Training and Event Attendance submittal two weeks prior to first training. Submittal shall:
    - a. Include a separate page/entry for every training session.

- b. Indicate date, time, and approximate length of training session.
  - c. Indicate person(s) conducting training.
  - d. Indicate whether training will be videotaped.
  - e. Intended curriculum and most appropriate attendees (e.g., engineer, operations, IT, etc.)
  - f. Include signature and title lines for:
    - 1) Owner acknowledging and accepting training schedule. Include both an accepted and rejected box. An alternate schedule time should be suggested by the Owner in the event the schedule is rejected.
    - 2) Countersigning by trainer indicating that training occurred.
    - 3) All persons attending training. Where attendees do not stay for the entire session, this should be noted on the form and initialed by Owner's representative attending training.
    - 4) Owner's representative attending training at the end of the session shall initial that:
      - a) Training Occurred.
      - b) Training Materials were provided and left with owner
      - c) Training was not interrupted or shortened by equipment or system troubleshooting. If it is, then there should be a line where Owner and Contractor can indicate when make-up training will be provided and how long it should be.
      - d) Training was generally sufficient for the proposed curriculum.
  - g. Include Notes section for Owner and Contractor to note any issues during training (areas requiring further development, etc.).
  - h. Following training occurrence, submit completed training records no later than 5 days following end of training. When training is conducted over a period of weeks, completed training submittals shall be consolidated into a single submittal and submitted every 2 weeks.
  - i. Provide all training material on DVD in Adobe PDF format.
- D. System contractor shall be present at the first two (2) uses of the facility. The contractor shall be on site the day before the event in addition to the day of the event.

## **PART 2 - PRODUCTS**

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Model numbers and manufacturers included in this specification are listed to establish a standard of product quality.
- B. Other qualified manufacturers will be considered subject to prior approval of complete technical data, samples, and, if requested, results of independent testing laboratory tests of proposed equipment.

- C. If proposed System includes equipment other than specified model numbers, submit a list of major items and their quantities, with a one-line schematic diagram for review.
- D. Include a list of previously installed projects using proposed equipment that are similar in nature to specified System.

## 2.2 GENERAL

- A. Product: New, free from defects and listed by UL when an applicable UL Standard exists. Provide product of a given type from one manufacturer.
- B. Regardless of the length or completeness of the descriptive paragraph herein, provide product complying with the specified manufacturer's published specifications.
- C. Equipment supply voltage: 120 VAC, 60 Hz.
- D. Equipment temperature limits: 0 to 50 degrees Centigrade.
- E. Provide product not specifically specified commensurate with the quality and standards established by the specified product.

## 2.3 HEADEND

- A. Headend Driver Amplifier (AMP)
  - 1. Provider Headend Driver Amplifier were required to meet performance requirements.
  - 2. Minimum RF Input: +10/+20 dB
  - 3. Gain: 20 dB/30 dB
  - 4. Gain Adjustment: 10 +/- dB in 0.5 dB steps
  - 5. Provide with 2RU 8-position chassis and power supply.
  - 6. Acceptable product:
    - a. ATX N-MAF20FA
    - b. ATX N-MAF30FA
- B. Trunk Fiber Optic Transmitters (FO-TX):
  - 1. Transmitter RF Input: +12 dBmV to +28 dBmV
  - 2. Frequency Range: 74 MHz to 862 MHz
  - 3. Optical Output: 4 mW to 26 mW
  - 4. Coordinate the applicable APC style connector with manufacturer for consistent match.
  - 5. Acceptable product:
    - a. Thor Broadcast F-RF-1310-TX-\*mW
- C. Fiber Optic Splitter (FO-SPL):
  - 1. 1x2, 1x4, 1x8, 1x16, and 1x32
  - 2. 1RU Rack Mount Chassis
  - 3. SC/APC Connectors
  - 4. Acceptable Product:

a. Thor Broadcast F-PLC Series

2.4 DISTRIBUTION

- A. Fiber Optic Node Receiver (NODE):
1. Provider fiber Node receiver with power supply for the reception and conversion of fiber optic signals to coax for distribution.
  2. Center Wavelength: 1310nm
  3. Output ++46dBmV
  4. Provide APC Fiber connections
  5. Provide with manufacturer recommended power supply.
  6. Acceptable product:
    - a. QFRF WR1000
- B. RF Amplifier (RFA)
1. Provider RF amplifier were required to meet performance requirements.
  2. Gain: 37 dB Min
  3. Output +48 dBmV Max
  4. Power Supply: 100 to 240 VAC 50/60 Hz
  5. Acceptable product:
    - a. ARRIS MDA-100

2.5 SPLITTERS, COMBINERS AND PASSIVE DEVICES

- A. The distribution components listed below cover 1000 MHz, Use is dependent on location within the system. Splitters & couplers are utilized in headend, local channel insertion and racks, multi-taps are utilized in NODE closets for distribution to drop taps.
- B. Drop Outlet:
1. Provide self-terminating feed through type.
  2. Housing: radiation proof.
  3. Provide cover plate to match service receptacles and data network plates. Coordinate color and finish with architect.
  4. Provide blanks in unused ports.
  5. Provide connector assembly mounted on a 106 Duplex Module Frame sub plate.
  6. Coordinate color of with architect.
  7. Standard of Performance:
    - a. Panduit CF1064 series frame
    - b. Panduit CMFSRxx self-terminating F-connector
    - c. Face Plate to match project power receptacles
    - d. Approved Equal
- C. Fixed Attenuator (PAD):
1. Provide as necessary to meet performance requirements.
  2. Provide 10 spares of 3, 6, 10 and 20 dB values.

3. Standard of Performance:
  - a. Blonder Tongue FAM Series
  - b. Approved Equal

D. DTV NODE Multi-Taps:

1. Modular multi-tap assembly.
2. Provide eight (8) port 1000 MHz directional taps.
3. Provide three (3) or six (6) tap plate capacity housings.
4. Tap value from 26 to 11.5 dB.
5. Terminate unused taps with 75-ohm terminator.
6. Standard of Performance:
  - a. Toner TXMT108-\*\* Total Tap
  - b. Toner TMXT-3H or TMXT-6H Housing
  - c. Approved Equal

E. DTV Housing Terminator:

1. Provide at last multi-tap in each NODE.
2. Standard of Performance:
  - a. Toner GTR-KS-M
  - b. Approved Equal

F. Fiber Attenuators:

1. Provide Fiber attenuators to match levels as required.
2. Provide each of the following dB values:
  - a. 3, 6, 9, & 12 db.
3. Provide SC/APC connectors that match equipment, and as recommended by the manufacturer.
4. Standard of Performance:
  - a. Blonder Tongue FOPD-SC
  - b. Approved Equal

## 2.6 CABLING AND ACCESSORIES

A. Drop Cable

1. Provide compliant with NEC type DTV.
2. Black jacket color, F6 or F11 Series type with copper clad center conductor.
3. Standard of Performance:
  - a. Belden 1189AP and Belden 7999AP (plenum) or equal
  - b. Belden 1322R and 1617A Series (non-plenum)
  - c. Approved Equal

B. Head-end Cable

1. Provide compliant with NEC type DTV rating.
2. Black jacketed F59 Series with copper clad aluminum center conductor.
3. Velocity of propagation: at least 65 percent nominal.
4. Frequency attenuation at 60° F: less than 10.5 dB per 100 feet at 1000 MHz.
5. Standard of Performance:
  - a. CommScope F59 HEC-2 or equal
  - b. Approved Equal

C. Video Cable

1. Provide compliant with NEC type CM or CMP rating as applicable.
2. Blue jacketed with copper clad aluminum center conductor.
3. Velocity of propagation: at least 80 percent nominal
4. Provide Return Air Plenum cable when run outside of equipment racks in ceilings.
5. Frequency attenuation at 60° F: less than 1.0 dB per 100 feet at 10 MHz.
6. Standard of Performance:
  - a. Belden 1694A
  - b. Approved Equal

D. Audio Cable

1. Provide compliant with NEC type CM rating.
2. Red jacketed, shielded twisted pair for line circuits.
3. Conductors: minimum 20 AWG tinned copper
4. Capacitance: less than 30 Pico farads per 100 feet
5. Provide Return Air Plenum cable when run outside of equipment racks in ceilings where required by NEC.
6. Standard of Performance:
  - a. West Penn 2454
  - b. Belden.1266A
  - c. Approved Equal

E. Control Cable

1. Provide compliant with NEC type CMP rating as applicable.
2. DC power cable: 12 AWG jacketed.
3. Control cables to be 18 AWG with overall shield and appropriate number of conductors and pairs required by manufacturer.
4. Standard of Performance:
  - a. Belden or equal
  - b. West Penn.
  - c. Approved Equal

F. DC Power Cable

1. Provide compliant with NEC rating for CL3P or CL2P plenum rating.
  2. Jacketed, one pair unshielded for control power circuits.
  3. Provide for extended distance.
  4. Conductors; minimum 12 AWG & 14 AWG stranded copper
  5. Larger cable shall be provided as required depending on distance and equipment requirements.
  6. Standard of Performance:
    - a. West Penn 25227 and 25226 series
    - b. Belden
    - c. Approved Equal
- G. Single-Mode Optical Fiber Cable:
1. Provide compliant with NEC type OFNR and ONFP ratings as applicable.
  2. 9/125 single-mode compliant with Corning SMF-28.
  3. Yellow jacket color.
  4. Provide six (6) strand multiple optical fiber cable runs to each Node.
  5. Armored Jacket
  6. Acceptable product:
    - a. Corning 012E61-31132-24 (Riser)
    - b. Corning 012E88-33131-29 (Plenum)
    - c. CommScope P-012-OZ-8W-F-S-U-B-K
- H. Fiber Optic Connector:
1. Provide commercial style APC, connections compatible with fiber equipment and where indicated on the plans.
  2. Provide connectors recommended by the manufacturer for compatibility with equipment and mounting panels and sub plates.
  3. Acceptable product.
    - a. Corning
- I. Wall Mount Fiber Optic Interconnect Box (FOI<sub>1</sub>):
1. Provide interconnect/termination box for fiber optic cabling.
  2. Interconnect box to be wall mount.
  3. Box to have internal cable-tie anchors, dust-proofing grommets, fiber management clips, and facilities to maintain proper cable bend radius.
  4. Size box to allow for 50% spare capacity.
  5. Provide APC adapter bezels for termination of unused fiber.
  6. Provide cable pigtailed compatible with the APC manufacturer connectors.
  7. Provide fusion splice housings.
  8. Provide blank bezels for unused ports.
  9. Acceptable product:
    - a. Interconnect Box: Panduit FWME12EBL Series
    - b. APC Adapter Panel: Panduit FAP6W APC series
    - c. Panduit APC Patch fiber cord and fusion splice pigtail
- J. Fiber Optic Rack Mount Enclosure:
1. Provide interconnect/termination box for fiber optic cabling.
  2. Interconnect box to be rack mounted.
  3. Box to have internal cable-tie anchors, dust-proofing grommets, fiber management clips, and facilities to maintain proper cable bend radius.
  4. Provide label designators for interconnect box.

5. Size box to allow for 50% spare capacity.
6. Provide APC adapter bezels for termination of fiber.
7. Provide blank bezels for unused ports.
8. Terminate and test all Fibers
9. Provide required patch cables to interconnect Fiber Transmitter.
10. Acceptable product:
  - a. Interconnect Box: Panduit FRME12EBL Series
  - b. Adapter Panel: Panduit FAP6Wxx/APC

K. F Connector:

1. Provide commercial style gold plated connector with integral sleeve for F6 Series, F11 Series, and F59 Headend cable.
2. Provide seal ring in all moisture intensive environments.
3. Install with manufacturer recommended compression tool.
4. Provide weatherized boots and seal covers for all antenna connections.
5. Verify connector cable type, size, and construction with manufacturer.
6. Standard of Performance:
  - a. Gilbert Engineering GF-US-6Q series, GF-US-11Q, and GF-US-59Q series respectively
  - b. Gilbert Engineering Seal ring: G-SR-1/2
  - c. Approved Equal

L. BNC Connector:

1. Provide commercial style gold plated connector dual crimp type with 75-ohm impedance the complete length of the connector for video cable.
2. Body: nickel plated.
3. Standard of Performance:
  - a. ADC BNC series
  - b. Kings 2065 series
  - c. Approved Equal

M. XLR Connector:

1. Provide gold plated connector incorporating metal shells and bodies as required on audio cable.
2. Standard of Performance:
  - a. Neutrik NC Series
  - b. Approved Equal

N. Adapters:

1. Provide commercial style KS adapter for multiple directional taps.
2. Standard of Performance:
  - a. Gilbert Engineering G-KS-KS-MG
  - b. Approved Equal



O. Ground Block:

1. Provide commercial style F and KS ground block per NEC Articles 810 and 820 with no less than #12 AWG grounding conductor.
2. Standard of Performance:
  - a. Gilbert Engineering GGB-4U and G-SPB-GLU
  - b. Approved Equal

P. Terminator:

1. Provide 75-ohm termination at unused ports.
2. Provide four spare "KS" type.
3. Provide 50 spare "F" type.
4. Standard of Performance:
  - a. Gilbert Engineering GTR-M and GTR-59-DCB
  - b. Approved Equal

Q. Tubing:

1. Provide heat shrink tubing on outdoor connectors
2. Standard of Performance:
  - a. Gilbert Engineering GC-HST series
  - b. Approved Equal

### **PART 3 - EXECUTION**

#### 3.1 GENERAL

- A. Coordinate incorporation of the Work specified herein with other project work so as to facilitate a cohesive final product.
- B. The installation recommendations contained within ASDI and TDMM are mandatory minimum standards and requirements.
- C. Mount equipment and enclosures plumb and level.
- D. Permanently installed equipment to be firmly and safely held in place. Design equipment supports to support loads imposed with a safety factor of at least five.

#### 3.2 INSTALLATION OF CABLE AND WIRING

A. Cabling and Wiring:

1. Provide cabling for audio, video and RF connections utilizing distinctive jacket color coding.

2. Bend radius and rigging calculations and restrictions.
3. Provide appropriate support at all horizontal-to-vertical transitions in order to keep the weight of the cable from degrading at the point of transition.
4. Provide splice free wiring and cabling from origination to destination.
5. Make joints and connections with rosin-core solder or with mechanical connectors approved by the Architect; where spade lugs are used, crimp properly with ratchet type tool.
6. Take precaution to prevent and guard against electromagnetic and electrostatic hum. For line-level audio signal, float cable shield at the output of source device. Shield not connected to be folded back over cable jacket and covered with heat-shrink tubing. Do not cut off unused shield.
7. Isolate cables and wires of different signals or different levels; and separate, organize, and route to restrict channel crosstalk or feedback oscillation in any amplifier section in compliance with ASDI article 12.3.
8. Cover edges of cable and wire pass-through holes in chassis, housings, boxes, etc., with rubber grommets or Brady GRNY nylon grommetting.
9. Install cable so that a radius bend of no less than ten times the cables OD is maintained.

B. Housing Cabling and Wiring:

1. Install cable and wire neatly tied in manageable bundles with cable lengths cut to minimize excess cable slack but still allow for service and testing. Provide horizontal support bars if cable bundles sag.
2. Neatly bundle excess AC power cable from housing mounted equipment with plastic cable ties.
3. Provide plastic cable ties to bundle cabling and wiring. Electrical tape and adhesive backed cable tie anchors are not acceptable.
4. Install with connections completely visible and labeled.
5. Provide termination resistors of 5 % tolerance.

3.3 INSTALLATION OF CONNECTORS, PLATES & PANELS

- A. Install panel mounted connectors rigidly attached to panels, plumb and level.
- B. Custom rack panels shall be 1/8-inch-thick aluminum, standard EIA sizes, brushed black anodized finish (brushed in direction of aluminum grain only), unless otherwise noted.
- C. Custom connector plates (speaker, microphone, TV etc.) are typically stainless steel, unless otherwise noted or specified. However, it is the Installer's responsibility to verify plate finish with the Architect. Coordination with electrical and tele/data providers is required for color coordination.
- D. Install F-type connectors as recommended by manufacturer. Ensure the following: the connector is attached securely to cable, no strands of the braid are touching the center conductor, and the center conductor extends beyond the end of the connector approximately 1/8 inch.
- E. Install XLR type connectors in accordance with IEC-268 standard, with a wiring scheme of pin 2 hot (high), pin 3 (low), and pin 1 screen (shield).

- F. All patch panels shall be wired so that signal "sources" (output from devices) appear on the upper row of a row pair and all "loads" (inputs to devices) appear on the lower row of a row pair.

### 3.4 INSTALLATION POWER AND GROUNDING

- A. Coordinate final connection of power and ground wiring to housings.
- B. Hardwire power wiring directly to internal AC receptacles to ensure uninterrupted operation.
- C. Provide 3-conductor, isolated ground, 120 VAC outlets as required within each housing plus two spare outlets.
- D. Provide a copper ground buss top to bottom in each housing, insulated from the housing. Ground equipment chassis not having a three-wire power cord to these busses using 6/32 nuts, bolts, and lock-washers with No. 12 wire. Connect green ground wire from each AC outlet in housing to this buss bar.

### 3.5 INSTALLATION OF ELECTRONIC EQUIPMENT

- A. Take appropriate precautions against electrostatic discharge (ESD). Establish a personal ground before handling electronic equipment through the use of a grounded wrist wrap and/or an anti-static floor pad.
- B. Take appropriate precautions to protect the equipment from damage during installation. Equipment to be installed free of damages, scratches, dents, etc.
- C. Mount equipment plumb and level firmly and safely held in place.

### 3.6 INSTALLATION OF EQUIPMENT HOUSING

- A. Equipment housing includes all equipment racks, turrets, and boxes.
- B. Install equipment in housings, fully wire and test before delivery to job site.
- C. Install mounted equipment with black number 10 button head machine screws with Allen drive.
- D. Provide rear support for housing mounted equipment greater than 15 inches deep.
- E. Provide blank panels or vents (as appropriate) to fill unused panel space within the equipment housing. These panels and/or vents are to be painted to match housing. Exception is boxes such as JBT's and JBE's in which unused panel space is left open.
- F. Key door locks for each housing type alike.

- G. Looking at the racks and turrets from the rear, install AC power and ground on the left, and audio, video wiring on the right.
- H. Do not block access to any front mounted components when mounting product on rear housing rails.
- I. Provide shaft locks or security covers on non-user operated equipment having front panel controls. These panels are to be installed at the conclusion of testing.
- J. Provide lights mounted in the top of each rack to illuminate the interior for service or maintenance. Lights to be individually switchable and placed so as to provide maximum illumination throughout the rack. Lamps to be 60-watt portable style as specified with rack.
- K. Provide horizontal cable management tie-off bars to prevent cable sag.

### 3.7 LABELING OF EQUIPMENT

- A. Provide engraved lamicoïd or gravoply label adjacent to the front and rear of equipment mounted in housing. Install in a plumb, level, and permanent manner. Provide rear-mounted labels on equipment mounted in furniture console.
- B. Provide typed label on each patch panel designating port signal. If patch panel is does not have labels provided, then provide on 80-pound paper stock utilizing 10-point block sans serif font.
- C. Provide engraved label over each user-operated control that describes the function or purpose of the control. Adjust label size to fit available space.
- D. Provide each terminal strip with a unique descriptor and a numerical designator for each terminal. Show terminal strip descriptor and designator on System schematic drawing.
- E. Provide logical and legible cable and wiring label permanently affixed for easy identification.
  - 1. Labels on cables to be adhesive strip type covered with clear heat-shrink tubing. Factory stamped heat shrink tubing may be used in lieu of the adhesive strip style
  - 2. Wiring designator to be an alphanumeric code unique for each cable.
  - 3. Locate the cable designator at the origination and destination of each circuit within 3 inches of the point of termination or connection. Provide cable designator on circuits with intermediate splice points with an additional suffix to indicate each segment.
  - 4. Each cable installed in the project must be provided with a cable label at each end of the cable. This includes all drop service cables, interior rack cabling, headend cables, multi-taps, DSS dish, power cables and receptacles etc.

### 3.8 ENGRAVING

- A. Text font: 1/8-inch block sans serif characters unless noted otherwise.
- B. On dark materials, provide white characters; on stainless steel or brushed natural aluminum plates, or light-colored materials, provide black characters.
- C. Provide at least two lines of text with first line listing the general device name, e.g., amplifier. Second line to include schematic reference of the device, e.g., amp-1.
- D. Equipment label: black with white characters except where indicated.

### 3.9 CONTRACTOR COMMISSIONING

- A. Prior to energizing or testing the System ensures the following:
  - 1. Products are installed in proper and safe manner according to manufacturer's instructions.
  - 2. Insulation and shrink tubing are present.
  - 3. Dust, debris, solder splatter, etc. is removed.
  - 4. Cable is dressed, routed, and labeled; connections are consistent with regard to polarity.
  - 5. Labeling has been provided.
  - 6. Temporary facilities and utilities have been properly disconnected, removed, and disposed of off-site.
  - 7. Products are neat, clean, and unmarred and parts securely attached.
  - 8. Broken work, including glass, raised flooring and supports, ceiling tiles and supports, walls, doors, etc. have been replaced or properly repaired, and debris cleaned up and discarded.
- B. Prior to energizing the System verify and perform the following tests and adjustments in compliance with applicable EIA standards.
  - 1. Electronic devices are properly grounded.
  - 2. Powered devices have AC power from the proper circuit and hot, neutral, and ground conductors are connected correctly.
  - 3. Grounding System Tests:
    - a. Measure and record the DC resistance between the technical ground in any equipment rack or console and the main building ground. Resistance should be at least 0.15 ohms or less.
    - b. Temporarily lift the technical ground from the main electrical ground, measure and record the DC resistance between them. Resistance should be at least 1000 ohms.
  - 4. Systems, equipment, and devices are in full and proper adjustment and operation, and properly labeled and identified.
  - 5. Store extra materials, portable equipment, and spares at the premises as directed by the Owner.
- C. Perform the following Headend tests and adjustments in compliance with NCTA Recommended Practices for Measurements on Cable Television Systems. Correct

any technical deficiencies until the NCTA preferred performance objectives are accomplished.

1. Adjust, measure and record carrier frequencies for channels assigned utilizing the spectrum analyzer method. Provide ATSC (convention) channel number, QAM carrier frequency, digital sub-channel number, and virtual channel number.
  2. Adjust the gain of each active device to provide optimum signal to noise ratio per the manufacturer's instruction.
  3. QAM Measurements
    - a. Spectrum & digital average power level of each carrier
    - b. Modulation Error Rate – MER
    - c. Constellation display analysis – 64 & 256 QAM
      - 1) Gain Compression
      - 2) System Noise
      - 3) Phase Noise
    - d. Coherent Interference Signal to noise ratio – SNR
    - e. Carrier to noise ratio – CNR
    - f. Bit Error rate – BER
    - g. Tilt
    - h. QAM Ingress (Ingress under the carrier)
    - i. Coherent Disturbance
      - 1) Composite Second Order – CSO
      - 2) Composite Triple Beat - CBT
  4. Measure, record and correct any undesired disturbances utilizing a QAM signal level meter and spectrum analyzer. Include a written explanation within the report as to the nature of any uncorrected disturbance.
  5. Measure and record any spurious signals.
  6. Measure and record the audio and video input/output of each encoder/demodulator at the patch panel.
  7. Perform a subjective evaluation of each channels picture quality with an HD television receiver connected to headend test outlet. Provide a system with no visible picture impairments.
- D. Perform the following Distribution system tests and adjustments in compliance with NCTA Recommended Practices for Measurements on Cable Television Systems. Correct any technical deficiencies until the NCTA preferred performance objectives are accomplished.
1. Adjust the gain of each active device to provide optimum signal to noise ratio per the manufacturer's instruction.
  2. QAM Measurements
    - a. Spectrum & digital average power level of each carrier
    - b. Modulation Error Rate – MER:
    - c. Constellation display analysis – 64 & 256 QAM
    - d. Gain Compression

- e. System Noise
  - f. Phase Noise
  - g. Signal to noise ratio – SNR
  - h. Carrier to noise ratio – CNR
  - i. Bit Error rate – BER
  - j. Tilt
  - k. QAM Ingress (Ingress under the carrier)
  - l. Coherent Disturbance
    - 1) Composite Second Order – CSO
    - 2) Composite Triple Beat - CBT
3. Measure and record the frequency response utilizing the standard broadband or slow sweep method at the headend source, multitaps, amplifiers of any node and each drop-service outlet. A node is a fiber optic receiver or distribution amplifier.
  4. Measure and record the forward path digital carrier levels at the output of each amplifier and one television outlet of all multitaps. Measure at channels (QAM carriers) 2 (57 MHz), 70 (501 MHz) and 135 (861 MHz). Temporary set three of the encoder/modulators to these channels and provide, simultaneously, an audio and video test signal.
  5. Measure and record the return path digital carrier levels at the output of each amplifier and the output of the headend return path combiner.
  6. Perform leakage test utilizing an appropriately equipped QAM signal level meter.
  7. Measure and record the digital carrier levels and temperature every four hours three times within the same day. Make this measurement at the last multitap of each fiber optic receiver or distribution amplifier.
  8. Perform a subjective evaluation of each channels picture quality with an HD television receiver connected to each distribution NODE test outlet. Provide a system with no visible picture impairments.
  9. Measure and record the sub-band return visual carrier levels received at the headend. Measure with signal originating at the furthest and nearest drop outlet on each level of the building.

### 3.10 TEST EQUIPMENT

- A. Equipment listed by manufacturer and model number establishes a standard of quality; other approved equal equipment will be acceptable.
- B. Thirty days prior to start of testing, provide a list to the Architect of test equipment make, model numbers and calibration dates that will be used.
- C. Furnish the following equipment. Equipment to be available for the entire installation period through final system testing.
  1. Signal level meter: Blonder Tongue BT-QAM-PRO
  2. Multi-Meter: Fluke 87V
  3. Variable Attenuator: JFW Industries 75TA-006 F
  4. 75-ohm, 1 percent terminating resistors, impedance matching pads, traps, connection adapters, test cabling, etc., as required.

5. Variable Attenuator: Wavetek 7580.
  6. Fiber Optic Cable Test Kit: Optical Wavelength Laboratories KIT-WT-WSVSDST.
  7. 75-ohm, 1 percent terminating resistors, impedance matching pads, traps, connection adapters, test cabling, etc., as required.
  8. Ladders and scaffolding necessary to inspect multi-taps in cable trays and ceiling mounted junction boxes.
- D. Provide two (2) portable VHF or UHF business band radios for use during acceptance testing with transmission range sufficient to cover entire project.
1. Include rechargeable batteries and charger along with "holster" for wearing on belt.
  2. Radios to be available for duration of testing process, including any follow-up visits required prior to final acceptance.

**END OF SECTION**



## **SECTION 27 41 16**

### **INTEGRATED AUDIO-VIDEO SYSTEMS AND EQUIPMENT**

#### **PART 1 - GENERAL**

##### 1.1 SUMMARY

- A. Integrated Audio-Video Systems and Equipment as part of the Work.

##### 1.2 SECTION INCLUDES

- A. Project instruction for the Contractor, and Sound System description details
- B. Sound System Product description
- C. Project completion instruction for the Contractor

##### 1.3 RESPONSIBILITY

- A. Notwithstanding any detailed information in the Contract Documents, it is the responsibility of the Contractor to supply all materials, equipment, transportation, engineering, and labor necessary to provide a fully working, tested, and calibrated system. Supply accessories and minor equipment items (such as, but not limited to: power strips, adapters, connectors, mounting hardware, etc.) needed for a complete system, even if not specifically mentioned in these Specifications. Notify the Architect of any discrepancies in part numbers or quantities before bid. Failing to provide such notification, supply items and quantities according to the intent of the Specification and Drawings, without claim for additional payment.
- B. Specifications and drawings are complementary. Work called for by one is binding as if called for by both. Any discrepancies between specifications and drawings shall be brought to the attention of the Owner for clarification during the bidding period. No allowance shall subsequently be made to the Contractor by reason of his failure to have brought said discrepancies to the attention of the Owner.
- C. Execute all work in accordance with the National Electrical Code (NEC), the National Electrical Safety Code, the Occupational Safety and Health Act (OSHA) and all applicable State and Local codes, ordinances, and regulations. If a conflict develops between the contract documents and the appropriate codes and is reported to the Architect prior to bid opening, the Architect will prepare the necessary clarification. Where a conflict is reported after contract award, propose a resolution of the conflict and, upon approval, perform Work.
- D. Required licenses, insurance, and permits including payment of charges and fees.
- E. Verification of dimensions and conditions at the job site.

- F. Coordinate location and installation of equipment, power, grounding, and raceways with other building elements.
- G. Preparation of submittal information.
- H. Pick-up of Owner Furnished Equipment (OFE) and incorporation into project if applicable.
- I. Development and implementation of AV control system software code and control panel layouts, which will become the property of the Owner.
- J. Installation in accordance with the contract document, manufacturer's recommendation, and in conformity with applicable codes and authority having jurisdiction (AHJ).
- K. Final tests and adjustments, written report, and documentation.
- L. Instruction of operating personnel.
- M. Provision of manuals.
- N. Maintenance services and warranty.

#### 1.4 RELATED WORK

- A. Coordination between disciplines is required to achieve a proper system installation.
- B. Electrical
  - 1. Electrical work shall be coordinated with division 26.
  - 2. Provide breaker panel and distribution of electrical power from the panel to the equipment as required.
  - 3. A ground point will be provided in each equipment room or enclosure electrical panel. Provide connecting ground point to all equipment in accordance with NEC Code, local codes, and standards specified herein.
  - 4. Provide conduit infrastructure system
    - a. Conduit and Cable Management
      - 1) Install cabling in conduit, provided as shown on the Electrical and AV drawings. If additional conduit/raceway/tray is required for systems, provide at no additional cost.
      - 2) Conduit/raceway/tray/wire management not shown on these drawings, but required for a complete system, or by code, is to be included in this scope of work.
      - 3) Exterior junction boxes, conduit/raceway, terminations, etc. and those within enclosures where enclosures are exposed to outdoor conditions are to meet NEMA ratings for outdoor electrical applications.
- C. Structural

1. The contractor shall be responsible for design and structural engineering for all loudspeaker brackets attaching the loudspeakers (and/or loudspeaker hoisting system) to the building structure at position shown within the drawings. Coordinate device weight loads with the Project's Structural Engineer.

D. Networks

1. Provide network switches, cable plant, and interfaces as required for two discrete audio systems in the venue: Seating Bowl PA and Back-of-House PA.
2. Provide dedicated network cabling and hardware to support control of, and audio feed to, Priority Communications System processors and amplifiers which are part of the seating bowl public address system.
3. Coordinate with the data network installer and in-house IT department to establish non-conflicting IP addresses for all of the AV equipment. Ensure that the configuration of the audio distribution and control networks for both seating bowl PA and back of house systems audio are secure, and that all reasonable measures are taken to prohibit unauthorized access to the audio streams, audio routing, and control features of the Digital Audio Network (DAN).

1.5 REFERENCES

- A. Published specification standards, tests or recommended methods of trade, industry or governmental organizations apply to Work in this section where cited below:
1. American National Safety Institute (ANSI)
  2. American Society of Testing and Materials (ASTM)
  3. Electronics Industries Association (EIA)
  4. Federal Communications Commission (FCC)
  5. National Electrical Manufacturer's Association (NEMA)
  6. National Electrical Code (NEC)
  7. Underwriters Laboratories (UL)
  8. Occupational Safety and Health Administration (OSHA)
  9. Society of Motion Picture and Television Engineers (SMPTE)
  10. Building Industry Consulting Service International (BICSI)
  11. Americans with Disabilities Act (ADA)
  12. AVIXA published standards
  13. Davis and Davis, Sound System Engineering (3rd Edition) (SSE), Howard W. Sams, 2006
  14. Giddings, Audio System Design and Installation (ASDI), Howard W. Sams, 2013
  15. AV Installation Handbook Second Edition: The Best Practices for Quality Audiovisual Systems, Infocomm (AVIH), 2009
  16. Middle Atlantic – Thermal Management White Paper

1.6 DEFINITIONS

- A. In addition to those Definitions of Division 1, the following list of terms as used in this specification shall be defined as follows:

1. Furnish: To purchase, procure, acquire, and deliver complete with related accessories.
2. Install: To set in place, join, attach, link, set up, or otherwise connect together and test until complete before turning over to the Owner. All parts, items, or equipment supplied by Contractor.
3. Provide: To furnish and install.

## 1.7 SYSTEMS DESCRIPTIONS AND REQUIREMENTS

- A. The following is intended to provide an overview of the required work details, system features, and design concepts for the Work as shown on the project drawings and is not intended to be an exhaustive description of the systems.
  1. Back of House (BOH) Systems
    - a. BOH systems utilize QLAN, AES67, and Dante via an ethernet network to distribute audio to equipment rooms associated with venue locations. These locations are, but not limited to:
      - 1) Public spaces:
        - a) Concourse/Lobby Prefunction
        - b) Restrooms
        - c) Exterior Entrances
        - d) Club(s)
      - b. A DSP system is dedicated solely to the BOH systems.
        - 1) The DSP system will handle signal mixing, routing, and other processing duties for the BOH systems.
  - B. Exterior Entrances:
    1. Select public entry points are equipped with an individually zoned loudspeaker system.
    2. Audio sources to include Message Repeater, Digital Audio Network (DAN) feeds such as prefunction space or auditorium audio.
    3. Source and volume level controlled from the prefunction control panel.
  - C. Dressing Rooms
    1. Each dressing room area will be provided with a single channel intercom speaker station.
    2. These intercom stations will route to the existing stage managers rack and terminate to the existing Clear-Com system.
  - D. Main Concourse Level
    1. Club Lounge
      - a. Overhead flush ceiling loudspeakers.

- b. Touch Panel will control the sound and video within the space.
    - c. Audio sources to include Digital Audio Network (DAN) Feeds, local Bluetooth panel, and local Mic/Line level IO panel.
    - d. Multiple video displays will be located throughout the room for CATV or local video playback from HDMI input.
  2. Lobby Prefunction
    - a. Column style loudspeakers mounted to structure.
    - b. Touch Panel will control the sound and video within the space.
    - c. Audio sources to include Digital Audio Network (DAN) Feeds and local Mic/Line level IO panel.
  3. Lobby Restrooms
    - a. Overhead flush ceiling loudspeakers.
    - b. Source and Volume are controlled from the prefunction control panel.
  4. Speakeasy
    - a. Overhead flush ceiling loudspeakers.
    - b. Touch Panel will control the sound within the space.
    - c. Audio sources to include Digital Audio Network (DAN) Feeds, local Bluetooth panel, and local Mic/Line level IO panel.
- E. DSP Control System:
  1. The DSP Control System and Graphic User Interface (GUI) shall be programmed by the manufacturers applications team, or a contractors staff member certified with the selected system platform.
    - a. Provide this programming service as part of your base bid.
  2. The Graphic User Interface (GUI) should be designed using these general guidelines:
    - a. Use CAD based images of the venue whenever possible to convey geographic information. Include cardinal mapping points to indicate direction in reference to the image used.
    - b. Use Owner approved logos for Touch Panel backgrounds.
    - c. Reference Part 3.4 of this specification.
  3. The DSP Control System includes the following systems:
    - a. Back of House Public Spaces
      - 1) Create a base Back of House Control Page that allows the user to control Volume and Source selection (local, or from the Digital Audio Network) for each of the following Back of House areas:
        - a) Entry Points

- (1) Each Entry Point is an individual zone.
      - (2) Volume control and Source select managed from the Lobby Prefunction control panel.
    - b) Concourses
      - (1) Volume control and Source select managed from the Lobby Prefunction control panel.
    - c) Restrooms
      - (1) Volume control and Source select managed from the Lobby Prefunction control panel.
  - 2) Any Back of House space that receives auditorium audio is to be time aligned to the auditorium sound system.
- b. Club Lounge
- 1) The club is an individual zone, equipped with the following local inputs:
    - a) Bluetooth receiver from networked wall-mounted device.
    - b) XLR balanced audio inputs from networked wall-mounted device.
    - c) Wireless Microphones.
    - d) Inputs available from the Digital Audio Network.
  - 2) Touch Panel for local Volume control, Source selection, TV channel control, and local HDMI input selection.
  - 3) The Club Lounge will have an AV System that includes a digital media switching system, one (1) HDMI input panel and associated av support equipment. The Touch Panel in the Club controls the AV system and includes control of:
    - a) Source Selection
    - b) Program Audio Volume - up/down/mute
    - c) System – on/off
    - d) TV Source Routing
    - e) TV Channel
4. Common GUI features to all systems:
- a. Fire Alarm over-ride
    - 1) Provide Fire Alarm over-ride programming as necessary to mute signals from the Audio System.
      - a) Provide a bold indicator in DSP Graphic User Interface (GUI) on all computers and Touch Panels to indicate that the Sound System is in an Alarm condition.

b. System Health

- 1) Use a green colored button to indicate "good" and a red colored button to indicate "fault". This is intended to be a system wide fault detector programmed to include:
  - a) Amplifier Fault or Failure
  - b) Amplifier Open/Shorted Load
  - c) Amplifier Online/Offline
  - d) Network Fault or Failure
  - e) DSP Online/Offline
  - f) DSP Fault or Failure
- 2) Coordinate with the Owner and Operations team if they wish to receive SMS or an email when a fault occurs.

1.8 SUBMITTALS

- A. Provide submittals in accordance with Conditions of the Contract and Division 1, Submittal Procedures section unless otherwise indicated.
- B. Submittals shall contain sufficient information to describe the Work to be performed. Reviewed shop drawings and coordination drawings are to be used for final coordination and construction.
- C. Submittals must be original work produced by the contractor responsible for performing the work defined in this specification. Scanning, photographic copying, materially copying, or any other reproducing the contents of the drawings or specifications contained within the Contract Documents will be marked as unacceptable and not reviewed for any content. No claim shall be made for delay, undue burden, or additional costs for the effort to produce shop drawings, schedules, and equipment lists addressing this specification or the overall project manual.
- D. Supplementary submittal requirements:
  1. Provide the following for review within thirty days of issuance of Notice to Proceed (NTP) and prior to commencement of the Work:
  2. Each submittal is to include the following information:
    - a. Project title.
    - b. Submittal number. In the case of a resubmittal, use the original submittal number immediately followed by the suffix "R" immediately followed by a unique number and be numbered in consecutive order.
    - c. Date of submission.
    - d. Complete schedule of submittals.
    - e. Chronological schedule of the Work in bar chart form.
    - f. Product Data Submittal (PD):
      - 1) Provide product data submittal in a single combined PDF file.
      - 2) Provide an indexed list of products to be incorporated in the Work.

- 3) Manufacturer's data/specification sheets to be incorporated within the Work.
  - 4) In the index provide clickable hyperlinks that lead to the page of the submittal for the item.
  - 5) Organize index and data sheets in specification order. Provide a specification reference for each product (i.e. 2.6, A, 1). For data/specification sheets provide this in the upper right hand corner of the page.
  - 6) Remove any pages with non-English language text.
  - 7) When multiple products are shown on a data sheet, indicate which product(s) are to be provided with an arrow, highlight or note.
  - 8) Submittal shall not include user/operating manuals, service/installation manuals, marketing brochures.
  - 9) For items to be installed in areas visible to the public, prior to submittal, coordinate with Architect the desired color. Include color selection in submittal.
  - 10) Submissions that do not follow the format and configuration described above will be returned without review.
- g. Shop Drawing Submittal (SD):
- 1) Functional Diagrams/Schematics:
    - a) Detailed, redrawn wiring diagrams showing interconnection of devices, wiring and cabling diagrams depicting cable types and unique designators/labels, and device designators for each system. Provide connector type and terminal strip identification, along with color codes for cables connecting to these devices. Give each device a unique designator and use this designator consistently throughout the project.
- h. Coordination Drawings:
- 1) Coordination drawings showing major elements, components, raceway, cabling and devices of the systems in relationship with other building components on:
    - a) Floor plans
    - b) Reflected ceiling plans
    - c) Elevations
    - d) Sections
    - e) Rack elevations, front and rear, including non-rackmounted equipment within racks; AC power outlet and terminal strip locations; wire routing and cabling within housings.
    - f) Patch panel layouts and designation (labeling) strips, including color schemes.
    - g) Projector, loudspeaker, camera mounting details, include hardware types and load capacity.
    - h) Fabricated Plates and Panels: Provide complete drawings on custom fabricated plates or panels. Drawings shall include dimensioned locations of components, component types,



- engraving information, plate material and color, and bill of material.
  - i) Full fabrication details of any custom enclosures and millwork indicating size, material, finish and openings for equipment.
  - j) Labeling: Equipment and cabling labeling scheme. Include font sizes and styles, explanation of scheme, and designator schedule.
  - k) Schedules: Wiring schedule showing source and destination of wiring and indicating which wiring is in conduit. Junction box schedule showing type of box, size, mounting and location. Include this information with remainder of wiring diagrams.
  - l) Consultant's project documents in electronic format will not be supplied to the Contractor for their use as part of submittals.
  - m) Detail drawings executed at an appropriate scale, but not smaller than 1/8 inch = 1'-0".
  - n) Submissions that do not follow the format and configuration described above will be returned without review.
  - o) Any other pertinent data which is necessary to provide the Work.
- i. Structural rigging and mounting details:
- 1) All loudspeaker structural rigging and mounting detail drawings shall be signed and sealed by a professional engineer licensed to practice in the state in which the project is located. The signed and sealed drawings noted above to include the following:
    - a) Attachment method to building structure for suspended loudspeakers or mounting brackets.
    - b) Detail the product manufacturer, part numbers and load capacity of the hardware fittings and materials selected.
    - c) A copy of the design calculations.
    - d) Any secondary steel required for attachment to the building structure. All fittings, hardware, materials, and cable used for suspended loudspeakers.
    - e) All custom brackets, mounts, suspension grids or trusses and loudspeaker cabinet frames or brackets not supplied by the manufacturer of the specific loudspeaker to be mounted or suspended.
- j. Control System Software:
- 1) Provide electronic copies of proposed control system user interfaces within sixty (60) days of issuance of Notice to Proceed (NTP).
- k. IP Addresses:

- 1) Coordinated with the venue IT Administrator, provide a list of IP addresses, by device, used in the project.

E. Resubmission requirements:

1. Make all requested corrections or change in submittals required. Resubmit for review until no exceptions are taken.
2. Indicate all changes that have been made other than those requested.

F. Approval of Submittals: The submittal information will be reviewed by the general contractor, owner, Architects, engineers, and consultants. Each submittal package will be returned, stamped as follows:

1. "No Exceptions Taken" proceed with construction, all job site coordination will be at the direction of the general contractor.
2. "Make Corrections Noted: No Resubmission Required" submittals have been returned with conditional approval. Corrections, as indicated on the returned drawings and/or specifications, must be made before construction can begin.
3. "Make Corrections Noted: Submit Corrected Copy" submittals have been returned with conditional approval. Corrections, as indicated on the returned drawings and/or specifications, must be made in writing and returned to the consultant before construction can begin.
4. "REJECTED, Submit Specified Item" a specified item in the submittal has been rejected for the reasons noted. Re-submit in compliance with the specifications.
5. "REJECTED, Revise and Re-submit" submittal has been rejected for the reasons noted. Re-submit in compliance with the specifications.
6. "No Review Action Required" all information provided was for information or coordination purposes only. Review is not required.

1.9 CONTRACT CLOSE-OUT DOCUMENTS:

A. Provide close-out submittals in accordance with Conditions of the Contract and Division 1, Submittal Procedures section unless otherwise indicated, after substantial completion but prior to final observation:

B. Supplementary submittal requirements:

1. Provide the following in one electronic submission for review.
2. Equipment Manuals:
  - a. Manufacturer's owner/instruction manual for each type of Product by manufacturer and model or part number unless specified otherwise herein
  - b. Supply manufacturer's serial numbers for each Product
  - c. For custom circuits or modifications, a description of the purpose, capabilities, and operation of each item
  - d. Separately bind list by manufacturer and model or part number of Products incorporated within the Work, arranged in alpha numeric order. When applicable, bind Manufacturer's warranty statements separately.

3. Test Reports: Recorded findings of Commissioning.
4. System Operation and Instructions: Prepare a complete and typical procedure for the operation of the equipment as a system, organized by subsystem or activity.
  - a. This procedure should describe the operation of system capabilities.
  - b. Assume the intended reader of the manual to be technically inexperienced but unfamiliar with the components and the facility.
5. Service Information, including service phone number(s) and hours; service schedule; description of products recommended or provided for maintenance purposes, and instructions for the proper use of these products.
6. Any other pertinent data generated during the Project or required for future service.
7. Within three weeks of final observation, submit the following in one electronic submission for review. Upon Owners and/or Consultant's request, provide hard copy files of the following:
  - a. Record drawings: Final rendition of Shop Drawings depicting what is actually incorporated within the Work.
  - b. Record drawings in AutoCAD editable DWG format and Adobe PDF format. Resolution to be sufficient to permit Owner's technicians to be able to clearly read all notes and text on screen.
  - c. One set of signed proof-of-training documents.
8. Submittal Format:
  - a. Record Drawings: Drawings executed at an appropriate scale, but not smaller than 1/8 inch = 1'-0".
  - b. Segregate documents into separate folders containing data relevant to operational, maintenance, and warranty issues. Appropriately duplicate data within the separate bindings when it will reasonably clarify procedures, e.g.; operational data in a maintenance folder.
  - c. Project Record Manual
    - 1) Provide product data submittal in a single PDF file.
    - 2) Provide an indexed list of major groupings.
    - 3) In the index, provide clickable hyperlinks that lead to the page of that major grouping.
    - 4) Organize index and major groupings in logical signal-flow order.
9. Resubmission requirements:
  - a. Make all requested corrections or change in submittals required. Resubmit for review until no exceptions are taken.
  - b. Indicate all changes that have been made other than those requested.

## 1.10 CUSTOM SOFTWARE

### A. Introduction:

1. Proprietary software provided for the Technical Systems shall be subject to this software license between the Contractor and the Owner as an essential element of the system as defined in the system specification and associated documents, drawings and agreement.
2. Contractor shall agree that 3rd party proprietary software provided with the system shall be subject to this agreement.
3. Contractor and Owner agree that this software license is deemed to be part of, and subject to, the terms of the Agreement applicable to both parties; and shall supersede any standard manufacturer or Contractor's standard license agreement.
4. Proprietary software shall be defined to include, but not be limited to, device and system specific software and firmware designed to run on conventional computer based operating platforms as well as all micro-processor based hardware used to program, setup, or operate the system or its components.
5. For sake of this agreement, MS Windows shall not be considered "proprietary" software, unless a non-public version of Windows® or any of its components are critical to the operation of the system in which case it shall be deemed proprietary.

B. License Grant and Ownership:

1. Contractor hereby grants to Owner a perpetual, non-exclusive, site license to all software for Customer's use in connection with the establishment, use, maintenance and modification of the system implemented by Contractor. Software shall mean executable object code of software programs and the patches, scripts, modifications, enhancements, designs, concepts or other materials that constitute the software programs necessary for the proper function and operation of the system as delivered by the Contractor and accepted by the Owner.
2. Except as expressly set forth in this agreement, Contractor shall at all times own all intellectual property rights in the software. Any and all licenses, product warranties or service contracts provided by third parties in connection with any software, hardware or other software or services provided in the system shall be delivered to Owner for the sole benefit of Owner.
3. Owner may supply to Contractor or allow the Contractor to use certain proprietary information, including service marks, logos, graphics, software, documents and business information and plans that have been authored or pre-owned by Contractor. All such intellectual property shall remain the exclusive property of Owner and shall not be used by Contractor for any purposes other than those associated with delivery of the system.

C. Copies, Modifications, and Use:

1. Source code shall be available to Owner for a period of not less than 10 years.
2. Owner may make copies of the software for archival purposes and as required for modifications to the system. All copies and distribution of the software shall remain within the direct control of Owner and its representatives.
3. Owner may make modifications to the source code version of the software, if and only if the results of all such modifications are applied solely to the system. In no way does this Software License confer any right for Owner to license, sublicense, sell, or otherwise authorize the use of the software, whether in executable form, source code or otherwise, by any third parties.

4. All express or implied warranties relating to the software shall be deemed null and void in case of any modification to the software made by any party other than Contractor.

D. Warranties and Representations:

1. Contractor represents and warrants to Owner that:
  - a. It has all necessary rights and authority to execute and deliver this Software License and perform its obligations hereunder and to grant the rights granted under this Software License to Owner;
  - b. The goods and services provided by contractor under this Software License, including the software and all intellectual property provided hereunder, are original to Contractor or its subcontractors or partners; and
  - c. The software, as delivered as part of the system, will not infringe or otherwise violate the rights of any third party, or violate any applicable law, rule or regulation.
2. Contractor further represents and warrants that, throughout the System Warranty Period, the executable object code of software and the system will perform substantially in accordance with the System Specifications and Agreement. If the software fails to perform as specified and accepted all remedies are pursuant to the policies set forth in the Specification and in the Agreement. No warranty of any type or nature is provided for the source code version of the software which is delivered as is.
3. Except as expressly stated in this Agreement, there are no warranties, express or implied, including, but not limited to, the implied warranties of fitness for a particular purpose, of merchantability, or warranty of no infringement of third party intellectual property rights.

1.11 QUALITY ASSURANCE

- A. Qualifications: Contractor to be experienced in the provision of systems similar in complexity to those required for this project, and meet the requirements listed below. Provide documentation at the time of bid to support these qualifications:
  1. Form of corporation.
  2. No less than three years experience with equipment and systems of the specified types.
  3. Experience with at least three comparable scale projects within the last three years.
  4. Be a franchised dealer and service facility for the manufacturer's products furnished.
  5. Maintain a fully staffed and equipped service facility with full-time field technicians.
  6. Have at least one supervisory on-site employee who has completed and has been certified CTS-I by Infocomm.
  7. Adequate plant capacity and equipment to complete the Work.
  8. Adequate staff with commensurate technical experience.

9. Suitable financial status (i.e.; bonding and materials purchase capacity) to meet the obligations of the Work.
  10. Adequate regional service organization to meet warranty response requirements of the Project.
  11. Provide listing with appropriate explanation regarding the status of Contractor's resolved or unresolved legal disputes within the last six calendar years.
  12. Provide listing with appropriate explanation regarding any projects within the last 3 years where the Contractor has failed to meet construction schedules due to Contractor's cause.
  13. Completed current version of the AIA Contractor's Qualification Form.
- B. Subcontractors: at the time of bid, the Contractor shall provide a list of structural, electrical, sound, or any other subcontractors intended to do the Work, or are being retained as local service providers throughout the warranty period. Subcontractors shall be appropriately state licensed in their specialty and must provide the same qualification documents as the Contractor.
- C. Work: Perform Work in compliance with the applicable standards listed herein and governing codes and regulations of the authorities having jurisdiction and the Contract Documents.
1. Drawings and specification requirements govern where they exceed Code and Regulation requirements.
  2. Where requirements between governing Codes and Regulations vary, the more restrictive provision applies.
  3. Nothing in the Contract Documents grants authority or permission to disregard or violate any legal requirements.
- D. Coordinate exact location and installation of equipment, power, grounding, and raceway requirements with the Owner.

#### 1.12 DELIVERY, STORAGE & HANDLING

- A. Ship Products in its original container, to prevent damaging or entrance of foreign matter.
- B. Handling and shipping in accordance with Manufacturer's recommendation.
- C. Provide protective covering during construction of all installed devices, to prevent damaging or entrance of foreign matter.
- D. Replace, at no expense to Owner, Products damaged during storage, handling, or through the course of construction.

#### 1.13 PROJECT CONDITIONS

- A. Verify conditions on the job site applicable to this work. Notify Architect in writing of discrepancies, conflicts, or omissions promptly upon discovery.

- B. The Drawings diagrammatically show cabling and arrangements of equipment fitting the space available without interference. If conditions exist which make it impossible to install work as shown, recommend solutions and/or submit drawings to the Architect for approval, showing how the work may be installed.

#### 1.14 WARRANTY

- A. Warrant labor and equipment for one year following the date of substantial completion to be free of defects and deficiencies, and to conform to the drawings and specifications as to kind, quality, function, and characteristics. Repair or replace defects occurring in labor or equipment within the Warranty period without charge.
- B. This warranty is in addition to any specific warranties issued by manufacturers for greater periods of time.
- C. Within the warranty period, answer service calls within twenty-four (24) hours during normal working hours and correct the deficiency within forty-eight (48) hours.
- D. Provide Owner with the name and telephone number of the person to call for service. This information to be part of Project Closeout Documents.
- E. Thirty days prior to the end of the warranty period provide a complete checkout of all system components. Repair or replace any defective equipment discovered during the testing. Correct any defects in wiring or other functional problems reported by Owner. Warranty replacement and service of equipment shall not apply to Owner furnished equipment (OFE). Coordinate an observation visit with the Owner.

### **PART 2 - PRODUCTS**

#### 2.1 GENERAL

- A. Products quantity is as required. If a quantity is given, provide at least the given amount. Some product listed may not be required to fulfill the obligations of the Work.
- B. Equipment and materials shall be new and conform to applicable UL or ANSI provisions.
- C. Regardless of the length or completeness of the descriptive paragraph herein, provide Products complying with the specified manufacturer's published specifications.
- D. Remove or blank out all manufacturers' names, logos, or other symbols from loudspeakers or other objects placed in view of the public. If logos are removable, remove and repaint to the color of the adjacent surface and reattach.

- E. Take care during installation to prevent scratches, dents, chips, etc.

## 2.2 ACCEPTABLE MANUFACTURERS

- A. Model numbers and manufacturers included in this specification are listed as standard of function, performance, and quality, forming the basis of design.
- B. If a specified product has been discontinued by a manufacturer, provide the replacement model (as certified by the manufacturer) at no additional cost.
- C. Where required, provide manufacturer's rack mount adapter or one manufactured by Middle Atlantic or Winstead unless specified elsewhere.

## 2.3 MICROPHONES AND ACCESSORIES

### A. Voice Microphones:

- 1. Provide the all the following items.
  - a. Shure Beta58 (Quantity: 2).

### B. PTT Desktop Microphone:

- 1. Frequency Response: 50 to 17,000 Hz
- 2. Polar Pattern: Cardioid
- 3. Output Impedance: 150 ohms
- 4. Maximum SPL (1kHz at 1% THD, 1 kohm load) Cardioid: 123.0 dB
- 5. Signal to Noise Ratio (referenced at 94 dB SPL) Cardioid: 65.0 dB
- 6. Dynamic Range: 94.0 dB
- 7. Common Mode Rejection: 45.0 dB minimum
- 8. Mute Switch Attenuation: 50.0 dB minimum
- 9. Acceptable product to include:
  - a. Shure MX412D (Quantity: 1).

### C. Microphone Cables:

- 1. Each cable to be provided with heat-shrink label identifying facility name and cable length.
- 2. Each cable to be provided with a hook and loop tie strip to keep cable coiled. Use a different color of tie for cables of each length.
- 3. Color: Black.
- 4. Provide the following quantities:
  - a. 25-foot Microphone Cable, (Quantity: 4).
  - b. 50-foot Microphone Cable, (Quantity: 2).
  - c. Acceptable product:
    - 1) ProCo Sound Excellines MIC Series, Part # EXMN-(Length).
    - 2) Approved equal.



D. Microphone Stands, Mounting Hardware, and Accessories:

1. Provide ALL the following items:
  - a. Low Stand: Atlas/Soundolier DS7E (Quantity: 2).
  - b. Tripod Stand: K&M 201A/2 Black #20130-500-55 (Quantity: 2).
  - c. Extendable Boom: K&M 211/2 Black #21120-577-55 (Quantity: 2).
  - d. Carrying Case: K&M 21315-000-00 (Quantity: 1).

2.4 AUDIO INPUT SOURCES

A. Message Repeater (MSG REPEATER):

1. Integrate into DSP Core processor.
2. Format: MP3 or WAV files.
3. Presets: Program for a minimum of 6 messages.
4. Allow for message selection and message start/stop from Lobby TP control panel.
5. Acceptable product:
  - a. QSC Q-sys.

B. Digital Bluetooth Audio Receiver (BT, Type 1):

1. Bluetooth Receiver for wireless audio streaming
2. Bluetooth Version: 4.0, A2DP
3. Bluetooth Wireless Range: Up to 30' Feet
4. Power: Over CAT5/6.
5. Receiver Output: CAT5/6 (up to 100m)
6. Size: 2-gang wall box.
7. Acceptable product:
  - a. Attero Tech unD6IO-BT.

C. Background Music Source (BGM-PLYR):

1. Use for streaming internet music channels from owner procured subscription service.
2. Supported Operating Systems:
  - a. Plays music from network shares on the following desktop operating systems: Microsoft Windows XP, 2000, Vista 7-10, Apple Macintosh 7-10.
3. Internet Radio:
  - a. TuneIn Radio, iHeartRadio, Calm Radio, Radio Paradise, Slacker Radio.
4. Supported Cloud Services:

- a. SoundMachine, Tunify, Custom Channels, SiriusXM for Business, Spotify, Tidal, Amazon, Deezer, Qobuz, TuneIn, Radio.com.
  5. Network: Gigabit Ethernet RJ45.
  6. USB:
    - a. 1 x Type-A port for connection to USB memory sticks (Fat32 or NTFS formatted) and supported peripherals.
    - b. 1 x Type-B (mini) for product servicing.
  7. Audio Input: Mic/Line Balanced Phoenix.
  8. Audio Output: Analog Balanced Phoenix.
  9. Coordinate software configuration for full function with owner streaming service.
  10. Provide with 1-RU rack mount shelf for every (2) units and fill unused slots with blanks panels.
  11. Acceptable product:
    - a. Bluesound Professional B100S with RM100 Rack Kit.
- D. Stereo Isolation Interface (ST-ISO):
1. Provide one (1) for each EDI used to feed audio system.
  2. Inputs:
    - a. RCA phono in / through jacks.
    - b. 3.5 mm plug on a 30" hard wired cable.
    - c. 1/4" TS input jacks.
  3. Outputs: XLR jacks.
  4. Ground Lift switch.
  5. Stereo/Mono switch.
  6. Acceptable product:
    - a. Whirlwind PCDIHW (Quantity: 1).

## 2.5 MEDIA INGEST AND DISTRIBUTION

- A. CATV Television Tuner (TVT):
1. Type: Analog, ATSC, NTSC and Clear QAM (MPEG2 and MPEG4). 2. DTV Standards: (1080i/ 29.97/ Hz/720p/480p/480i).
  2. Aspect Ratio: Adjustable, variety of modes for widescreen 16:9 and normal 4:3 broadcasts.
  3. Captioning: Onscreen Analog and Digital, set by program or customized for size, font, and attributes. Line 21 analog captioning on Composite Video
  4. Favorites: Favorite channel menu
  5. Lock: Parental option for channels and/or rating
  6. RF Input: Air/Cable, 'F', female, 75-ohm impedance.
  7. HD Outputs: HDMI and switchable RGB/Component outputs operate simultaneously.

8. Component: RCA YPrPb outputs (1080p@60Hz, 720p@59.94/60 Hz, 1080i/480p@ 29.97 Hz).
  9. RGB: RGBHV DB-15 female (1080p@60Hz, 720p@59.94/60 Hz, 1080i/480p@ 29.97 Hz).
  10. HDMI: HDMI receptacle (1080p@60Hz, 720p@59.94/60 Hz, 1080i/480p@ 29.97 Hz), version 1.3, PCM/AC3 digital audio, auto or manual DVI compatibility.
  11. Composite Video: RCA female jack, always operational, echoes digital HD output
  12. Audio Outputs: All operate simultaneously, including SDI audio, select Consumer or Pro digital audio.
  13. Digital Audio: S/PDIF: Coax and TOSlink optical output, Dolby 5.1, PCM, or PCM variable.
  14. Stereo Audio: 2 stereo RCA female jacks, variable level.
  15. 1RU Rack mountable.
  16. Acceptable product to include all the following:
    - a. Contemporary Research 232-ATSC 4 HDTV Tuner.
    - b. Contemporary Research RK1 Single Rack Mount Kit.
- B. AV Wall Plate, Type 1 (AV1):
1. Wall plate HDMI to HDBT transmitter.
  2. One (1) HDMI 2.0 Input
  3. One (1) HDBaseT Output
  4. HDCP 2.2 compliant
  5. 1-gang wall box mount transmitter design.
  6. Acceptable products:
    - a. AVPro Edge AC-CXWO-HDMO-T.
    - b. Approved equal.
- C. Digital Media Receiver (DMR):
1. Digital Media Receiver
  2. Mounts Behind TV in Display Box
  3. RS-232 Control Port
  4. One (1) HDBaseT input
  5. One (1) HDMI 2.0 output
  6. Provide with power as needed
  7. Acceptable products:
    - a. AVPro Edge AC-EX70-444-RNE-(P).
    - b. Approved equal.
- D. AV Matrix Switcher (88MTX):
1. Inputs: 8 HDMI
  2. Outputs: 8 HDBT, HDMI, and Audio
  3. Performance features:
    - a. HDMI 2.0(a/b)

- b. 18Gbps Uncompressed Bandwidth Support on HDMI
  - c. 18Gbps with ICT on HDBaseT outputs
  - d. 4K60 4:4:4 Support
  - e. Full HDR Support (HDR 10 & 12 Bit)
  - f. Dolby Vision, HDR10+ and HLG Support
  - g. HDCP 2.3 (and all earlier versions supported)
  - h. 1080p > 4K Upscaling on HDMI outputs
  - i. 4K > 1080P Downscaling on HDBaseT outputs
  - j. Advanced EDID Management
  - k. IR, RS-232 and LAN Control Options
  - l. Digital Toslink Out (7CH PCM, DD, DTS)
  - m. Balanced Analog Out (2CH PCM)
  - n. Audio Delay for Digital & Analog Out
  - o. HDBaseT Compatibility mode for mixed systems
  - p. Driver Support for Crestron, C4, RTI, ELAN and more
  - q. Extracted Audio Now Has 3 Operating Modes. Bound to Input, Bound to Output, or Independent Matrix
  - r. Built in Test Pattern on Each Output to Verify Infrastructure
- 4. 2-RU Rack mountable
  - 5. Acceptable products:
    - a. AVPro Edge AC-MX-88HDBT.
    - b. Approved equal.

## 2.6 AUDIO CONTROL COMPUTERS

- A. Provide for CPU-AUDIO.
- B. The DSP system and control software shall be operational 30 days prior to the first use of the installed system.
- C. Signal processing shall be performed by computer-based system. The DSP control platform is to incorporate amplifier and loudspeaker control, monitoring and configurable DSP.
- D. The system shall have the following capabilities:
  - 1. CPU: 2.10 GHz Intel® Core i7-12700 processor.
  - 2. Motherboard: ATX with Intel W680 Chipset - 12th Gen Intel Core LGA1700.
  - 3. Operating System: Microsoft Windows 11 Professional, 64-bit.
  - 4. Enclosure/Case: 2-RU Rack Mountable.
  - 5. Power supply: 400 watts.
  - 6. Memory: 32 GB, DDR5 4800MHz.
  - 7. Internal Hard Disk 1: 500GB SSD M.2 6.9Gb/s.
  - 8. Internal Hard Disk 2: 500GB SSD M.2 6.9Gb/s.
  - 9. Raid Adapter: Configure Raid 1 (Mirroring).
  - 10. Network Adapter: Quad port 10/100/1000 Mbps.
  - 11. Blu-ray: Minimum of 12x recording speed. Include disc recording software.
  - 12. Video: HDMI, DVI-D, and DisplayPort outputs.
  - 13. Software to be included:

14. Provide current version of all software and license all software to the Owner.
  - a. Norton Internet Security.
  - b. Nero Platinum Edition.
15. Warranty: Three-Year Onsite Warranty with 24/7 Phone and Next Business Day Service.
16. Computer system shall be completely tested by manufacturer prior to delivery.
17. Acceptable product:
  - a. SuperLogics SL-2U-W680SAE-DF (custom configured as above).

E. Rack KVM Monitor (KB-MON):

1. Computer Connections: 8.
2. Display: 17-inch high definition (1080P), widescreen (16:9).
3. External Console Ports:
  - a. Keyboard: USB.
  - b. Mouse: USB.
  - c. Monitor: 1 HDMI, 1 DVI-D, and 1 HDB-15.
  - d. Speaker: 1 mini stereo.
4. KVM Ports:
  - a. KB/Mouse: USB.
  - b. Monitor: 8 HDMI and 6 DVI-D.
  - c. Speaker: N/A.
5. Dual rail design allows monitor to reside in open position for system monitoring while keyboard is recessed.
6. 1-RU Rack Mountable.
7. Acceptable Product:
  - a. Middle Atlantic RM-KB-LCD17HD.

## 2.7 SOFTWARE AND PROGRAMMING

A. Software-based Equipment:

1. Provide network analysis and configuration software to setup, control, and monitor network components.
2. This project requires site specific configuration of software-based equipment. Contractor's software development staff shall be certified in the engineering, programming, and commissioning of all components of the system selected for use on this project.
3. Provide 12 months of on-site software upgrades from date of final acceptance.
4. For electronic devices, firmware updates are often released by the manufacturer to improve performance. While these updates are beneficial in

most cases, caution should always be taken when performing a firmware update on a device or system as to not compromise compatibility between it and other devices in the system. It is the responsibility of the Contractor to work with the manufacturer(s) in any event of a firmware update that introduces an incompatibility among the installed devices.

5. The software development is to be done in four phases.
  - a. During the first phase, development of the general configuration and functions are to be established. Participants of the development are the Contractor's software development staff, Contractor's project manager, the Arena Operator's Representative, and the Arena Operator. This requires multiple meetings with these principles and is an interactive and iterative process. The first meeting of this phase to be in person with subsequent meetings by web-based meeting software. This meeting to be scheduled no less than 8 months prior to projects substantial completion date.
  - b. During the second phase, the Contractor's software development staff produces the initial configuration software fulfilling the requirements developed during the first phase. This also requires multiple meetings with the software development staff, the Contractor, the Arena Operator's Representative, and the Arena Operator and is an interactive and iterative process. The first meeting of this phase to be in person with subsequent meetings by web-based meeting software. This meeting to be scheduled no less than 6 months prior to projects substantial completion date.
  - c. Upon completion of the second phase, install the configuration software within the systems, and inspect the systems for performance compliance. During this process the Manufacturer with the assistance of this Contractor debugs the system software code as required to ensure a properly functioning system. At the end of this phase, the Contractor is to provide written notification that the product is operating properly and that the functions and configurations established in Phases One and Two are working and have been properly implemented. This meeting to be scheduled no less than 2 months prior to projects substantial completion date.
  - d. During the fourth phase, the Contractor's software development staff, Contractor's project manager, the Operator's Consultant, and the Arena Operator inspect the operational aspects of the systems and develop final software configurations. Upon completion of final configuration, this Contractor and the software development staff installs and debugs the final system software code as required to ensure a properly functioning system as established during the fourth phase.
6. Provide technical support personnel on-site for a minimum of five days during the contractor commissioning and the Arena Operator Representative testing and tuning processes. Personnel to test and observe the functioning of the software-based systems. Should problems exist, personnel to remain and assist contractor in correcting the malfunctions until system is functioning properly and be present for final observation and testing.

B. DSP Control Programming:

1. Provide latest version of interface software to link DSP system to user control system.
2. Provide site specific configuration of the DSP software for all systems as shown within the drawings.
3. Provide ongoing software upgrades and maintenance for 12 months from date of final acceptance.
4. Coordinate user interface, software functionality, and menu screens with Operator's Consultant.
5. Software to be configured for the following systems:
  - a. Club Areas:
    - 1) System to provide for delivery of game related announcements, music and video accompaniment and associated programming to guests in the venue.
    - 2) System to permit individual spectral and temporal adjustment of similar speaker groups to synchronize the sound from the different speaker locations.
    - 3) Program the system to use presets to allow rapid setup of standard configurations.
    - 4) System to permit selected portions of the speakers to be linked to the temporary reinforcement system for supplemental delay fill. In this mode the selected speakers will be signal aligned with the temporary system and saved as a recallable preset.
    - 5) System to permit logical portion of the venue to be adjusted separately from other areas for maintenance and operational considerations. Provide as graphical overlay on venue. Coordinate these mute zones with the Owner.
      - a) Global: Full system mute. Overlay on venue map.
      - b) Section: Provide individual speaker zone mute. Overlay on enlarged venue chart to allow for clear identification of speaker zones.
    - 6) System to permit for preset reconfiguration of the venue system for use during other non-sporting events.
  - b. Lobby Prefunction System:
    - 1) The system is to provide sound to lobby prefunction area and is controlled by the control panel in the lobby prefunction area.
    - 2) Provide dynamics control and spectral adjustment for each speaker zone or segment.
    - 3) Provide visual indication of overall signal level within each speaker zone or segment.
    - 4) System to respond to an alarm override closure from the alarm system and mute all audio output. At completion of alarm override, system to revert to previous operating mode and configuration.
  - c. Restroom System:

- 1) The system is to provide sound to lobby restrooms and is controlled by the control panel in the lobby prefunction area.
  - 2) Provide dynamics control and spectral adjustment for each speaker zone or segment.
  - 3) Provide visual indication of overall signal level within each speaker zone or segment.
  - 4) System to respond to an alarm override closure from the alarm system and mute all audio output. At completion of alarm override, system to revert to previous operating mode and configuration.
- d. Entrance Gate System:
- 1) Provide control for all the exterior entrances.
  - 2) The system is to provide sound to entrance and is controlled by area from the lobby prefunction area.
  - 3) Provide dynamics control and spectral adjustment for each speaker zone or segment.
  - 4) Provide visual indication of overall signal level within each speaker zone or segment.
  - 5) System to respond to an alarm override closure from the alarm system and mute all audio output. At completion of alarm override, system to revert to previous operating mode and configuration.
- e. Security:
- 1) Provide supervisor or higher password protection to all configuration screens not intended to be manipulated by regular operators.
  - 2) Each normal user to have distinct password for logging of system usage.
6. Provide copies of software configuration to control system contractor to permit control system to interface with DSP unit. Make revisions as necessary to configuration file to facilitate control system integration.
- C. Amplifier Control System Software:
1. Control System Makeup:
    - a. All amplifiers shall be network monitored and controlled.
    - b. Control System shall use a Windows 10 based software system.
    - c. Graphical displays and menu screens to maintain a consistent user interface.
    - d. Screen selections shall be implemented by mouse pointer or keyboard.
    - e. System shall be implemented from control computer described above.
    - f. Control System shall communicate with other components via non-proprietary communication protocol. Provide all necessary repeaters, signal conditioners, format converters, etc. needed to connect the audio control room with the amplifier rooms. Data cable not to be run with audio cables.



- g. Control System software shall include password protection for multiple user levels.
2. Control System Setup Functions:
- a. Amplifier setup and adjustment.
  - b. Each amplifier shall be individually adjustable and adjustable in preprogrammed groups from control screen on computer. When used in groups, amplifiers shall maintain their own relative gain levels.
    - 1) Provide loudspeaker processing configuration for testing and tuning as follows:
      - a) Individual output control.
      - b) Group output by speaker type and venue zone.
  - c. Controls shall include volume up/down in 1/2 dB increments and provide mute on/off, power, signal polarity, and peak voltage limiting.
  - d. Internal digital signal processing will provide for narrow band parametric equalization, asymmetrical equalization filters, delay, crossover, custom FIR filters provided by loudspeakers manufacturers, limiting and dynamics.
  - e. System shall permit both channels to be linked for common operation or separated for individual adjustment.
  - f. Provide ability to include user provided amplifier labels for identifying which unit is being controlled.
  - g. System shall provide for power on and power off of amplifiers.
  - h. Amplifier control screens shall include graphical indications of input and output levels, power status, reserve headroom and thermal conditions of amplifier.
  - i. System shall have easy access to pre-set amplifier configurations.
  - j. Each amplifier to be able to retain its current gain settings in the event of power outage or loss of communication with the control computer.
3. Other system capabilities:
- a. Amplifier diagnostics and error reporting.
  - b. Control system shall monitor operating parameters of each amplifier.
  - c. System shall alert operator when an amplifier or group of amplifiers is clipping or overheating.
  - d. System to indicate the relative impedance of the speaker line and alert the operator when the load on the amplifier has changed significantly.
  - e. Provide user adjustability for amplifier alert by permitting operator to set degree of clipping or overheating before generating an alert.
  - f. Provide user selection on how alerts and errors are indicated, including any combination of log file, printer, visual indicator, email or audible indicator.
4. Visual system monitoring:
- a. Provide for multiple bar graph displays of amplifier outputs on system monitor.

- b. Size of graph and quantity displayed to be determined by operator.
  - c. Each graph shall indicate amplifier level in dB and include user provided label for describing amplifier function.
  - d. Graph shall also include information on amplifier clipping, reserve headroom, polarity, and mute status.
  - e. Provide integration of monitoring into DSP software platform.
5. System shall remain fully operable if one or more amplifiers ceases operation or goes offline.
  6. System shall remain fully operable if the control system goes offline.
  7. Software to run stand-alone with monitoring functions integrated into the main DSP control software.
  8. Acceptable software platforms:
    - a. QSC Q-Sys.

## 2.8 DIGITAL SIGNAL PROCESSING AND CONTROL EQUIPMENT:

- A. Signal processing for local rack systems shall be performed by an independent DSP unit.
- B. Primary audio signal processing shall be performed by a networked system of digitally controlled processing units. Each unit shall be capable of operating independently or in groups.
- C. The system shall have the following capabilities:
- D. Digital Signal Processing Unit (DSP UNIT):
  1. The audio processing unit shall be an industrial package designed for fixed installation.
  2. The unit shall include an architecture based on an integrated floating-point DSP engine dedicated DSP processing chips.
  3. The unit shall operate using Ethernet Layer 3 technology to support transmit and receive of at least 64 simultaneous high-speed digital audio channels. Use of proprietary digital buss to route digital audio between DSP Units and DSP Expanders within an amplifier room is acceptable.
  4. The unit shall include software-based configuration and control through a Windows-based software application, with additional tools for creating user interface clients and integration with control panel and third-party control systems.
  5. The unit shall include modular input/output audio and control expanders for support of individual, multi-channel audio cards.
  6. The unit shall be fan cooled and shall operate with a universal computer-grade modular power supply.
  7. Provide integration of the amplifier software for monitoring the status of each amplifier and controlling simple mute and level functions. Note that the amplifier software platform will be used setup on internal amplifier DSP parameters.
  8. Provide integration of the audio-video system components for monitoring and operational control include, but not limited to; audio amplification and

distribution, audio-video media ingest, routing, and distribution components, and output devices including televisions. Note: television control will only apply to television locations that have a control panel within the space.

9. Provide integrated message playback for areas such as the lobby and exterior entrances where ingress and egress security or promotional messages may be desired. Allow for separate messages in each area as coordinated with the building operator.
10. Provide with all software licenses required for system configuration.
11. Acceptable product:
  - a. QSC Q-sys Core 610.

E. QSC Q-sys DSP Audio I/O Expanders (DSP-I/O):

1. Select for use with QSC Core 610 processing option.
2. Analog audio input and outputs connections to Core processor.
3. Provide quantity as needed to accommodate the connections identified within the drawing functional details and plan drawings.
4. Acceptable product:
  - a. Four (4) mic/line inputs:
    - 1) QSC Qsys QIO-ML4i.
  - b. Four (4) line outputs:
    - 1) QSC Qsys QIO-L4o.
  - c. Two (2) mic/line inputs and two (2) line outputs:
    - 1) QSC Qsys QIO-ML2x2.
  - d. Sixteen (16) mic/line inputs and Sixteen (16) line outputs:
    - 1) Attero Tech by QSC Synapse D16Mio.
  - e. Thirty-Two (32) mic inputs:
    - 1) Attero Tech by QSC Synapse D32Mi.
  - f. Thirty-Two (32) line inputs:
    - 1) Attero Tech by QSC Synapse D32i.
  - g. Thirty-Two (32) line outputs:
    - 1) Attero Tech by QSC Synapse D32o.

F. QSC Q-syDSP GPIO and Control Expanders (DSP-CNTL):

1. Select for use with QSC Core 610 processing option.
2. General purpose input and outputs connections to Core processor.

3. Infrared input and outputs connections to Core processor.
4. Serial input and outputs connections to Core processor.
5. Provide quantity as needed to accommodate the connections identified within the drawing functional details and plan drawings.
6. Acceptable product:
  - a. GPIO: Eight (8) general purpose inputs & eight (8) general purpose outputs:
    - 1) QSC Qsys QIO-GD8x8.
  - b. IR: One (1) IR receiver input and four (4) IR emitter outputs:
    - 1) QSC Qsys QIO-IR1x4.
  - c. SER: Four (4) RS232 ports (one port with RS485 and RS422 compatibility):
    - 1) QSC Qsys QIO-S4.

G. Touch Screen Controllers – (TP1):

1. Type: Projective capacitive (PCAP) multi-touch technology, high-resolution 24-bit color display.
2. Resolution: 1280 x 720 pixel.
3. Brightness: 450 Nits.
4. Viewable Screen Dimensions (Diagonal): 5.0 inch.
5. Aspect ratio: 16:9.
6. Contrast ratio: 800:1.
7. Power: PoE Class 2.
8. Orientation: Portrait or landscape.
9. Wall box: 1-Gang.
10. Acceptable product:
  - a. QSC TSC-50-G3.

H. Touch Screen Controllers – (TP2):

1. Type: Projective capacitive (PCAP) multi-touch technology, high-resolution 24-bit color display.
2. Resolution: 1280 x 800 pixel.
3. Brightness: 400 Nits.
4. Viewable Screen Dimensions (Diagonal): 7.0 inch.
5. Aspect ratio: 16:10.
6. Contrast ratio: 850:1.
7. Power: PoE Class 3.
8. Orientation: Portrait or landscape.
9. Wall box: 2-Gang.
10. Acceptable product:
  - a. QSC TSC-70-G3.

I. Touch Screen Controllers – (TP3):

1. Type: Projective capacitive (PCAP) multi-touch technology, high-resolution 24-bit color display.
2. Resolution: 1920 x 1200 pixel.
3. Brightness: 380 Nits.
4. Viewable Screen Dimensions (Diagonal): 10.07 inch.
5. Aspect ratio: 16:10.
6. Contrast ratio: 800:1.
7. Power: PoE+ Class 4.
8. Orientation: Portrait or landscape.
9. Wall box: 2-Gang.
10. Acceptable product:
  - a. QSC TSC-101-G3.

2.9 AMPLIFIERS

A. Power Amplifiers:

1. Multi-channel power amplifier with the EIA standard RS-490 power rating at 1% THD into 8 Ohm load or 70-volt constant voltage load as applicable.
2. Provide protection of circuit components in the event of input over-drive, output overload, or short circuits.
3. Frequency response:  $\pm 1$  dB, 20 Hz to 20 kHz with less than 1 per cent THD at rated output.
4. Input impedance: 20 kOhms balanced.
5. Output regulation: 2 dB from no load to full load conditions.
6. Noise generation: at least 85 dB below rated output with input shorted.
7. Provide quantity of channels required as shown within the functional diagrams.
8. Provide rear rack rail support for all amplifiers.
9. Provide one spare amplifier for each amplifier type used for the project.
10. Acceptable products:
  - a. Type 1 Power Amplifier – Minimum 700 watts/channel at 70V or 4 Ohms:
    - 1) QSC CX-Q 2K4.
  - b. Type 2 Power Amplifier – Minimum 60 watts/channel at 4 Ohms or 120 watts bridged at 70V:
    - 1) QSC SPAQ 100-2f.

2.10 NETWORK EQUIPMENT

A. Network Overview:

1. A Gigabit Ethernet structured cabling system and data network will be provided to transfer networked audio and control from the audio control room DSPs to the amplifiers and other system devices.
2. The system as specified incorporates one or more networking standard(s) for audio, and various control protocols will be implemented. Special consideration will be needed when using more than one networking standard on the same network switch.
3. The minimum network switch requirements will vary based on the selected DSP manufacturer, audio transport method, and network topology.
4. Proper system deployment will require coordination between the Contractor, Owner, and IT staff. Coordination of IP addresses, VLANs, QoS, IGMP, and other network requirements are part of this Work.

B. Ethernet Switch (NET-SWT, Type 1):

1. Compatible and approved by DSP and amplifier system manufacturer.
2. Ports: 24 or 48 with 10/100/1000 RJ-45 auto-sensing ports plus minimum of 2 SFP ports.
3. PoE: Each port to be POE+ capable.
4. Capacity: 48 port 176 Gb/s, 24 port 128 Gb/s.
5. Power Supply: Field-replaceable 750WAC.
6. Redundant Power Supply: Field-replaceable 750WAC, internal or external to switch depending on manufacturer platform selected.
7. Software:
  - a. Capable of Layer 2 switching and Layer 3 routing.
  - b. IPv6, IP Base software feature set.
  - c. Quality of Service (QoS).
  - d. SNMP remote monitoring capability.
  - e. Spanning tree and meshing protocol capable.
8. Port Count: Size to allow a minimum of 20% spare ports.
9. 1-RU rack mountable.
10. Provide quantity as needed for port count and spare ports.
11. Acceptable Product:
  - a. Extreme Networks X440-G2-24p/48p-10GE4.
  - b. HP/Aruba 2930F Series.
  - c. Approved Equal.

C. Ethernet Switch (NET-SWT, Type 2):

1. Compatible and approved by DSP and amplifier system manufacturer.
2. Ports: 12 10/100/1000 RJ-45 auto-sensing ports plus minimum of 2 SFP ports.
3. PoE: Each port to be POE+ capable.
4. Capacity: 12 port 104 Gb/s
5. Power Supply: Field-replaceable 750WAC.
6. Redundant Power Supply: Field-replaceable 750WAC, internal or external to switch depending on manufacturer platform selected.
7. Software:

- a. Capable of Layer 2 switching and Layer 3 routing.
  - b. IPv6, IP Base software feature set.
  - c. Quality of Service (QoS).
  - d. SNMP remote monitoring capability.
  - e. Spanning tree and meshing protocol capable.
8. Port Count: Size to allow a minimum of 20% spare ports.
  9. 1-RU rack mountable.
  10. Provide quantity as needed for port count and spare ports.
  11. Acceptable Product:
    - a. Extreme Networks X440-G2-12p-10GE4.
    - b. HP/Aruba 2930F Series.
    - c. Approved Equal.
- D. Network Switch Fiber Module:
1. Type: 1000BASE-SX/LX.
  2. Fiber Type: Multi-mode or single-mode.
  3. Bandwidth: 500 MHz.
  4. Operating Distance: 550m.
  5. Provide quantity in each switch to fulfill the functional requirements detailed within the drawings.
  6. Acceptable product:
    - a. Extreme Networks.
    - b. HP/Aruba.
    - c. Approved Equal.
- E. LC Fiber Patch Cords:
1. Fiber Type: Multi-mode or Single-mode.
  2. Connector: Duplex LC-LC.
  3. Length: As needed.
  4. Acceptable product:
    - a. Belden FX Series.
    - b. Approved Equal.
- F. RJ-45 Patch Cords:
1. Provide for interconnecting audio system Ethernet enabled devices to network switches.
  2. Cables to be factory made with flexible boot over connector.
  3. Provide an assortment of cable jacket colors to aid in wire tracing. Provide equal quantities of red, green, blue and yellow jacketed cables.
  4. Cables to be rated Category 6.
  5. Acceptable product:
    - a. Belden CAT6 CAD9Z(Color)(Length)M.
    - b. Approved Equal.

G. Fiber Termination Panel – Rack Mounted:

1. Unit provided to terminate fiber runs terminating in main and remote AV racks.
2. Enclosure to be able to terminate up to 96 fibers.
3. Enclosure able to accept up to eight (8) Adapter Plates.
4. Rack mounted enclosure.
5. Provide additional adapter plates to terminate new fiber optic cabling and select module density based on number of terminations required.
6. Provide enclosure size and adapter quantity according to quantity of fibers being terminated.
7. Acceptable product:
  - a. Rack Chassis:
    - 1) 1RU – Belden AX100041.
    - 2) 2RU - Belden AX100068.
    - 3) 3RU – Belden AX104934.
    - 4) 4RU – Belden AX100116.
    - 5) Approved Equal.
  - b. Fiber Adapters:
    - 1) 6LC Duplex OM1 – Belden AX101741.
    - 2) 12LC Duplex OM1 – Belden AX101729.
    - 3) 6LC Duplex SM – Belden AX101743.
    - 4) 12LC Duplex SM – Belden AX101731.
    - 5) Approved Equal.

H. Fiber Termination Panel – Wall Mounted:

1. Unit provided to terminate new fiber runs requiring terminations on wall.
2. Enclosure to be able to terminate up to 48 (LC) fibers.
3. Enclosure able to accept four (4) Quick-Pack Adapter Plates.
4. 2RU Rack mounted enclosure.
5. Provide additional adapter plates to terminate new fiber optic cabling and select module density based on number of terminations required.
6. Acceptable product:
  - a. Enclosure:
    - 1) Belden AX103928.
    - 2) Approved Equal.
  - b. Fiber Adapters:
    - 1) 12LC Duplex OM1 – Belden FF1U12LD.
    - 2) 12LC Duplex SM – Belden FFSU12LD.
    - 3) Approved Equal.

2.11 POWER CONDITIONING



A. Power Protection (SURGE):

1. Provide surge protection device to maintain clean power to the following equipment:
  - a. DSP devices.
  - b. Computer CPU's, Monitors and KVM switch, DSP analog to digital converters.
  - c. Fiber Transport system components.
  - d. All UPS backup power supplies.
  - e. Acceptable products:
    - 1) Middle Atlantic PD-920R-SP.
    - 2) Approved Equal.

B. Backup Power (UPS-Type 1):

1. Provide UPS systems to maintain power to all the following:
  - a. Computer CPU's, associated video monitors and KVM switch components.
  - b. Provide UPS system for all Digital Signal Processing (DSP) units.
  - c. Provide UPS system for all network components.
2. UPS's shall be line-interactive style with sufficient battery reserve to operate for 15 minutes. Size each UPS unit for 25% additional capacity.
3. 2-RU Rack mountable.
4. Acceptable product:
  - a. Middle Atlantic UPS-S Series.
  - b. Approved Equal.

C. Rack Power Strip (POWER DIST):

1. 20 Amp/2400 Watt rating
2. Front panel AC voltmeter.
3. Spike and surge suppression with over-voltage shutdown
4. 1-U Rack Mountable
5. Acceptable product:
  - a. Middle Atlantic PD-920R.
  - b. Approved Equal.

D. AV Rack Power Distribution System

1. Provide system to power sound and audio-visual system rack equipment. This includes, but is not limited to, equipment such as the console, mixers, program sources, DA's, signal processing equipment, and amplifiers.
2. Power distribution equipment must support dedicated grounds (providing an individual ground wire for each circuit). Sharing of grounds or neutrals between circuits is not acceptable. All outlets to be isolated ground type.

3. Power distribution equipment must be listed by a recognized safety testing agency.
4. Quantity: One (1) for each AV rack. Size of raceway and number of power modules provided as required for proper circuiting of each rack. Replace existing power distribution within equipment racks being reused in West amplifier room.
5. Acceptable product manufacturers:
  - a. Middle Atlantic Products:
    - 1) MPR-3 32" Modular Power Raceway.
    - 2) MPR-6 56" Modular Power Raceway.
    - 3) MPR-9 80" Modular Power Raceway.
    - 4) M-20IGA Power Module(s).
    - 5) Blanks and cable jumpers as required.
  - b. Approved Equal.

## 2.12 LOUDSPEAKERS

### A. Type 30 Speaker – Restroom Ceiling:

1. Configuration: 4/5-inch coaxial 2-way.
2. Coverage pattern: 110° conical.
3. Sensitivity: 90 dB at 1W/1M.
4. Frequency operating range: 80 Hz to 20 kHz.
5. Transformer: Internal 16-Watt, 70.7 Volt.
6. Provide all necessary grilles, backcans, mounting hardware, brackets, and tile supports.
7. Paint grille to match surrounding surfaces at the direction of the Architect.
8. Acceptable product:
  - a. Bose DM5C.
  - b. JBL Control 24CT Micro Plus.

### B. Type 31 Speaker – Club Ceiling:

1. Configuration: Pendant Style, 5-inch coaxial 2-way.
2. Coverage pattern: 120° conical.
3. Sensitivity: 87 dB at 1W/1M.
4. Frequency operating range: 65 Hz to 20 kHz.
5. Transformer: Internal 60-Watt, 70.7 Volt.
6. Provide with necessary mounting hardware and supports required to suspend from building structure.
7. Acceptable product to include the following:
  - a. Bose DM5P.
  - b. JBL Control 65P/T.

### C. Type 32 Speaker – Exterior Entrance:

1. Configuration: Two-way column cabinet.
2. HF: (16) 1-inch drivers.
3. LF: (4) 5-inch low frequency driver.
4. Coverage pattern: Vertically selectable.
5. Sensitivity: 98 dB at 1W/1M in speech mode.
6. Frequency operating range: 60 Hz to 20 kHz.
7. Transformer: Internal 150-Watt, 70.7 Volt, Bypass 8 ohm.
8. Crossover: Internal passive crossover.
9. Weather Rating: IP55.
10. Color: Black.
11. Provide all necessary mounting hardware, brackets, supports and any secondary steel required to attach to building structure.
12. Provide set screw with security head (allen, torx, etc.) type fitting.
13. Acceptable product:
  - a. JBL CBT-70J-1 with MTC-CBT-FM2 mounting bracket.

D. Type 33 Speaker – Lobby Prefunction:

1. Configuration: Two-way column cabinet.
2. HF: (8) 1-inch drivers.
3. LF: (7) 3-inch low frequency driver.
4. Coverage pattern: 130° H x +6°/-22° V.
5. Sensitivity: 91 dB at 1W/1M.
6. Frequency operating range: 110 Hz to 20 kHz.
7. Transformer: Internal 150-Watt, 70.7 Volt, Bypass 8 ohm.
8. Crossover: Internal passive crossover.
9. Color: Black.
10. Provide all necessary mounting hardware, brackets, supports and any secondary steel required to attach to building structure.
11. Acceptable product:
  - a. Tannoy VLS-15.

## 2.13 SPEAKER HARDWARE AND SUPPORT STRUCTURE

- A. Provide a modular loudspeaker hardware system as required to mount and suspend speakers in the arrangement as shown on the Drawings.
- B. Attachment system to be supplied by vendor whose primary specialty is fabricating support systems for loudspeakers or similar devices over an audience.
- C. Provide safety cable on all bracket mounted loudspeakers.
- D. Provide auxiliary support steel and hardware required to attach to building structure and design members to have a minimum safety factor of at least 7:1. Reference architectural and structural documentation for details on structural elements.
- E. All wire rope used for loudspeaker suspension to have a minimum safety factor of 10:1.

- F. Fabricate all components from powder coated steel for maximum resistance to corrosion.
- G. Acceptable manufacturer:
  - 1. ATM Flyware / Allen Products
  - 2. Whirlwind Metal Fabrication (U-Brackets Only).
  - 3. Custom Engineered by Contractor (reference submittal requirements for additional information).
- H. Shoulder Type Machinery Eye Bolts:
  - 1. Forged Steel – Shoulder, Quenched and Tempered.
  - 2. Fatigue rated at 1-1/2 times the Working Load Limit at 20,000 cycles.
  - 3. Product to meet or exceed all the requirements of ASME B30.26 including identification, ductility, design factor, proof load and temperature requirements.
  - 4. Select size of product based on working load limits required.
  - 5. Acceptable product:
    - a. Crosby Group S-279 / M-279 Series.
    - b. Chicago Hardware Company 261 Series.
- I. Forged Eye Nuts:
  - 1. Forged Steel – Quenched and Tempered.
  - 2. Tapped with standard UNC class 2 threads after galvanizing.
  - 3. Product to meet or exceed all the requirements of ASME B30.26 including identification, ductility, design factor, proof load and temperature requirements.
  - 4. Select size of product based on working load limits required.
  - 5. Acceptable product:
    - a. Crosby Group G-400 Series.
    - b. Chicago Hardware Company 167 Series.
- J. Anchor Shackles:
  - 1. Forged - Quenched and Tempered, with alloy pin.
  - 2. Working Load Limit permanently shown on every shackle.
  - 3. Hot Dip galvanized or Self-Colored.
  - 4. Product to meet the performance requirements of Federal Specification RR-C-271D Type IVA, Grade A, Class1.
  - 5. Select size of product based on working load limits required.
  - 6. Provide all screw pin type shackles with mouse wire.
  - 7. Acceptable product:
    - a. Crosby Group G-209 / S-209 Series Screw Pin.
    - b. Chicago Hardware Company 201 Series.
- K. Wire Rope Thimble:

1. Product to meet the performance requirements of Federal Specification FF-T-276b Type II.
2. Hot Dip galvanized.
3. Select size of product based on wire rope size required for suspended load.
4. Acceptable product:
  - a. Crosby Group G-411 Series.
  - b. Chicago Hardware Company 224/225 Series

L. Wire Rope:

1. Strands: 7 x 19 Utility Cable
2. Type: Galvanized
3. Select size of product-based working load limits required
4. Acceptable Product:
  - a. WireCo World Group
  - b. Approved equal

M. Wire Rope Sleeves:

1. Type: Copper Duplex
2. Select size of product-based wire rope size required for suspended load
3. Acceptable Product:
  - a. WireCo World Group SW-740 Series
  - b. Approved equal

## 2.14 HEARING ASSISTANCE SYSTEM

A. General:

1. Purpose: provide radio frequency transmission of locally selected audio program to patrons in venue with wireless receiver.
2. Coordinate frequencies of transmitters with other users in the area to avoid conflicts.

B. Portable ALS System:

1. For use club lounge.
2. Listen Technologies:
  - a. Kit to include the all the following:
    - 1) One (1) LT-800-072 Stationary RF Transmitter (72 MHz).
    - 2) One (1) LA-125 Rack Panel Mounted Antenna (72 MHz).
    - 3) Four (4) LR-3200-072 Portable Digital RF Receiver (72 MHz).
    - 4) Eight (8) LA-161 Single Ear Bud.
    - 5) Four (4) LA-438 Neck Loop.
    - 6) One (1) LA-304 Assistive Listening Notification Signage Kit.
    - 7) Portable Rack:

- a) Gator GRR-4L rack.
- b) Rack Power Strip (POWER DIST).
- c) 2-RU Rack Drawer with customizable foam insert.

## 2.15 MISCELLANEOUS EQUIPMENT

### A. Line Level Isolator (LLI):

1. Two channel isolator
2. XLR input and output
3. Maximum Signal Handling: +19dBu
4. Acceptable Product:
  - a. Jensen Iso-Max PI2XX

### B. Intercom Wall Station (ICS):

1. Single-Channel Remote Speaker Station
2. Half-duplex, push-to-talk functionality
3. Four modes of operation that are internally programmable
4. Microprocessor controlled logic and switching
5. Balanced local program input with separate level control
6. Visual and audible call signaling
7. Built-in speaker
8. Acceptable Product:
  - a. Clear-Com KB-701.

## 2.16 EQUIPMENT HOUSING & ACCESSORIES

### A. Audio Equipment Racks:

1. Type: Frame and panel with locking rear door
2. Size: 32-inches deep with 38 units of vertical space
3. Construction: Factory assembled 16-gauge cold-rolled steel frames with all corners welded
4. Black enameled finish
5. Provide all necessary side panels, trim pieces, tops, and blank panels.
6. Acceptable Product:
  - a. Middle Atlantic Products AXS-IR-4132-26
  - b. Include the following accessories:
    - 1) Middle Atlantic Track-50 and Track-L
    - 2) Middle Atlantic AXS-WT50 Cable Management

### B. Rack Fan(s):

1. Fan: 4.5-inch, 115V.
2. Include mounting panel as required by selected rack configuration.

3. Include cord and hardware.
4. Provide four (4) fans units.
5. Provide rack top panel as needed.
6. Acceptable products:
  - a. Middle Atlantic MAFAN with GUARD.

C. Fan Thermostat Control:

1. Switched 15A duplex outlet.
2. Temperature Range: 50 – 90 Degrees F°.
3. On and Stand-by LED indicators.
4. Integral mounting ears.
5. Provide for each rack and fan assembly.
6. Acceptable product:
  - a. Middle Atlantic FC-4-1C.

D. Rack Temperature Display:

1. Provide one display in top front panel space of each rack.
2. Decora mount in 1-RU rack panel.
3. Digital readout in Fahrenheit or Celsius.
4. Connect to DAP GPIO for high temperature alarm to the audio control room.
5. Acceptable products:
  - a. Middle Atlantic TEMP-DEC with DECP-1X1 Panel.

E. Rack Lamp:

1. Provide one in the rear of each equipment rack.
2. Acceptable product:
  - a. Middle Atlantic LT-GN-WL Rack light.

F. Rack Blanks:

1. Flanged, aluminum panel.
2. Blank anodized finish.
3. Provide where shown on drawings.
4. Acceptable product:
  - a. Middle Atlantic BL series.

G. Cable Entry Rack Brush Grommet:

1. Provide above and below network switches with front cable access.
2. 1-RU with Brush Cable Entry.
3. Acceptable products:
  - a. Middle Atlantic BR-1.

H. Cable Management:

1. Provide for industry standard cable management in the rear of all audio and AV racks.
2. Quantity: Provide as needed.
3. Acceptable product:
  - a. Middle Atlantic LPB Horizontal Lacer Bar.
  - b. Middle Atlantic P, LP, OP, or OWP Vertical Lacer Bar.

I. Rack Drawer:

1. Provide two (2) drawers in AV closet rack.
2. Provide 3RU drawer or as shown on drawings.
3. Drawer depth to be 14.5 inches.
4. Acceptable product:
  - a. Middle Atlantic D series.

J. Equipment Rack Screws:

1. Install rack mounted equipment with black 10-32 star post security screws with flat nylon washers
2. Quantity as required
3. Provide one spare bit located in a clear plastic bag attached to the inside of each equipment rack in plain view
4. Acceptable Product:
  - a. Middle Atlantic HTX

2.17 PLATES AND PANELS

- A. Provide plates and panels and as described in Drawings. Engrave as shown on Drawings. Other Plates and Panels may be required to satisfy the requirements of the Work.
- B. Custom panels shall be flanged standard EIA sizes, brushed black anodized finish unless otherwise noted.
- C. Plate finish shall be coordinated with the Architect. Plastic plates are not acceptable.
- D. Panel, plate, and label engraving shall be 1/8-inch block sans serif characters unless noted otherwise. On dark panels or pushbuttons, letters shall be white; on stainless steel or brushed natural aluminum pushbuttons, letters shall be black.
- E. Custom and/or Engraved Panels:
  1. Custom panels constructed of 1/8 inch brushed aluminum
  2. Finish: black anodize
  3. Acceptable Product:



- a. Liberty Cable/Panel Crafters
- b. RCI Custom
- c. ProCo
- d. Whirlwind

## 2.18 CABLES & WIRING

- A. All electrical conductors installed under this contract, except where otherwise specified, shall be soft drawn annealed stranded copper having a conductivity of not less than 98% of pure copper, and meet appropriate ratings (e.g., CMR, CMP, etc.)
- B. Cable shall carry appropriate fire rating (e.g., CMR, CMP, OFNR, OFNP, etc.) on jacket of cable.
- C. Where cables are routed through cable tray, provide tray rated cable of equal specification.
- D. Where speaker cables are run exposed through a return air plenum, provide plenum rated cable of equal specification.
- E. Shielded cables located in raceways shall have aluminum foil shield with drain wire.
- F. The Belden cables listed below are approved for use on this project and are listed to set the acceptable standard of performance. If field conditions or actual cable pathway requires tray or plenum cable, provide version of cable that meets required rating. Cables from Commscope, Gepco, Liberty, Optical Cable Corporation, and West Penn are also acceptable provided they meet the performance specifications and conduit fill of the approved listed cables.
- G. Low-Impedance Loudspeaker Cables:
  1. Belden 5000UP - 12 gauge twisted pair, jacketed. Provide Belden 6000UE in plenum spaces.
- H. High-Impedance Loudspeaker Cables:
  1. Homerun - Belden 5000UP - 12 gauge twisted pair, jacketed. Provide Belden 6000UE in plenum spaces.
  2. Speaker to Speaker - Belden 5200UP - 16 gauge twisted pair, jacketed. Provide Belden 6200UE in plenum spaces
- I. Microphone and Line Level Cable: Belden 9451 - Single Pair twisted, 22 gauge, shielded, jacketed.
- J. Clear-Com Intercom Cable: Belden 8762 - Single Pair twisted, 20 gauge, shielded, jacketed.
- K. Ethernet Cable: Belden 2412 - 4 pair, enhanced Category 6 non-bonded pairs.
- L. Indoor Fiber Optic Cable: Belden FISD012F9 or FISD012A9 Single-mode, 12 strand, Double Jacketed, Interlocked Armor Distribution Cable.

## 2.19 CONNECTORS

### A. XLR Panel mount Connectors:

1. Provide panel mount XLR connectors with unified metal shell
2. RF-Protector connectors
3. Shell Color: Black
4. Contacts: Silver
5. Terminations: Solder
6. Acceptable Product:
  - a. Male Connectors: Neutrik NC\*MD-L-1-BAG Series
  - b. Female Connectors: Neutrik NC\*FD-L-1-BAG Series

### B. XLR Cable Connectors:

1. Provide XLR cable connectors with die cast shell
2. No-screw type assembly
3. Chuck-type strain relief
4. Shell Color: Black
5. Contacts: Silver
6. Terminations: Solder
7. Acceptable Product:
  - a. Male Connectors: Neutrik NC\*MX-BAG Series
  - b. Female Connectors: Neutrik NC\*FX-BAG Series.

### C. 1/4" Panel mount Connectors:

1. Provide panel mount 1/4" connectors with unified metal shell
2. Shell Color: Black
3. Contacts: Silver
4. Terminations: Solder
5. Acceptable Product:
  - a. Female Connectors: Neutrik NJ3FP6C-BAG Series

### D. 1/4" Cable Connectors:

1. Provide 1/4" cable connectors with die cast shell
2. No-screw type assembly
3. Chuck-type strain relief
4. Shell Color: Black
5. Contacts: Nickel
6. Terminations: Solder
7. Acceptable Product:
  - a. Male Connectors: Neutrik NP3C-BAG Series

### E. BNC Cable Connectors:

1. Provide cable mount BNC connectors

2. Contacts: Brass or copper
3. Terminations: Crimp
4. Acceptable Product:
  - a. Kings
  - b. Amp
  - c. Amphenol
  - d. Canare
  - e. Liberty

F. RCA Male Cable Connectors:

1. Provide RCA cable connectors with die cast shell
2. Shell Color: Silver
3. Contacts: Silver
4. Terminations: Solder
5. Acceptable Product:
  - a. Switchcraft 3502 Series
  - b. Liberty

G. F Connector:

1. Provide commercial style gold plated connector with integral sleeve for F6 Series, F11 Series, and F59 Headend cable
2. Provide seal ring in all moisture intensive environments
3. Install with manufacturer recommended compression tool
4. Provide weatherized boots and seal covers for all antenna connections
5. Verify connector cable type, size and construction with manufacturer
6. Acceptable Product:
  - a. Gilbert Engineering GF-US-6Q series, GF-US-11Q, and GF-US-59Q series respectively
  - b. Gilbert Engineering Seal ring: G-SR-1/2

H. RJ45 Connectors:

1. UTP Category 6, 8-pin wiring inserts T568A/B jacks
2. Acceptable Products:
  - a. Belden PN#AX101320 (color to match plate)

### **PART 3 - EXECUTION**

#### **3.1 GENERAL**

- A. Coordination of the Work specified herein with other project work so as to facilitate a cohesive final Product.

- B. The installation recommendations contained within ASDI and Telecommunications Distribution Methods Manual are mandatory minimum standards and requirements.
- C. Mount equipment and enclosures plumb and level.
- D. Permanently installed equipment to be firmly and safely held in place. Design equipment supports to support loads imposed with a safety factor of at least five. Seismic bracing shall be installed on appropriate equipment where local codes require such installation.
- E. Verify all locations of equipment in all rooms with Owner's Representative, Owner, and Consultant.

### 3.2 INSTALLATION

#### A. Installation of cable and wiring

##### 1. Cabling and Wiring:

- a. Install cable in a manner to adhere to manufacturer's specifications for maximum cable pulling tension, minimum bend radius, and any other restrictions.
- b. Provide appropriate support at all horizontal-to-vertical transitions in order to keep the weight of the cable from degrading at the point of transition.
- c. If a J-hook or trapeze system is used to support cable bundles, all horizontal cables shall be supported at a maximum of 48-inch (1.2 meter) intervals. At no point shall the cables rest on light fixtures, acoustic ceiling grids, panels, conduits, sprinkler pipe, water pipe and/or HVAC system ducting.
- d. Horizontal distribution cables shall be bundled in groups of no more than 50 cables when being supported by J-Hook or trapeze systems. Cable bundle quantities in excess of 50 cables may cause deformation of the bottom cables within the bundle and degrade cable performance. An exception to this rule is when cable is installed in cable tray systems.
- e. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.
- f. Cables shall not be attached to ceiling grid or lighting fixture wires. Where support for horizontal cable is required, install appropriate carriers to support the cabling.
- g. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced prior to final acceptance at no cost to the Owner.
- h. Cables shall be identified by a self-adhesive machine label in accordance with the System Documentation Section of this specification and ANSI/TIA/EIA-606-A. The cable label shall be applied to the cable behind the faceplate on a section of cable that can be accessed by removing the cover plate.

- i. Unshielded twisted pair cable shall be installed so that there are no bends smaller than four times the cable outside diameter at any point in the run and at the termination field.
- j. Provide splice free wiring and cabling from origination to destination. Cables shall be installed in continuous lengths from origin to destination (no splices). Properly designed transition points, or consolidation points are not considered 'splice' points.
- k. Make joints and connections with rosin-core 60/40 solder or with mechanical connectors specifically intended for the type and class of cable being used. Where spade lugs are used, crimp properly with ratchet type tool.
- l. Take precaution to prevent and guard against electromagnetic and electrostatic hum. For line-level audio signal, float cable shield at one end. Shield(s) that are not connected are to be folded back over the cable jacket and covered with heat-shrink tubing. Do not cut off unused shield.
- m. Isolate cables and wires of different signals or different levels are to be separated, organized, and routed in order to restrict channel crosstalk, or create feedback oscillation in any amplifier section. Keep wiring separated into groups for microphone level circuits, line level circuits, loudspeaker circuits, and power circuits.
- n. Connect cable to active components through XLR connections whenever multiple formats are available. Make connections to speaker transformers with properly sized closed-end connectors crimped with factory approved ratchet type tool. Wire nut or "Scotchlock" connectors are not acceptable. Do not wrap audio cable splices or connections with adhesive backed tape.
- o. Cover edges of cable and wire pass-through holes in chassis, housings, boxes, etc., with rubber grommets or Brady GRNY nylon grommetting.
- p. Execute wiring in strict adherence to:
  - 1) Phillip Giddings. Audio System Design and Installation. Indianapolis: Howard W. Sams & Co., 1990.
  - 2) Don Davis and Carolyn Davis. Appendix II, Recommended Wiring Practices. Sound System Engineering, 2nd Edition. Indianapolis: Howard W. Sams & Co., 1989.
  - 3) AV Installation Handbook Second Edition: The Best Practices for Quality Audiovisual Systems, Infocomm, 2009

2. Equipment Housing Cabling and Wiring:

- a. Lace, tie, or harness wire or cable as required herein, and in accordance with accepted professional practice. Dress, lace, or harness all wire or cable to prevent mechanical stress on electrical connections; no wire or cable shall be supported by a connection point. Install cable and wire neatly tied in manageable bundles with cable lengths cut to minimize excess cable slack but still allow for service and testing. Provide horizontal support bars if cable bundles sag.
- b. Provide adequate service loops so that equipment mounted on rack slides may be pulled fully out to their locked position without straining cable.

- c. Neatly bundle excess AC power cable from housing mounted equipment with plastic cable ties.
- d. Provide plastic cable ties or Velcro straps to bundle cabling and wiring. Electrical tape and adhesive backed cable tie anchors are not acceptable.
- e. Install with connections completely visible and labeled.
- f. Provide termination resistors, if required, of 5 percent tolerance. Mount the termination resistors fully visible.

B. Installation of connectors, plates & panels:

1. Install panel mounted connectors rigidly attached to panels, plumb and level.
2. Custom rack panels shall be flanged standard EIA sizes, brushed black anodized finish unless otherwise noted.
3. Custom connector plates (loudspeaker, microphone, etc.lamicoi) are typically stainless steel, unless otherwise noted or specified. However, verify plate finish with the Owner.
4. Install XLR type connectors in accordance with IEC-268 standard, with a wiring scheme of pin 2 hot (high), pin 3 (low), and pin 1 screen (shield).
5. Other Plates and Panels may be required to satisfy the requirements of the Work.

C. Installation power and grounding:

1. Coordinate final connection of power and ground wiring to housings.
2. Hardwire power wiring directly to internal AC receptacles to ensure uninterrupted operation.
3. Provide 3-conductor, isolated ground, 120 VAC outlets as required within each housing. Provide a minimum of two spare outlets in each rack.
4. Provide a copper ground buss top to bottom in each housing, insulated from the housing. Ground equipment chassis not having a three wire power cord to these busses using 6/32 nuts, bolts and lock-washers with No. 12 wire. Connect green ground wire from each AC outlet in housing to this buss bar.
5. Replace manufacturers supplied 18 gauge IEC power cords with UL listed 18 gauge pre-molded 6", 12", 18", or 24". Use minimum length required. No looped or cable tied IEC power cords will be permitted within the equipment rack.
6. Replace manufacturers supplied 14 gauge IEC power cords with UL listed 14 gauge pre-molded 18" or 36" folamr all equipment IEC capable. Use minimum length required and minimize looped or cable tied IEC power cords present in the equipment rack.

D. Installation of electronic equipment:

1. Take appropriate precautions against electrostatic discharge (ESD). Establish a personal ground before handling electronic equipment through the use of a grounded wrist wrap and/or an anti-static floor pad.
2. Take appropriate precautions to protect the equipment from damage during installation. Equipment to be installed free of damages, scratches, dents, etc.
3. Mount trim potentiometers, custom circuit cards, relays, and transformers (except large 70V units) in shielded enclosures, and mark their function and connections with engraved lamicoi labels.

4. Mount equipment plumb and level, firmly and safely held in place.

E. Installation of equipment housing:

1. Mount equipment in racks or other project specific equipment housing apparatus. Fully wire and test before delivery to job site. If field conditions prevent prior assembly of racks, notify Owner in writing that racks will be fabricated on site and the reasons for the change.
2. Provide rear support for housing mounted equipment greater than 15 inches deep.
3. Provide blank panels to fill unused panel space within the equipment housing.
4. If Key door locks are required, key each housing type alike.
5. Looking at the rack from the rear, locate AC power and speaker wiring on the left; line level audio, video, and RF wiring on the right.
6. Provide shaft locks or security covers on non-user operated equipment having front panel controls. These panels are to be installed at the conclusion of testing.
7. If forced-air active thermal management is used, provide ventilation blocking material on the front, sides, and rear of the equipment rack as needed. Reference Middle Atlantic Products "Controlling the Temperature Inside Equipment Racks". Air temperature inside of the rack is not to exceed 90 degrees Fahrenheit.
8. Panels, or equipment mounted on the rear rack rails, shall not block access to any front mounted components.
9. If equipment rack is not equipped with casters, provide two inch high wood base to isolate equipment rack from floor. Wood base should be capable of supporting the load.

F. Installation of loudspeakers:

1. Loudspeakers shall be mounted at the operating position in a safe, secure, and permanent manner.
2. Rigging, mounting, and support systems for loudspeakers shall be reviewed and certified by a registered Professional Engineer (PE) licensed to practice in the State in which the project is located. Documentation shall be included as a submittal item. Once the systems are installed, the PE shall physically inspect the methods and means used to verify compliance with the original design.
3. Paint loudspeakers, supports, and related hardware color as directed by the Owner.
4. The aiming direction of all loudspeakers shall be adjustable by  $\pm 5$  degrees horizontally and vertically.
5. Structural support members to have a safety factor of at least five. Mounting hardware and wire rope to have a safety factor of eight. All fasteners are to be graded, and certified for use in the intended applications. Overhead suspension hardware shall comply with ASME B30.20 standards and all applicable local building and safety codes. Overhead suspension hardware must be of a type that includes product traceability controls.
6. Loudspeakers are to be oriented parallel to their mounting surface unless otherwise noted.
7. Provide a safety cable connected to a secondary location for each loudspeaker.

8. All loudspeakers located in ceiling tiles shall be located in the center of the tile unless noted otherwise.

G. Installation of projectors:

1. Confirm distance of specified projection lens before mounting projector.
2. Projectors shall be mounted plumb and level at the operating position in a safe, secure, and permanent manner.
3. All hardware required to locate the mount and projector at the required location shall be provided.
4. Projectors shall be mounted using tamper proof secure hardware.
5. Contractor may be required to adjust projection screen, projection screen upper and lower limit switches, and lifts specified elsewhere not installed as part of this Contract.

H. Installation of flat panel monitors:

1. Confirm location before mounting.
2. Monitors shall be mounted plumb and level at the operating position in a safe, secure, and permanent manner.
3. All hardware required to locate the mount and monitor at the required position shall be provided.
4. Locate monitor on the center line of the room unless noted otherwise.

I. Outdoor mounting of equipment

1. Objects mounted outdoors and within the building bowl structure shall be properly treated for exposure to moisture and temperature extremes.
2. Mounting hardware shall be non-corrosive or be coated with a corrosion inhibiting layer.
3. Structural supports for loudspeakers, or other equipment, shall have inherent corrosion resistance, or be covered with a corrosion inhibiting layer.
4. Speaker components mounted in exterior environments shall be rigidly connected to the structure to prevent movement caused by wind gusts.
5. Speaker and microphone enclosures to include grille capable of breaking up direct water sprays or rain.
6. Seal all exposed electrical connections on speaker enclosure with waterproof silicone sealant.
7. Treat paper cones of outdoor speakers with silicone based moisture repellent if not factory treated.
8. Provide screened cover over all openings in horn type speakers to keep out birds, insects, or small animals. Screened covering to be stretched with no visible wrinkles.

### 3.3 FIRESTOP

- A. A fire-stop system is comprised of the item or items penetrating the fire rated structure, the opening in the structure, and the materials and assembly of the materials used to seal the penetrated structure. Fire-stop systems comprise an effective block for fire, smoke, heat, vapor, and pressurized water stream.



- B. All penetrations through fire-rated building structures (walls and floors) shall be sealed with an appropriate fire-stop system. This requirement applies to through penetrations (complete penetration) and membrane penetrations (through one side of a hollow fire rated structure). Any penetrating item i.e., riser slots and sleeves, cables, conduit, cable tray, and raceways, etc. shall be properly fire-stopped.
- C. Fire-stop systems shall be UL Classified to ASTM E814 (UL 1479) and shall be approved by a qualified Professional Engineer (PE), licensed (actual or reciprocal) in the state where the work is to be performed.
- D. A drawing showing the proposed fire-stop system, stamped/embossed by the PE shall be provided to the Owner's Technical Representative prior to installing the fire-stop system(s).
- E. All fire-stop systems shall be installed in accordance with the manufacturer's recommendations and shall be completely installed and available for observation by the local authorities prior to cable system acceptance.

### 3.4 CONTROL SYSTEM PROGRAMMING

#### A. Transport Control

- 1. Provide standard Stop, Play, Pause, Fast Forward, and Rewind for each playback device and menu control for DVD players. Buttons should be arranged in a conventional fashion that will be familiar to the normal user.
- 2. The selected control function should be displayed by showing the appropriate button "pressed". It should remain this way until another function is selected.
- 3. For devices that will go into a standby mode after a period of time, the control system shall sense this mode and restore normal operating mode once a transport function has been selected. This may require the use of current sensors to determine the state of the unit. No direct user action should be required at the playback device to restore the normal operating mode.

#### B. Screen/Shade Control

- 1. In addition to up-down functions, provide a Stop function to allow the movement to be halted. Once movement has been stopped, the up or down buttons should resume travel in the selected direction.
- 2. Control system shall not prevent screen/shade wall controls from being used as well.
- 3. Touch panel controls should be readily accessible to the user to permit direct control of shades or screen with having to navigate through multiple control pages.

#### C. Room Combining

- 1. Combining of adjacent areas shall be done through a graphical representation of the physical areas to be combined. Use of a floor plan metaphor is recommended with the graphic oriented correctly with respect to control panel location.

2. Use buttons or other appropriate objects placed along the common wall to enable the combining function.
3. When spaces are combined, the graphic appearance of those areas shall change to reflect this configuration. Once an area is separated from a combination, the color of its area should revert to the normal room color.
4. Common control functions between combined rooms shall be linked, allowing control of the combined area from any one of the touch panels. Examples of common functions include:
  - a. Background music selection
  - b. Background music volume
  - c. Background music muting
  - d. Lighting preset recall
  - e. Master volume (not individual channel volume)
5. When combining adjacent rooms, the control system shall force the common functions to a predetermined default configuration so all rooms have the same configuration.
6. To avoid unintentional changes, a control panel will not be able to operate a function in a remote location without also operating that same function in the room where the panel is located.

#### D. Level Control

1. Objects requiring level adjustment such as volume or tone controls shall be through Up/Down buttons with a graphical representation of the actual level.
2. Increment of level change to be adjusted for reasonable range without the need to push the Up or Down buttons needlessly.

#### E. Volume Mute

1. Where the ability to mute the sound is needed, the button shall use the label "Vol On" and "VOL OFF" instead of Mute and Unmute. When in a "VOL OFF" mode, pushing the "VOL UP" button shall restore the sound and bring the system out of the muted mode.
2. VOL ON/OFF buttons shall change color to indicate the status of the button.

#### F. Standard Colors

1. Control functions shall be color coded to add clarity and show relationships between different groups of controls.
2. The color Red shall be reserved to indicate a fault or abnormal condition.
3. Green may be used to indicate normal operation, but may be used for standard control colors as well.
4. Similar controls should maintain the same color scheme across all control pages.
5. When a function is selected, the graphical depiction of that button should appear to be pressed and its color change to a darker shade of the regular button color.
6. Color schemes used for background and foreground objects should be selected to be complimentary and provide a consistent theme throughout the control pages.

#### G. Minimum Button Size and Placement

1. Minimum visual size of a button is 3/8" wide by 1/4" high.
2. Spacing between buttons should be no less than 1/16".
3. Where buttons are immediately adjacent, the active selection area of the button should be reduced to 80% of the visual area of the button.

#### H. Button Actions

1. When a function on a control page is selected, that button or visual object associated with that function should change to reflect what has been chosen.
2. For functions that are momentary selections (i.e. VOL UP), the change of state is visible for as long as the button is being pressed.
3. For function that are maintained selections (i.e. PLAY), the change of state remains visible until another function is selected and resets the previous function..
4. The state change of a button or visible object should depict real-world objects as much as possible including the appearance of the button be pressed inward, change in shade of the original color, but not a change in hue.

#### I. Labels

1. Use of simple words or titles are preferred to indicate functionality, navigation and system status.
2. Use of stylish symbols should be avoided unless their identity is commonly recognized by the general public. Standard symbols for transport functions are acceptable.
3. Labels should be presented in a clear, sans serif type face that will remain legible on lower resolution touch panels.
4. Where physical buttons are present along the side of a touch panel, these buttons should be engraved and filled with a contrasting color.

#### J. Power On/Off

1. For panels requiring an ON/OFF control, these functions should be linked through current sensors or other methods for the control system to detect the power on condition of the component being controlled.
2. Powering off a system should not interfere with the ability of a projector to complete its cool down cycle.

#### K. Look & Feel

1. Control pages should utilize a clean, elegant but stylish appearance.
2. Use a common graphical template across all control pages for a consistent look.
3. The touch screen layout should utilize graphical elements such as drop shadows, gradient fills and transparency to provide a pleasing overall appearance.
4. Utilize graphical representations of floor plans to convey location information.
5. Include company logos, icons or watermarks to portray the corporate identity.
6. Provide clear navigation tools for moving between control pages.

7. Each sub-page should have a "BACK" button to return to the previous page. This button should appear in the same location on each page.
8. Provide a "HELP" button or icon on each user page to provide clear, non-technical instructions on how to use the functions available to regular users.

#### L. Security

1. Provide password access to control pages not intended to be accessed by the general public.
2. Unless otherwise noted, provide a minimum of three levels of access
  - a. General User
  - b. Non-Technical Employee
  - c. AV Technician
3. Segregate the control functions to only allow authorized individuals access to more sophisticated control pages.
4. Provide a timeout feature to automatically return the control panel back to the default opening screen after 30 seconds of inactivity. After this reset, passwords must be reentered to return to a previous control page.

#### M. Presets

1. For systems that have different operating modes or configurations, provide the ability to store and recall preset combinations of system settings.
2. Provide a "Preset" page that permits a minimum of five presets to be recalled. Each button to include a label describing the function or configuration associated with that button.
3. Provide the ability for new presets to be stored over previous settings. New preset to be able to change the label to reflect the new or revised configuration.
4. When a preset has been recalled, the control page should indicate the active configuration.

### 3.5 LABELING OF EQUIPMENT

- A. Provide each terminal strip with a unique descriptor and a numerical designator for each terminal. Show terminal strip descriptor and designator on system schematic drawing.
- B. Provide logical and legible cable and wiring label permanently affixed for easy identification.
  1. Labels on cables to be adhesive strip type covered with clear heat-shrink tubing. Factory stamped heat shrink tubing may be used in lieu of the adhesive strip style.
  2. Wiring designator to be an alpha-numeric code unique for each cable. Actual cable designation assignments to be determined by Contractor. Add cable designation codes to system schematic drawings.
  3. Locate the cable designator at the origination and destination of each circuit within 3 inches of the point of termination or connection. Provide cable

designator on circuits with intermediate splice points with an additional suffix to indicate each segment.

### 3.6 ENGRAVING

- A. Text font: 1/8-inch block sans serif characters unless noted otherwise.
- B. On dark materials, provide white characters; on stainless steel or brushed natural aluminum plates, or light-colored materials, provide black characters.
- C. Provide at least two lines of text with first line listing the general device name, e.g., amplifier. Second line to include schematic reference of the device, e.g., AMP-1.
- D. Equipment label: black with white characters except where indicated.

### 3.7 COMMISSIONING

- A. Prior to energizing or testing the system, ensure the following:
  - 1. All products are installed in proper and safe manner according to manufacturer's instructions.
  - 2. Insulation and heat shrink tubing are present where required.
  - 3. Dust, debris, wire trimmings, etc. is removed.
  - 4. Cable is dressed, routed, and labeled; connections are consistent with regard to polarity.
  - 5. Labeling has been provided.
  - 6. Temporary facilities and utilities have been properly disconnected and removed.
  - 7. Products are neat, clean, and unmarred. Parts securely attached.
  - 8. Broken work, including glass, raised flooring and supports, ceiling tiles and supports, walls, doors, etc. have been replaced or properly repaired.
- B. Prior to energizing the System, verify and perform the following tests and adjustments in compliance with applicable EIA standards.
  - 1. Electronic devices are properly grounded.
  - 2. Test each AC power receptacle with a circuit checker for proper hot, neutral, and ground connections.
  - 3. Verify each individual component is operating properly.
  - 4. Verify each individual component's performance meets the manufacturer's published performance for this unit.
  - 5. Measure and record the DC resistance between the technical ground in any equipment rack or console and the main building ground. Resistance should be 0.15 Ohms or less.
- C. Loudspeaker Circuit Verification Test
  - 1. Measure the impedance of each loudspeaker line leaving the equipment racks.
  - 2. For constant voltage systems measure the impedance at 100 (or 250) Hz, 1 KHz and 8 (or 10) KHz of each line leaving the equipment rack with the line

- disconnected from the driving source. For band limited devices, use a frequency appropriate for the operating range of the transducer.
3. When documenting the results of these tests, include the calculated impedance based on number of units on a line and the size and distance of the run. Correct any field readings that differ more than 20% from the calculated impedance.
  4. Include the results of the tests in the Project Record Manual.
- D. Loudspeaker Polarity Verification Test
1. Use an electronic polarity checker, SysTune, SMAART, or other two-channel FFT measurement system to test each loudspeaker. All loudspeakers should have the same relative polarity.
  2. Follow manufacturer's recommendations in conducting the tests.
  3. Include the results of the tests in the Project Record Manual.
- E. Audio Signal Paths
1. Verify operation from each source device through all switching, amplification, and distribution devices.
- F. System Gain Adjustment
1. Adjust each active device to have proper gain structure from the mixer output to the input of the amplifier.
  2. With all amplifiers turned off, connect a sine wave or pink noise generator to the input of the mixer. Using a RMS AC voltmeter with a dB scale, adjust the mixer to an output between -10 and 0 dBu. Note the dBfs level should be -18dB for digital outputs. Once the level has been established, it should remain unchanged throughout the test. All equalizers should be set flat for this test.
  3. Follow the signal flow from the mixer to each subsequent component. Measure the input level and output level of each device at the point of connection to the device. The input level reading should differ no more than 0.25 dB from the level recorded for the preceding device. Diagnose and correct the wiring or equipment when any readings exceed this range.
  4. Adjust the output of each component to achieve the proper output level.
  5. Record the output levels of each device in the Project Record Manual.
- G. Signal Delay Adjustment
1. Adjust the delay to each subsystem to ensure proper synchronization between the main speakers and delayed speakers.
  2. Using SysTune, SMAART, or other two-channel FFT measurement system, measure the arrival time of the distant signal and then measure the arrival of the local signal.
  3. Based on the arrival times measured, adjust the delay applied to the local speakers to synchronize them with the distant speakers. Repeat the test to verify the delay has been set to within 1 ms of the arrival of the distant signal. Once the precise delay time has been determined, provide an additional 10 ms of Haas effect delay to maintain directional orientation toward the original sound source.

4. Continue to test and adjust each separate subsystem with a dedicated delay channel.
5. Provide hard-copy printout of each delay adjustment showing first the arrival times with no delay set and then the result after the delay has been adjusted. Record the settings of each delay in the Project Record Manual.

H. Remote Input Verification Test

1. Using a microphone or portable signal generator, connect to each microphone/line level receptacle throughout the facility.
2. Verify that the receptacle under test appears at the correct input and is operating properly.
3. In a similar manner, check all remote tielines and media related lines for correct wiring and labeling.

I. System Equalization

1. Using SysTune, SMAART, or other two-channel FFT measurement system, equalize all loudspeaker systems to provide a suitable frequency response as follows:
  - a. Speech Reinforcement Systems: flat response from 125 Hz to 2.5 KHz, with 2 dB roll off above. Adjust initial settings as necessary for best intelligibility
  - b. Program Reproduction Systems: flat response from 65 Hz to 8 KHz, with 2 dB per octave roll off above. Adjust subwoofer level to +6dB above man speakers from 35Hz to Hz. Adjust initial settings to optimize audio quality.
2. Verify system gain and amplifier levels.
3. Provide program levels of at least 95 dB and speech reinforcement levels of at least 70 dB in the seating area without objectionable distortion, buzzes, or rattles.
4. Provide hard copy printouts of the spectral response with the test data.

J. RFI and Parasitic Oscillation

1. With systems operating, check to ensure that all systems are free from spurious oscillation and radio frequency interference in the absence of audio signal.

K. Buzzes, Rattles, and other Distortions

1. Adjust the system for normal operating level in the space. Apply a slow sine wave sweep from 60 Hz to 3 KHz and listen carefully for buzzes, rattles, and other objectionable distortions.
2. Correct the cause of the defect. If the cause is not from the system, bring the cause to the attention of the Owner, indicating cause and suggestive corrective actions.

L. Video Systems Test

1. Projected images and screen must be plumb with respect to ceiling line.
  - M. Video System Tests. Verify performance of all video equipment, components, and systems, as specified herein.
    1. Video (signal):
      - a. S/N (peak to RMS), unweighted DC to 4.2 MHz: 55 dB minimum.
      - b. Crosstalk, unweighted DC to 4.2 MHz: 45 dB minimum.
      - c. Frequency Response: Within plus to minus 0.5 dB to 4.2 MHz.
      - d. Line and Field Tilt: 2% maximum.
      - e. Differential Gain: 2% maximum.
      - f. Differential Phase: 2 degrees maximum.
      - g. Frequency Response: DC to 4.2 MHz within plus or minus 0.5 dB.
  - N. Video Signal Paths
    1. Verify operation from each source device through all switching, amplification, and distribution devices.
  - O. Video Test Report shall include the following:
    1. Test Failures and Notices
      - a. Sink Device EDID Test – Open items or failures shall not be accepted.
      - b. Cable Length Test – Open items or failures shall not be accepted.
      - c. HDCP KSV Limitations – Limitations shall not be accepted.
      - d. Cable Limitations - Limitations shall not be accepted.
      - e. EDID Limitations - Limitations shall not be accepted.
      - f. Cable Length Limits exceeded – Failing cables shall not be accepted.
    2. Device Model Number, Serial Number, and Firmware Version for main chassis and each input and output card.
    3. Device Model Number, Serial Number, and Firmware Version for connected transmitter and receiver devices.
    4. EDID – Input Resolution and 3D support status for each input.
    5. EDID – Supported Output Resolution and 3D support status for devices connected to each output.
    6. EDID – Supported Audio formats for each input.
    7. EDID – Supported Audio formats for devices connected to each output.
  - P. Control Systems
    1. Verify operational functions of the control system and all interfaced devices.
    2. Verify operational functionality of any wireless user devices.
- 3.8 CAT5E/CAT6 CABLE CERTIFICATION
- A. General Field Test Requirements



1. All CAT5E/CAT6 cabling links installed as part of this scope shall be tested for the following, in accordance with the field test specifications defines in ANSI/TIA-568-C.2 "Commercial Balanced Twisted-Pair Telecommunications Cabling and Components Standard." This document will be referred to as the "Category 5e Standard":
  - a. Wire Map
  - b. Length
  - c. Insertion Loss
  - d. NEXT loss
  - e. PS NEXT Loss
  - f. ACR-F Loss
  - g. PS ACR-F Loss
  - h. Return Loss
  - i. Propagation Loss
  - j. Delay Skew
2. The installed twisted-pair horizontal links shall be tested from terminated end point to terminated end point for compliance with the "Permanent Link" performance specification as defined in the Category 5e Standard.
3. One hundred percent of the installed cabling links must pass the requirements of the Category 5e standard mentioned above and as further detailed in Section B below. Any failing link must be diagnosed and corrected. The corrective action shall be followed with a new test to prove that the corrected link meets the performance requirements. The final and passing result of the tests for all links shall be provided in the test results documentation in accordance with Section C below.
4. The test equipment (tester) shall comply with the accuracy requirements for level IIe field testers as defined in ANSI/TIA-1152. The tester including the appropriate interface adapter must meet the specified accuracy requirements. The accuracy requirements for the permanent link test configuration (baseline accuracy plus adapter contribution) are specified in Table 2 of ANSI/TIA-1152 (Table 2 in this TIA document also specifies the accuracy requirements for the channel configuration).
5. The RJ45 test plug shall fall within the values specified in ANSI/TIA-568-C Annex C for NEXT, FEXT and Return Loss.
6. The tester shall be within the calibration period recommended by the vendor in order to achieve the vendor-specified measurement accuracy.
7. The tester interface adapters must be of high quality and the cable shall not show any twisting or kinking resulting from coiling and storing of the tester interface adapters. In order to deliver optimum accuracy, preference is given to a permanent link interface adapter for the tester that can be calibrated to extend the reference plane of the Return Loss measurement to the permanent link interface. To ensure that normal handling on the job does not cause measurable Return Loss change, the adapter cord cable shall not be of twisted-pair construction.
8. The Pass or Fail condition of the link-under-test is determined by the results of the required individual tests (detailed in Section 4.2.2 of ANSI/TIA-1152). Any Fail result yields a Fail for the link-under-test. In order to achieve an overall Pass condition, the results for each individual test parameter must Pass.

9. A Pass or Fail result for each parameter is determined by comparing the measured values with the specifies test limits for that parameter.

B. Performance Test Parameters

1. The test parameters are defined by the Category 6A Standard. The test of each link shall contain all of the following parameters as detailed below. In order to pass the test, all measurements (at each frequency in the range from 1 MHz through 100 MHz) must meet or exceed the limit value determined in the above mentioned standard.
2. Wire Map - Shall report Pass if the wiring of each wire-pair from end to end is determined to be correct.
3. Length – The field tester shall be capable of measuring length of all pairs of a basic link or channel based on the propagation delay measurement and the average value for NVP. The physical length of the link shall be calculated using the pair with the shortest electrical delay. This length figure shall be reported and shall be used for making the Pass/Fail decision. The Pass/Fail criteria are based on the maximum length allowed for the Permanent Link configuration (90 meters – 295 feet) plus 10% to allow for the variation and uncertainty of NVP.
4. Insertion Loss (Attenuation) – Insertion Loss is a measure of signal loss in the permanent link or channel. The term “Attenuation” has been used to designate “Insertion Loss.” Insertion Loss shall be tested from 1 MHz through 100 MHz in maximum step size of 1 MHz. It is preferred to measure insertion loss at the same frequency intervals as NEXT loss in order to provide a more accurate calculation of the Attenuation-to-Crosstalk Ratio (ACR) parameter. Minimum test results documentation (summary results): Identify the worst wire pair (1 of 4 possible). The test results of the worst wire pair must show the highest attenuation value measured (worst case), the frequency at which the worst case value occurs, and the test limit value at this frequency.
5. NEXT Loss – Pair-to-pair near end crosstalk loss (abbreviated as NEXT loss) shall be tested for each wire pair combination from each end of the link (a total of 12 pair combinations). This parameter is to be measured from 1 through 100 MHz. NEXT Loss measures the crosstalk disturbance on a wire pair at the end from which the disturbance signal is transmitted (near-end) on the disturbing pair. The maximum step size for NEXT loss measurements shall not exceed the maximum step size defined in the Category 5e Standard as shown in Table 1. Minimum test results documentation (summary results): Identify the wire pair combination that exhibits the worst value of NEXT (worst case). NEXT is to be measured from each end of the link-under-test. These wire pair combinations must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.
6. Table 1 – Maximum frequency step size as defined in ANSI/TIA-1152

Frequency Range (MHz)	Maximum Step Size (MHz)
1-31.25	0.15
31.26-100	0.25

7. NEXT Loss – Power Sum NEXT Loss shall be evaluated and reported for each wire pair from both ends of the link under-test (a total of eight results). PS NEXT Loss captures the combined near-end crosstalk effect (statistical) on a

- wire pair when all other pairs actively transmit signals. Like NEXT this test parameter must be evaluated from 1 through 100 MHz and the step size may not exceed the maximum step size defined in the Category 5e Standard as shown in Table 1. Maximum test results documentation (summary results): Identify the wire pair that exhibits the worst-case margin and the wire pair that exhibits the worst value for PS next. These wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.
8. ACR-F Loss, pair to pair – Attenuation Crosstalk Ratio Far-end is calculated from the pair-to-pair FEXT Loss. It shall be measured for each wire-pair combination from both ends of the link under-test. FEXT Loss measures the crosstalk disturbance on a wire pair at the opposite end (far-end) from which the transmitter emits the disturbing signal on the disturbing pair. FEXT is measured to compute ACR-F Loss that must be evaluated and reported in the test results. ACR-F measures the relative strength of the far-end crosstalk disturbance relative to the attenuated signal that arrives at the end of the link. This test yields 24 wire pair combinations. ACR-F is to be measured 1 through 100 MHz and the maximum step size for FEXT loss measurements shall not exceed the maximum step size defined as the standard as in Table 1. Minimum test results documentation (summary results): Identify the wire pair combination that exhibits the worst value for ACR-F. These wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.
  9. PS ACR-F Loss – Power Sum Attenuation Crosstalk Ratio Far-end is a calculated parameter that combines the effect of the FEXT disturbance from three wire pairs of the fourth one. This test yields eight wire-pair combinations. Each wire-pair is evaluated from 1 through 100 MHz in frequency increments that do not exceed the maximum step size defined in the standard as shown in Table 1. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst pair combinations must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.
  10. Return Loss – Return Loss (RL) measures the total energy reflected on each wire pair. Return Loss is to be measured from both ends of the link-under-test for each wire pair. This parameter is also to be measured from 1 through 100 MHz in frequency increments that do not exceed the maximum step size defined in the Category 5e Standard as shown in Table 1. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst value of Return Loss. These wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.
  11. Propagation Delay – Propagation delay is the time required for the signal to travel from one of the links to the other. This measurement is to be performed for each of the four wire pairs. Minimum test results documentation (summary results): Identify the wire pair with the worst propagation delay. The report shall include the propagation delay value measured as well as the test limit value.
  12. Delay Skew – [as defined in the Category 5e Standard; Section 6.2.19] This parameter shows the difference in propagation delay between the four wire pairs. The pair with the shortest propagation delay between the four wire

pairs. The pair with the shortest propagation delay is the reference pair with a delay skew value of zero. Minimum test results documentation (summary results): Identify the wire pair with the worst-case propagation delay (the longest propagation delay). The report shall include the delay skew value measured as well as the test limit value.

### C. Test Result Documentation

1. The test results/measurements shall be transferred into a Windows based database utility that allows for the maintenance, inspection, and archiving of these test records. A guarantee must be made that the measurement results are transferred to the PC unaltered, i.e., "as saved in the tester" at the end of each test and that these results cannot be modified at a later time.
2. The database for the completed job shall be stored and delivered electronically, including the software tools required to view, inspect, and print any selection of test reports.
3. A paper copy of the test results shall be provided that lists all the links that have been tested with the following summary information:
  - a. The identification of the link in accordance with the naming convention defined in the overall system documentation.
  - b. The overall Pass/Fail evaluation of the link-under-test including the NEXT Headroom (overall worst case) number.
  - c. The date and time the test results were saved in the memory of the tester.
4. General information to be provided in the electronic data base with the test results information for each link:
  - a. The identification of the customer site as specified by the end-user.
  - b. The identification of the link in accordance with the naming convention defined in the overall system documentation.
  - c. The overall Pass/Fail evaluation of the link-under-test
  - d. The name of the test limit selected to execute the stored test results
  - e. The cable type and value of NVP used for length calculations
  - f. The date and time the test results were saved in the memory of the tester
  - g. The brand name, model, and serial number of the tester.
  - h. The identification of the tester interface
  - i. The revision of the tester software and the revision of the test limits database in the tester
  - j. The test results information must contain information on each of the required test parameters that are listed in Section B and as further detailed below under paragraph C5.
5. For each of the frequency-dependent test parameters, the value measured at every frequency during the test is stored. The PC-resident database program must be able to process the stored results to display and print a color graph of the measured parameters. The PC-resident software must also provide a summary numeric format in which some critical information is provided numerically as defined by the summary results (minimum numeric test results documentation) as outlined above for each of the test parameters.

6. The detailed test results data to be provided in the electronic database must contain the following information:
  - a. Length: Identify the wire-pair with the shortest electrical length, the value of the length rounded to the nearest 0.1 m330 and test limit value.
  - b. Propagation delay: Identify the pair with the shortest propagation delay, the value measured in nanoseconds (ns) and the test limit value.
  - c. Delay Skew: Identify the pair with the largest value for delay skew, the value measured in nanoseconds (ns) and the test limit value.
  - d. Insertion Loss (Attenuation): Minimum test results documentation as explained in Section B for the worst pair.
  - e. Return Loss: Minimum test results documentation as explained in Section B for the worst pair as measured from each end of the link.
  - f. NEXT, ACR-F: Minimum test results documentation as explained in Section B for the worst pair combination as measured from each end of the link.
  - g. PS NEXT and PS ACR-F: Minimum test results documentation as explained in Section B for the worst pair combination as measured from each end of the link.

### 3.9 FINAL OBSERVATION & TESTING

- A. Upon completion of installation, initial adjustments, tests, and measurements specified in Part 3, and submission and review of the results, a final observation and test will be performed by the Owner or Owner's representative no earlier than two weeks after receipt of the written results.
- B. Provide a minimum of one (1) person for observation and testing familiar with aspects of the System to assist the Owner.
- C. The process of testing the System may necessitate moving and adjusting certain components.
- D. Testing includes operation of each major system and any other components deemed necessary. Perform tests and provide required test equipment, tools and material required to make any necessary repairs, corrections, or adjustments.
- E. The following procedures will be performed on each System:
  1. Observation of the methods and means employed to incorporate the System within the facility.
  2. Verification of proper operation, from controlling devices to controlled devices.
  3. Verification of proper adjustment, balance, and alignment of equipment for optimum quality and to meet the manufacturer's published specifications. Establish and mark normal settings for each level control, and appropriately record these settings within the Record Documents.
  4. Other tests on equipment or systems deemed appropriate.
- F. In the event the need for further adjustment or work becomes evident during testing, the Contractor is to continue his work until the System is acceptable at no

addition to the contract price. If approval is delayed because of defective equipment, or failure of equipment or installation to meet the requirements of these specifications and any extension of the observation and testing period is required, the Contractor shall pay for additional time and expenses of the Owner at the standard rate in effect at that time.

### 3.10 TEST EQUIPMENT

- A. Thirty days prior to start of testing, provide a list to the Owner of test equipment make, model numbers, and calibration dates that will be used.
- B. The following equipment shall be available on site for the entire test period through final system testing.
  - 1. Sound Level Meter : ANSI S1.4-1971 Type S1A with digital or analog display. Meter to provide ranges of 40 to 120 dBA.
  - 2. Pink Noise Source - Equal energy per octave bandwidth 20 Hz to 20,000 Hz,  $\pm 1$  dB (long-term average) at 0 dBm output. Stability:  $\pm 2$  dB per day.
  - 3. Impedance Meter - Capable of testing audio lines at three frequencies, minimum, between 250 Hz and 5k Hz. Measurement Range: 1 Ohm to 100 kOhms.
  - 4. Audio Oscillator: bandwidth 20 Hz to 20k Hz  $\pm .5$  dB at 0 dBm output. Output to be balanced. Oscillator to include adjustable output level over the range from  $-30$  dBu to  $+10$  dBu.
  - 5. Multimeter - Measurement range, DC to 20k Hz, 100 mV to 300 V, 10 ma to 10 A, dB.
  - 6. NTSC Test generator
  - 7. Sound system measurement and alignment system
    - a. SysTune, SMAART, or other two-channel FFT measurement system, with industry standard measurement microphones. Provide adequate microphone cabling for the venue size, or a wireless microphone system qualified for use with a test measurement system. Provide one microphone stand with each microphone.
  - 8. Video (analog) test generator capable of generating signal up to 1920 x 1200 with audio.
  - 9. Video (digital) test generator capable of generating signal up to 1920 x 1200 with audio.
  - 10. Two-way radios to connect personnel in the equipment room(s) with personnel in other areas of the site for coordinated systems test and setup.
  - 11. Ladders and scaffolding necessary to inspect elevated equipment, junction boxes, etc.

### 3.11 INSTRUCTION OF OWNER PERSONNEL

- A. Provide 8 hours instruction to Owner designated personnel focusing on the use, operation, and maintenance of the systems, scheduled as a minimum of two separate sessions, by an instructor fully knowledgeable and qualified in system operation. The System Reference Manuals should be complete and on site at the

time of this instruction. Coordinate schedule of demonstration with Owner's Representative.

- B. Video record all training sessions and compile a training video to be provided to the Owner electronically.
- C. Provide sign in sheet to document the attendee's presence.
- D. If Contractor is not properly equipped to conduct Owner training on particular equipment, arrange for factory representatives of the equipment to be present to provide training at no additional cost to the Owner.
- E. Provide on-site event support for 4 events, chosen at the discretion of the Owner, by a technician fully knowledgeable and qualified in sound system operation, programming, and troubleshooting.

### 3.12 CLEANUP AND REPAIR

- A. Upon completion of the work, remove refuse and rubbish from and about the premises. Leave areas and equipment clean and in an operational state. Repair any damage caused to the premises by the installation of systems at no cost to the Owner.

**END OF SECTION 27 41 16**

## **SECTION 27 41 43**

### **INSTALLATION OF TELEVISION DISPLAYS AND MOUNTS**

#### **PART 1 - GENERAL**

##### 1.1 SECTION INCLUDES

- A. Coordination, provision, installation, commissioning, testing, instruction, and warranties for display systems. Provide plant, materials, equipment, transport, and labor necessary to accomplish this and have a complete and proper System.
- B. Also includes:
  - 1. Required licenses and permits including payment of charges and fees.
  - 2. Verification of dimensions and conditions.
  - 3. Provision of submissions.
  - 4. Installation in accordance with the contract document, manufacturer's recommendation, and in conformity with applicable codes and authority having jurisdiction.
  - 5. Distribution of electrical service, including ground, to the installed devices.

##### 1.2 RELATED WORK

- A. Provision of electrical power and infrastructure per electrical and technology documents.

##### 1.3 REFERENCES

- A. Published specification standards, tests or recommended methods of trade, industry or governmental organizations apply to Work in this section were cited below:
  - 1. American with Disabilities Act (ADA)
  - 2. American National Safety Institute (ANSI)
  - 3. American Society of Testing and Materials (ASTM)
  - 4. Building Industry Consulting Service International (BICSI)
  - 5. BICSI's Telecommunications Distribution Methods Manual (TDMM)
  - 6. Electronics Industries Association (EIA)
  - 7. Federal Communications Commission (FCC)
  - 8. Institute of Electrical and Electronic Engineers (IEEE)
  - 9. National Electrical Manufacturer's Association (NEMA)
  - 10. National Electrical Code (NEC)
  - 11. Telecommunications Industries Association (TIA)
  - 12. Underwriters Laboratories (UL)



#### 1.4 DESCRIPTIONS AND REQUIREMENTS

- A. The following is intended to further describe the Work and clarify design and project intent and is not an exhaustive description of the television display system. Refer to the Electronic Systems ("AV" series) drawings and the Architectural TV Matrix for further information relating to this Section.
  
- B. Displays and Mounts:
  - 1. Install the displays and mounts specified within.
  - 2. Confirm with the Owner and Architect that all display mounting conditions are ADA compliant.
  - 3. Each display connected to the IPTV Distribution System will require a Cat-x cable to the wall outlet.
    - a. All cables must be kept concealed from view. Provide covering for mounts to conceal cable where possible.
  - 4. Provide the manufacturer's remote control supplied with the display for control.
  - 5. Digital Media Receivers (DMR)
    - a. DMR(s) are provided by the Audio Video System contractor under section 27 41 16.
  
- C. Owner Furnished Equipment (OFE):
  - 1. The owner reserves the right to provide TV displays and mounts from existing stock and/or to provide on a direct basis.
  - 2. Base will assume TV displays and mounts will be provide under the contractors scope of work.
  
- D. Commissioning:
  - 1. It is the intent that the Contractor provides a complete and working system free of defects. All systems and connections described must be verified to be in operational order as intended.

#### 1.5 RESPONSIBILITY AND RELATED WORK

- A. Coordinate exact location and installation of equipment and schedule work with other trades and stadium project managers.
  
- B. Refer to the bid forms and contractual requirements listed in the bid package as provided by the Owner. The project will be priced in separate phases with individual pricing as well. The general conditions outlined in these technical documents are to be considered complimentary to those listed in the Owner documents. In the event of a conflict, the most stringent will apply.

- C. Conduit, wire ways, wall boxes, pull boxes, junction boxes, and AC power circuits and ground wiring are defined elsewhere.
- D. Supply accessories and minor equipment items needed for a complete system, even if not specifically mentioned in these Specifications, without claim for additional payment. The Contractor is responsible for providing all components necessary for complete and operational system. Any system changes or revisions necessary to make the system conform to the building, walls, steel, electrical services etc., shall be included at time of bid and installed without claims for additional compensation.
- E. The Owner reserves the right to make reasonable device and equipment location changes prior to rough installation without claim for additional expense.
- F. Notwithstanding any detailed information in the Contract Documents, it is the responsibility of this Contractor to supply systems in full working order. Notify the appropriate design professionals and Owner of any discrepancies in part numbers or quantities before bid. Failing to provide such notification requires this Contractor to supply items and quantities according to the intent of the Specifications without claim for additional payment.
- G. Obtain permits necessary for the execution of any work pertaining to the installation, or any operation by the Owner including any associated charges or fees.
- H. Execute work in accordance with the National Electrical Code, the National Electrical Safety Code, and applicable State and Local codes, ordinances, and regulations. If a conflict develops between the contract document and the appropriate codes and is reported to the appropriate design professional and Owner representative prior to bid opening, the design professional and Owner representative will prepare the necessary clarification. Where a conflict is reported after contract award, propose a resolution of the conflict and, upon approval, perform work.

#### 1.6 QUALITY ASSURANCE

- A. Contractor's Qualifications: Firm experienced in the provision of systems similar in complexity to those required for this project; and meet the following:
  - 1. No less than three years' experience with equipment and systems of the specified types.
  - 2. Experience with at least three (3) comparable scale projects within the last two years.
  - 3. Be a franchised dealer and service facility for the manufacturer's products furnished.
  - 4. Maintain a fully staffed and equipped service facility.
  - 5. At the request of the design professionals and Owner Representative, demonstrate that:
    - a. Adequate plant and equipment are available to complete the work.
    - b. Adequate staff with commensurate technical experience is available.

- B. Manufacturer's Qualifications: No less than 5 years continuous experience in the production of specified types of product. Production based on applicable NEMA standards.
- C. Work: Perform Work in compliance with the applicable standards listed herein and governing codes and regulations of the authorities having jurisdiction and the Contract Documents.
  - 1. Drawings and specification requirements govern where they exceed Code and Regulation requirements.
  - 2. Where requirements between governing Codes and Regulations vary, the more restrictive provision applies.
  - 3. Nothing in the Contract Documents grants authority or permission to disregard or violate any legal requirements.

#### 1.7 SUBMITTALS:

- A. The submittal information required by the specification is to be presented complete. Cost for the Owner's consultant to review secondary and re-submittals due to the Contractor's failure to include required submittal information, or rejection of incomplete or improperly prepared submittal information will be the responsibility of the Contractor.
  - 1. Refer to the bid documents for project completion requirements. Due to the time frame of the project, it is important for the Contractor to be prepared to provide the required documentation and be prepared to proceed once approved by the Owner.
- B. Provide for approval no later than fourteen (14) days after issuance of Notice to Proceed and prior to commencement of Work:
  - 1. A complete schedule of submittals.
- C. Provide for approval no later than twenty-one (21) days after issuance of Notice to Proceed and in accordance with previously submitted submittal schedule.
  - 1. Section 1: Complete list of products to be incorporated within the Work.
  - 2. Section 2: Manufacturer's data sheets for each product.
    - a. Provide original manufacturer's data sheets in order as they appear in the specification. These data sheets are submitted for each product in sufficient detail to facilitate proper evaluation to the product suitability for incorporation within the Work.
  - 3. Section 3: Samples of cable types proposed with representative labeling.
- D. Provide for approval no later than fifteen (15) days after notice to proceed:
  - 1. Provide drawings created with CAD software such as AutoCAD using standard industry graphic standards.

2. Provide installing drawings showing special details depicting methods and means specific to each product, assembly and each product manufacturer's recommended installation methods and means.
3. Provide point-to-point schematic drawings detailing inter-component and intra-component, on contractor-assembled components, manufactured product connections or fabricated products, wiring and cabling diagram depicting cable types, designator, and color codes.
4. Provide detail drawings depicting any unique installation methods specific to each product. Including any support backing.
5. Any other pertinent data generated which is necessary to provide the Work.

E. Submittal Format:

1. Provide each submittal with a unique number and be numbered in consecutive order.
2. Provide each submittal binder with a cover and a spine reflecting the project title and submittal number.
3. Provide each submittal with a complete table of contents with the following information:
  - a. Project title and number.
  - b. Submittal number: In the case of a re-submittal, use the original submittal number immediately followed by the suffix "R" immediately followed by a unique number and be numbered in consecutive order.
  - c. Date of submission.
  - d. Referenced addendum or change-order number as applicable.
  - e. Referenced specification Section, Part, Article, Paragraph, and page number or drawing reference as applicable.
  - f. Index Product Data sheets by manufacturer and model or part number.
4. Separate major grouping with labeled tabs.
5. Each submission page stamped with Contractor's certification stamp, initialed or signed certifying:
  - a. Review, approval, and acceptance of submission.
  - b. Certification of product compliance to specification.
  - c. Verification product may be incorporated within the work.
6. Arrange product data list in alphanumeric order by manufacturer and model or part number. Follow list by manufacturer's data sheets, arranged in the same order. If a data sheet shows more than one product, indicate the model being proposed with an arrow or other appropriate symbol.
7. Drawings executed at an appropriate scale, not smaller than 3/8"=1'.

F. Submittal Copies:

1. These requirements represent minimum project requirements; a project's general conditions may require additional copies for project distribution.
2. Submit one (1) PDF copy of all drawings.
3. Submit one (1) PDF copy of product data submittals.

4. Provide documents in electronic form such as CD or DVD format depending on storage capacity required for the material and drawing data.

G. Resubmission Requirements:

1. Make any requested corrections or change in submittals required. Resubmit for review until no exceptions are taken.
2. Indicate any changes that have been made other than those requested.

1.8 PROJECT RECORD MANUAL

- A. Submit PDF copies (this is a minimum of two for the Owner and one for the design professional and Owner representative's; additional copies may be required by the project's general conditions) after substantial completion and prior to final inspection.
- B. The Project Record Manual shall be segregated into three separate sections as follows:
  1. Operations Manual:
    - a. Product Data: Product actually incorporated within the Work:
      - 1) Manufacturer's data for each type of product conforming to the scheme above. The list shall include manufacturer's serial numbers.
      - 2) Each products Owner/Instruction Manual.
      - 3) For custom circuits or modifications, a description of the purpose, capabilities, and operation of each item.
      - 4) Manufacturer's wiring diagram for each type of product actually incorporated.
      - 5) Separately list by manufacturer and model or part number of all products incorporated within the Work arranged in alphanumeric order.
    - b. Record drawings: Final rendition of that specified depicting what is actually incorporated within the Work.
  2. Service & Maintenance Manual:
    - a. Provide a PDF copy of the service manual on every piece of equipment for which the manufacturer offers a service manual. Arrange manuals in the same order as the operations manual.
    - b. Manufacturer's maintenance and care instructions.
    - c. Maintenance Instructions, including maintenance phone number(s) and hours; maintenance schedule; description of products recommended or provided for maintenance purposes, and instructions for the proper use of these products.
  3. Warranty Manual:

- a. Manufacturer's warranty statements on each product.
  - b. Date of substantial completion and ending dates for warranties for each group of products.
  - c. Each piece of equipment must be logged with location, make and model and serial numbers.
- C. Ship product in its original container, to prevent damaging or entrance of foreign matter.
- D. Handling and shipping in accordance with manufacturer's recommendation.
- E. Provide protective covering during construction, to prevent damaging or entrance of foreign matter.
- F. Replace at no expense to Owner, product damaged during storage, handling, or the course of construction.

#### 1.9 PROJECT CONDITIONS

- A. Verify conditions on the job site applicable to this work. Notify design professional and Owner representative in writing of discrepancies, conflicts, or omissions promptly upon discovery.

#### 1.10 FINAL OBSERVATION AND TEST

- A. Upon completion of installation, initial adjustments, tests, and measurements specified in Part 3, and submission and review of the results, a final observation and test will be observed by the design professional and Owner representative no earlier than two weeks after receipt of the written results.
- B. Provide a minimum of one (1) person familiar with all aspects of the System to assist the design professionals and Owner representatives.
- C. Testing includes operation of each major system and any other components deemed necessary. Perform tests and provide required test equipment, tools and material required to make any necessary repairs, corrections, or adjustments.
- D. The following procedures will be performed on each System:
  - 1. It is not the intent to readjust all systems at the time of final observations. It is the contractor's responsibility to have the systems ready and completely adjusted and documented prior to the final observations.
  - 2. Inspection of the methods and means employed to incorporate the System within the facility.
  - 3. Verification of proper operation, from controlling devices to controlled devices.
  - 4. Verification of proper adjustment, balance, and alignment of equipment for optimum quality and to meet the manufacturer's published specifications. Other tests on equipment or systems deemed appropriate.

- E. In the event the need for further adjustment or work becomes evident during testing, the Contractor is to continue his work until the System is acceptable at no addition to the contract price. If approval is delayed because of defective equipment, or failure of equipment or installation to meet the requirements of these specifications and any extension of the inspection and testing period is required, the contract price will be reduced for the additional time and expenses of the Owner, at the standard rate in effect at that time.

#### 1.11 WARRANTY

- A. Warrant labor and product for one year following the date of substantial completion to be free of defects and deficiencies, and to conform to the drawings and specifications as to kind, quality, function, and characteristics. Repair or replace defects occurring in labor or product within the Warranty period without charge.
- B. This warranty is in addition to any specific warranties issued by manufacturers for greater periods of time.
- C. Within the warranty period, answer service calls within eight hours, and correct the deficiency within twenty-four hours.
  - 1. The contractor must be prepared to install equipment replacements during this period so that the stadium does not loose operations or experience depredated signals.
  - 2. Should existing equipment fail such as RF amplifiers, the contractor must be prepared to replace with equal product to the existing equipment.

### **PART 2 - PRODUCTS**

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Model numbers and manufacturers included in this specification are listed to establish a standard of product quality.
- B. Other qualified manufacturers will be considered subject to prior approval of complete technical data, samples, and, if requested, results of independent testing laboratory tests of proposed equipment.
- C. If proposed system includes equipment other than specified model numbers, submit a list of major items and their quantities, with a one-line schematic diagram for review.
- D. Include a list of previously installed projects using proposed equipment that are similar in nature to specified System.

#### 2.2 GENERAL

- A. Product: New, free from defects and listed by UL or other acceptable testing agencies acceptable to local authorities with jurisdiction. Provide product of a given type from one manufacturer.
- B. Regardless of the length or completeness of the descriptive paragraph herein, provide product complying with the specified manufacturer's published specifications.
- C. Equipment supply voltage: 120 VAC, 60 Hz.
- D. Indoor equipment temperature limits
  - 1. Operating Limits: 0 to 40 Degrees Centigrade
  - 2. Non-Operating Limits: -15 to 50 Degrees Centigrade
- E. Outdoor equipment temperature limits:
  - 1. Operating Limits: 0 to 50 Degrees Centigrade
  - 2. Non-Operating Limits: -30 to 60 Degrees Centigrade
- F. Provide product not specifically specified commensurate with the quality and standards established by the specified product.
- G. Acceptable TV Display Manufactures:
  - 1. LG Commercial Electronics <http://www.lg.com/us/commercial/display>
  - 2. Samsung USA Business <http://www.samsung.com/us/business>
  - 3. As Approved
- H. Acceptable TV Display Mount Manufactures:
  - 1. Chief <http://www.chiefmfg.com>
  - 2. Peerless AV <http://www.peerless-av.com>
  - 3. Premier Mounts <http://www.mounts.com/>
  - 4. As Approved

## 2.3 INDOOR TELEVISION DISPLAYS

- A. 43" Display:
  - 1. Provide Commercial Grade LCD UHD TV Display
  - 2. Brightness 300 nits
  - 3. Native Resolution 3840 x 2160
  - 4. Tuner: ATSC, Clear QAM, Analog NTSC.
  - 5. Control: RS232C Control Input.
  - 6. Minimum Two (2) HDMI Inputs.
  - 7. USB 2.0 Input.
  - 8. Mount: 200 X 200 VESA.
  - 9. Standard of Performance:
    - a. LG 43UR640S9UD.



- B. 50" Display:
  - 1. Provide Commercial Grade LCD UHD TV Display
  - 2. Brightness 400 nits
  - 3. Native Resolution 3840 x 2160
  - 4. Tuner: ATSC, Clear QAM, Analog NTSC.
  - 5. Control: RS232C Control Input.
  - 6. Minimum Two (2) HDMI Inputs.
  - 7. USB 2.0 Input.
  - 8. Mount: 200 X 200 VESA.
  - 9. Standard of Performance:
    - a. LG 50UR640S9UD.
  
- C. 55" Display:
  - 1. Provide Commercial Grade LCD UHD TV Display
  - 2. Brightness 400 nits
  - 3. Native Resolution 3840 x 2160
  - 4. Tuner: ATSC, Clear QAM, Analog NTSC.
  - 5. Control: RS232C Control Input.
  - 6. Minimum Two (2) HDMI Inputs.
  - 7. USB 2.0 Input.
  - 8. Mount: 300 X 300 VESA.
  - 9. Standard of Performance:
    - a. LG 55UR640S9UD.
  
- D. 65" Display:
  - 1. Provide Commercial Grade LCD UHD TV Display
  - 2. Brightness 400 nits
  - 3. Native Resolution 3840 x 2160
  - 4. Tuner: ATSC, Clear QAM, Analog NTSC.
  - 5. Control: RS232C Control Input.
  - 6. Minimum Two (2) HDMI Inputs.
  - 7. USB 2.0 Input.
  - 8. Mount: 300 X 300 VESA.
  - 9. Standard of Performance:
    - a. LG 65UR640S9UD.

## 2.4 DISPLAY MOUNTS

- A. 32" to 65" Display Shallow Fixed Mount:
  - 1. Provide for use with displays listed above
  - 2. Final model number may vary
  - 3. Use in conjunction with DB3 to maintain ADA clearances.
  - 4. Standard of Performances:
    - a. Chief RMF2.
  
- B. 40" to 55" Display Fixed Wall Mount:
  - 1. Provide for use with displays listed above

2. Final model number may vary
  3. Provide bracket for digital media player
  4. Standard of Performances:
    - a. Chief LSMU
- C. 40" to 55" Display Tilting Wall Mount:
1. Provide for use with displays listed above
  2. Final model number may vary
  3. Provide bracket for digital media player
  4. Standard of Performances:
    - a. Chief LTMU
- D. 40" to 55" Display Tilting Ceiling Mount:
1. Provide for use with displays listed above
  2. Final model number may vary
  3. Provide bracket for digital media player
  4. Standard of Performance:
    - a. Chief LCM1U w/CMA105/CMS Adjustable Column
- E. 40" to 55" Display Back-to-Back Tilting Ceiling Mount:
1. Provide for use with displays listed above
  2. Final model number may vary
  3. Provide bracket for digital media player
  4. Standard of Performance:
    - a. Chief MCB1U w/CMA105/CMS Adjustable Column
- F. 65" to 82" Display Fixed Wall Mount:
1. Provide for use with displays listed above
  2. Final model number may vary
  3. Provide bracket for digital media player
  4. Standard of Performances:
    - a. Chief XSM1U
- G. 65" to 82" Display Tilting Wall Mount:
1. Provide for use with displays listed above
  2. Final model number may vary
  3. Provide bracket for digital media player
  4. Standard of Performances:
    - a. Chief XTMU

H. 65" to 82" Display Tilting Ceiling Mount:

1. Provide for use with displays listed above
2. Final model number may vary
3. Provide bracket for digital media player
4. Standard of Performance:
  - a. Chief XCM1U w/CMA105/CMS Adjustable Column

I. 65" to 75" Display Back-to-Back Tilting Ceiling Mount:

1. Provide for use with displays listed above
2. Final model number may vary
3. Provide bracket for digital media player
4. Standard of Performance:
  - a. Chief LCB1U w/CMA105/CMS Adjustable Column

2.5 CABLING AND ACCESSORIES

A. HDMI Cable:

1. HDMI "A" Male to "A" Male
2. 10.2 Gbps / 4Kx2K / 3D / CEC /ARC
3. Standard of Performance:
  - a. Extron HDMI Pro Series

B. Control Cable:

1. Provide compliant with NEC type CMP rating as applicable.
2. Control cables have overall shield and appropriate number of conductors and pairs required by manufacturer.

2.6 DISPLAY WALL BOX

A. Provide for all interior wall mounted TV and Videowall displays for consolidation and coordination of the power, data, and AV connectivity. Turn over to electrical contractor for installation.

B. Articulating Mount with Display Wall Box (DB1):

1. Provide for 37" to 65" size class displays
2. UL 2416 Listed Enclosure
3. Accommodates two (2) 120VAC Duplex Receptacles
4. Overall Dimensions: 14.25" x 14.25" x 3.90"
5. Include Flange and Cover
6. Acceptable Product:

- a. Peerless-AV IM747PU
- C. Recessed Mount Display Wall Box (DB2):
- 1. Provide for back-to-back display mounting condition
  - 2. UL 2416 Listed Enclosure
  - 3. Accommodates two (2) 120VAC Duplex Receptacles
  - 4. Overall Dimensions: 11 1/4" x 11 5/8" x 3 7/8"
  - 5. Include Flange and Cover
  - 6. Acceptable Product:
    - a. Legrand Wiremold EFSB2
- D. Recessed Mount Display Wall Box (DB3):
- 1. Provide for 37" to 98" size class displays
  - 2. UL 2416 Listed Enclosure
  - 3. Accommodates two (2) 120VAC Duplex Receptacles
  - 4. Overall Dimensions: 14.25" x 14.25" x 3.90"
  - 5. Include Flange and Cover
  - 6. Acceptable Product:
    - a. CHIEF PAC526FCW

### **PART 3 - EXECUTION**

#### 3.1 GENERAL

- A. Coordinate incorporation of the Work specified herein with other project work so as to facilitate a cohesive final product.
- B. The installation recommendations contained within ASDI and TDMM are mandatory minimum standards and requirements.
- C. Mount equipment and enclosures plumb and level.
- D. Permanently installed equipment is to be firmly and safely held in place. Design equipment supports to support loads imposed with a safety factor of at least five.

#### 3.2 INSTALLATION OF CABLE AND WIRING

- A. Cabling and Wiring:
  - 1. Provide cabling for RF connections utilizing black jacket color coding.
  - 2. Provide appropriate support at all horizontal-to-vertical transitions in order to keep the weight of the cable from degrading at the point of transition.
  - 3. Provide splice free wiring and cabling from origination to destination.

4. Install cable so that a radius bend of no less than ten times the cables OD is maintained.

### 3.3 INSTALLATION OF ELECTRONIC EQUIPEMENT

- A. Take appropriate precautions to protect the equipment from damage during installation. Equipment is to be installed free of damages, scratches, dents, etc.
- B. Mount equipment plumb and level firmly and safely held in place.

### 3.4 LABELING

- A. Provide legible cable and wiring label permanently affixed for easy identification per the Cable Numbering Plan.
  1. Labels on cables to be adhesive strip type covered with clear heat-shrink tubing. Factory stamped heat shrink tubing may be used in lieu of the adhesive strip style
  2. Wiring designator is to be an alpha-numeric code unique for each cable.
  3. Locate the cable designator at the origination and destination of each circuit within 3 inches of the point of termination or connection. Provide cable designator on circuits with intermediate splice points with an additional suffix to indicate each segment.

### 3.5 CONTRACTOR COMMISSIONING

- A. Prior to energizing or testing the System ensures the following:
  1. Products are installed in proper and safe manner according to manufacturer's instructions.
  2. Cables are connected, dressed, routed, and labeled.
  3. Products are neat, clean, and unmarred and parts securely attached.
  4. Broken work, including glass, ceiling tiles and supports, walls, doors, etc. have been replaced or properly repaired, and debris cleaned up and discarded.
- B. Prior to energizing the System verify and perform the following tests and adjustments in compliance with applicable EIA standards.
  1. Electronic devices are properly grounded.
  2. Powered devices have AC power from the proper circuit and hot, neutral, and ground conductors are connected correctly.
  3. Systems, equipment, and devices are in full and proper adjustment and operation, and properly labeled and identified.
  4. Store extra materials, portable equipment, and spares at the premises as directed by the Owner.
- C. TV Display Performance Verification Test

1. Verify the following signals and functionality:
  - a. IPTV Signal Verification
    - 1) HDMI output from DMP to TV display HDMI input
    - 2) RS-232 Control
    - 3) Verify audio and set volume limits
  - b. QAM RF Signal Verification
    - 1) QAM signal level to TV display RF input
    - 2) IR Control
    - 3) Verify audio and set volume limits

2. Disable the following:
  - a. Auto light level compensation
  - b. Motion detection for auto standby
  - c. WiFi Hotspot

D. Final Inspection and Test:

1. It is the responsibility of the Contractor to be cognizant of the project schedule and execute their work to comply with the Project Schedule for Final Inspection and Test.
2. The Contractor must ensure that the project management and the Architect are made aware of any issues that may prevent the Contractor from completing their work prior to the scheduled final inspection timeframe.
3. Prior to the scheduled final inspection and test timeframe the contractor must have:
  - a. Complete the required installation, tests, and measurements.
4. Submitted test results and as-built documentation at least three weeks prior to the final inspection and test timeframe.
5. Notified the Architect in writing of the date that they will be ready for final inspection and test.
6. No earlier than two weeks after receipt of the Contractor's notification the Architect's representative will schedule a final inspection and test

3.6 TEST EQUIPMENT

- A. Furnish the following equipment as required:
  1. QAM Signal Level Meter (SLM): Televes H30
  2. HDMI Test Signal Generator: QVS VPGH
  3. DVI Test Signal Generator: Extron VTG400DVI
- B. Equipment is to be available for the entire test period through final system testing.

- C. Following final inspection and testing turn over the Blu-ray test disc to the owner.
- D. Provide three portable VHF or UHF business band radios for use during acceptance testing with transmission range sufficient to cover entire project. Include rechargeable batteries and recharger along with holster for wearing on belt. Radios are to be available for duration of testing process, including any follow-up visits required prior to final acceptance.

**END OF SECTION**

## **SECTION 31 10 00**

### **CLEARING, GRUBBING, AND DEMOLITION**

#### **PART 1 - GENERAL**

##### 1.01 SCOPE:

- A. Clearing, grubbing, and demolition will consist of the removal and disposal of trees, brush, stumps, logs, grass, weeds, roots, decayed vegetative matter, posts, fences, stubs, buildings, footings, foundations, sidewalks, pavements, slabs, curbing, structures of any kind, and other objectionable matter occurring within the construction limits or rights-of-way of excavations, borrow areas, or embankments not to be retained.

#### **PART 2 - PRODUCTS**

- 2.01 This section omitted.

#### **PART 3 - EXECUTION**

##### 3.01 CONSTRUCTION METHODS:

- A. Clearing: Clearing will consist of the felling and cutting up, or the trimming of trees, and the satisfactory disposal of the trees and other vegetation together with the down timber, snags, brush and rubbish occurring within the areas to be cleared. Trees and other vegetation, except individual trees, groups of trees, and vegetation, as indicated on the drawings to be left standing, and stumps, roots and brush in the areas to be cleared must be cut off one foot above the original ground surface. Trim individual trees and groups of trees designated to be left standing within cleared areas of branches to heights necessary to prevent interference with the construction operations. Limbs and branches required to be trimmed must be neatly cut close to the whole of the tree or to main branches, and painted with an approved tree wound paint. Individual trees, groups of trees, and other vegetation, to be left standing, are to be thoroughly protected by barriers or by other means as the circumstances require. Clearing operations are to be conducted so as to prevent damage by falling trees to trees left standing, to existing structures and installations, and to those under construction, and so as to provide for the safety of employees and others.
- B. Grubbing: Grubbing is to consist of the removal and disposal of stumps, roots and matted roots from the site as indicated on the drawings. In foundation areas, stumps, roots, logs or other timber, matted roots, and other debris not suitable for foundation purposes must be excavated to a depth of not less than 18 inches below subgrades, shoulders or slopes. Depressions excavated below the original ground surface for or by the removal of stumps and roots, are to be refilled with suitable material and compacted to make the surface conform to the surrounding ground surface.
- C. Demolition: Remove all existing buildings and structures of any kind including all footings, foundation, concrete slabs, sidewalks, pavements, drives, and all other



obstructions on the site. Remove all existing utilities within the building area (and up to 10 feet beyond the building outline at a minimum), and cap off or remove all abandoned utilities beyond the building area as shown on the plans. Existing abandoned manholes shall be filled in accordance with local codes, regulations, etc., or removed. All existing utility trench backfill must be removed and replaced with new compacted engineered fill. All existing wells, septic systems, etc. must be abandoned, sealed and/or closed as required by the Local Boards of Health. Remove or treat as required by local authorities and Boards of Health all existing septic fields, septic tanks, wells, etc.

1. Demolished asphalt pavements may be salvaged and reclaimed in strict accordance with the Georgia Department of Transportation's Standard Specifications, Section 402-Hot Mix Recycled Asphaltic Concrete for reclaimed asphalt pavement (RAP). See also Specification 321216 ASPHALT PAVING for allowable uses.

3.02 DISPOSAL OF CLEARED, GRUBBED, AND DEMOLISHED MATERIAL:

- A. Saw logs, pulp wood, cord wood or other merchantable timber removed incidental to clearing and grubbing will become the property of the Contractor and, if desired, sold by him, provided disposal is otherwise in accordance with these specifications. Incombustible matter, demolition debris, and any other undesirable material removed shall be hauled away and deposited at locations off-site in accordance with all Local, State, and Federal laws. No burning or bury pits will be permitted.

**END OF SECTION 31 10 00**

**SECTION 31 20 00**

**EARTHWORK**

**PART 1 - GENERAL**

1.01 DEFINITIONS:

- A. Excavation consists of the removal of material encountered to subgrade elevations and the reuse of or disposal of materials removed.
- B. Subgrade: The uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.
- C. Borrow: Soil material obtained off-site when sufficient approved soil material is not available from excavations.
- D. Subbase Course: The layer placed between the subgrade and base course in a paving system or the layer placed between the subgrade and surface of a pavement or walk.
- E. Base Course: The layer placed between the subbase and surface pavement in a paving system.
- F. Unauthorized excavation: The removing of materials beyond indicated subgrade elevations or dimensions without direction by the Design Professional. Unauthorized excavation, as well as remedial work directed by the Design Professional, shall be at the Contractor's expense.
- G. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below ground surface.
- H. Utilities: on-site underground pipes, conduits, ducts, and cables.

1.02 SUBMITTALS:

- A. Product data for the following:
  - 1. Filter fabric. (If Required)
- B. Samples of the following:
  - 1. 12-by-12-inch sample of filter fabric. (If Required)
- C. Test Reports: In addition to test reports required under field quality control, submit the following:
  - 1. Laboratory analysis of each soil material proposed for fill and backfill from

on-site and borrow sources

2. One moisture-density relationship test (Standard Proctor) for each soil material
3. Report of results of bearing tests of each stratum tested

D. Photographs of existing adjacent structures and site improvements.

1.03 QUALITY ASSURANCE:

- A. Codes and Standards: Perform earthwork complying with requirements of these specifications and the directions of the Design Professional.
- B. Testing and Inspection Service: Design Professional will employ a qualified independent geotechnical engineering testing agency to classify proposed on-site and borrow soils to verify that soils comply with specified requirements and to perform required field and laboratory testing.

## **PART 2 - PRODUCTS**

2.01 MATERIALS:

- A. General: Provide approved borrow soil materials from off-site when sufficient approved soil materials are not available from excavations.
- B. Satisfactory Soil Materials: ASTM D 2487 soil classification groups GW, GP, GM, SW, SP, SM, GC, ~~ML, CL~~, and SC; free of rock or gravel larger than 2 inches in one dimension, debris, waste, frozen materials, vegetation and other deleterious matter.
- C. Unsatisfactory Soil Materials: ASTM D 2487 soil classification groups MH, CH, OL, OH, and PT.
- D. Backfill and Fill Materials: Satisfactory soil materials.
- E. Subbase and Base Materials: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand, ASTM D 2940, with at least 95 percent passing a 1 1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.
- F. Bedding Material: ASTM D 2321 material conforming to Class I or Class II specifications.
- G. Drainage Fill: Washed, evenly graded mixture of crushed stone, conforming to Georgia Department of Transportation #57 coarse aggregate.
- H. Impervious Fill: Clay or sand clay mixture capable of compacting to a dense state with permeability of less  $10^{-6}$ .

### **PART 3 - EXECUTION**

#### **3.01 EXCAVATION FOR WALKS AND PAVEMENTS:**

- A. Excavate surfaces under walks and pavements to indicated cross sections, elevations, and grades.

#### **3.02 EXCAVATION FOR UTILITY TRENCHES:**

- A. Excavate trenches to indicated slopes, lines, depths, and invert elevations shown on the plans.

- B. Excavate trenches to uniform widths to provide a working clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated, or required for stable trench wall.

- 1. Clearance: Not less than 12 inches or more than 16 inches on each side of pipe or conduit, unless otherwise indicated or required by OSHA.

- C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduits. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove stones and sharp objects to avoid point loading.

- 1. For pipes or conduits less than 6 inches in nominal diameter and flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support pipe and conduit on undisturbed subgrade.

- 2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe circumference. Fill depressions with tamped sand backfill.

- 3. Where encountering rock or another unyielding bearing surface, carry trench excavation 6 inches below invert elevation to receive bedding course.

#### **3.03 APPROVAL OF SUBGRADE:**

- A. Notify Design Professional when excavations have reached required subgrade.

- B. When Design Professional determines that unforeseen unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

- 1. Unforeseen additional excavation and replacement material will be paid according to the Contract provisions for changes in Work.

- C. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by the Design

Professional.

### 3.04 FILL:

- A. Preparation: Remove vegetation, topsoil, debris, wet, and unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placing fills. Plow strip, or break up, sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing surface.
- B. When subgrade or existing ground surface to receive fill has a density less than that required for fill, break up ground surface to depth required, pulverize, moisture-condition or aerate soil and recompact to required density.
- C. Place fill material in layers to required elevations for each location listed below.
  - 1. Under grass, use satisfactory excavated or borrow soil material.
  - 2. Under walks and pavements, use subbase or base materials, or satisfactory excavated or borrow soil material.

### 3.05 MOISTURE CONTROL:

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill layer before compaction to within 3 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 satisfactory soil material that is too wet to compact to specified density. Stockpile or spread and dry removed wet satisfactory soil material.

### 3.06 COMPACTION:

- A. Place backfill and fill materials in layers not more than 8 inches in loose depth for material compacted by heavy compacted 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 every side of structures to required elevations. Place backfill and fill uniformly along the full length of each structure.
- C. Percentage of Maximum Dry Density Requirements: Compact soil to not less than the following percentages of maximum dry density according to ASTM D 698:
  - 1. Under structures, building slabs and steps, compact the top 12 inches below subgrade and each layer of backfill or fill material at 95 percent maximum dry density.
  - 2. Under walkways, compact the top 6 inches below subgrade and each layer of backfill or fill material at 95 percent maximum dry density.

3. Under lawn or unpaved areas, compact the top 6 inches below subgrade and each layer of backfill or fill material at 90 percent maximum dry density.
4. Under pavements, compact the top 12 inches below subgrade and each layer of backfill or fill material at 100 percent maximum dry density.

### 3.07 GRADING:

- A. General: Uniformly grade areas to a smooth surface, free from irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevation indicated.
  1. Provide a smooth transition between existing adjacent grades and new grades.
  2. Cut out soft spots, fill low spots, and trim high spots to conform to 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 0.10 foot.
  2. Walks: Plus or minus 0.10 foot.
  3. Pavements: Plus or minus ½ inch.

### 3.08 SUBBASE AND BASE COURSE:

- A. Under pavements and walks, place subbase course material where called for on prepared subgrades. Place base course materials over subbases for pavements.
  1. Compact subbase and base courses at optimum moisture content to required grades, lines, cross sections and thickness to not less than 95 percent of ASTM maximum dry density for walks and 100 percent of ASTM maximum dry density for pavements.
  2. Shape subbase and base to required crown elevations and cross-slope grades.
  3. When thickness of compacted subbase or base course is 6 inches or less, place materials in a single layer.
  4. When thickness of compacted subbase or base course exceeds 6 inches, place materials in equal layers, with no layer more than 6 inches thick or less than 3 inches thick when compacted.
- B. Pavement Shoulders: Place shoulders along edges of subbase and base course to prevent lateral movement. Construct shoulders at least 12 inches wide of acceptable soil materials and compact simultaneously with each subbase and base layer.

### 3.09 FIELD QUALITY CONTROL:

- A. Testing Agency Services: Allow testing agency to inspect and test each subgrade and each fill or backfill layer. Do not proceed until test results for previously completed work verify compliance with requirements.
1. Perform field in-place density tests according to ASTM D 1556 (sand cone method), ASTM D 2167 (rubber balloon method), or ASTM D 2937 (drive cylinder method), as applicable.
    - a. Field in-place density tests are also allowed to be performed by the nuclear method according to ASTM D 6938, provided that calibration curves are periodically checked and adjusted to correlate to tests performed using ASTM D 1556. With each density calibration check, check the calibration curves furnished with the moisture gages according to ASTM D 6938.
    - b. When field in-place density tests are performed using nuclear methods, make calibration checks of both density and moisture gages at beginning of work, on each different type of material encountered, and at intervals as directed by the Design Professional.
  2. Paved Areas: At subgrade and at each compacted fill and backfill layer, perform at least one field in-place density test for every 2,000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.
  3. Wall Backfill: In each compacted backfill layer, perform at least one field in-place density test for each 100 feet or less of wall length, but no fewer than two tests along a wall face.
  4. Trench Backfill: In each compacted initial and final backfill layer, perform at least one field in-place density test for each 150 feet or less of trench, but no fewer than two tests.
- B. When testing agency reports that subgrades, fills, or backfills are below specified density, scarify and moisten or aerate, or remove and replace soil to the depth required, recompact and retest until required density is obtained.

### 3.10 PROTECTION:

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and re-establish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or lose compaction due to subsequent construction operations or weather conditions.
1. Scarify or remove and replace material to depth directed by the Design Professional; reshape and recompact at optimum moisture content to the required density.

- C. Settling: Where settling occurs during the Project correction period, remove finished surfacing, backfill with additional approved material, compact, and reconstruct surfacing.
    - 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to the greatest extent possible.
- 3.11 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 the property.

**END OF SECTION 31 20 00**



## **SECTION 31 23 00**

### **EXCAVATING, TRENCHING AND BACKFILLING FOR PIPE LINES**

#### **PART 1 - GENERAL**

1.01 This section covers excavation, trenching and backfilling for pipe lines, complete.

1.02 EXISTING IMPROVEMENTS:

A. Maintain in operating condition and protect from damage existing improvements including utilities, roads, streets, sidewalks, drives, power and telephone lines, gas lines, water lines, sewers, gutters and other drains encountered, and repair to the satisfaction of the Design Professional aerial, surface or subsurface improvements damaged during the course of the work. Where and if shown on the plans, the locations and existence or nonexistence of underground utilities are not guaranteed. Contact the various utility companies to determine and verify said information prior to proceeding with the work. Make reasonable and satisfactory provisions for the maintenance of traffic on streets, drives, walkways and at street crossings and if necessary to provide temporary walkways and bridges for crossing of the open trench as directed.

#### **PART 2 - PRODUCTS**

2.01 This section omitted.

#### **PART 3 - EXECUTION**

3.01 EXCAVATION:

- A. Excavation of every description and of whatever substances encountered is to be performed to the depths indicated on the drawings or as specified herein. Excavation shall be made by the open cut method except as otherwise specified or shown on the drawings. Excavation methods are to comply with these specifications and to the requirements of OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926, or successor regulations.
- B. Excavated materials not required for fill or backfill are to be removed and wasted as directed. Keep the banks of shallow trenches as nearly vertical as practicable and properly sheeted and braced where required. Except where otherwise indicated, trench bottoms are not to be less than 12 inches wider nor more than 16 inches wider than the outside diameter of the pipe to be laid therein, and excavated true to line, so that a clear space of not less than 6 inches nor more than 8 inches in width is provided on each side of the pipe. The bottom of trenches are to be accurately graded to provide uniform bearing and support for each section of the pipe on undisturbed soil at every point along its entire length, except for portions of the pipe sections where it is necessary to excavate for bell holes and for the proper sealing of pipe joints. Dig bell holes after the trench bottom has been graded. Excavate bell holes only to an extent sufficient to permit accurate work in the making of the joints

and to insure that the pipe, for a maximum of its length will rest upon the prepared

bottom of the trench. Depressions for joints other than mechanical are to be made in accordance with the recommendations of the joint manufacturers for the particular joint used. Excavation for structures and other accessories shall be sufficient to leave at least 12 inches in the clear between their outer surfaces and the embankment or timber which may be used to hold the bank and protect them. Where damage is liable to result from withdrawing sheeting, the sheeting will be ordered to be left in place. Except at locations where excavation of rock from the bottoms of trenches is required, take caution not to excavate below the depths indicated. Where rock excavation is required, excavate rock to a minimum overdepth of 4 inches below the normal required trench depth. The overdepth rock excavation and excess trench excavation must be backfilled with loose, moist earth, thoroughly tamped. Rock is defined as materials which are so hard or cemented that the excavation of such material requires blasting. The excavation is to proceed in a conventional manner with satisfactory effort made to remove hard materials before the Design Professional makes a determination of need for blasting. Predrilling and blasting will be allowed, if evidence is provided for the Design Professionals review that boring logs will show that excavating the material is possible. Evidence will be provided for the Design Professional's review and approval before predrilling and blasting is undertaken. The excavation and removal of isolated boulders or rock fragments larger than one cubic yard in volume encountered in materials of common excavation is classified as rock excavation. Whenever wet or otherwise unstable soil that is incapable of properly supporting the pipe, as determined by the Design Professional or indicated on the drawings, is encountered in the trench bottom, remove the soil to a depth required for the lengths designated by the Design Professional, and the trench backfilled to trench bottom grade, as specified, with coarse sand, fine gravel, or other suitable material. Backfill with earth under structures will not be permitted and unauthorized excess excavation below the levels indicated for the foundation of structures will be filled with sand, gravel, or concrete, as directed.

**Grading and Stacking:** Grading in the vicinity of trench excavation will be controlled to prevent surface ground water from flowing into the trenches. Remove water accumulated in the trenches by pumping or by other approved methods. During excavation, store material suitable for backfilling in an orderly manner at a distance from the edges of trenches to avoid overloading and prevent slides or cave-ins. Remove material unsuitable for backfilling, as determined by the Design Professional, from the job site and dispose of in a manner as approved by the Design Professional.

**Shoring and Sheetting:** Shoring, sheetting, and bracing required to perform and protect the excavation and to safeguard employees and the public shall be performed. The failure of the Design Professional to direct the placing of protection will not relieve the responsibility for damage resulting from its omission.

Whenever sheetting is driven to a depth below the elevation of the top of the pipe, that portion of the sheetting below the elevation of the top of the pipe will not be disturbed or removed. Cut off sheetting left in place not less than 1 foot below finished grade. No sheetting will be removed until the excavation is substantially backfilled as specified.

**Water Removal:** Where water is encountered, prevent from accumulating in excavated areas by pumping, well-pointing and pumping, or by other means approved by the Design Professional as to capacity and effectiveness. Discharge water removed from excavations at points where it will not cause injury to public or private property, or the work completed or in

progress. Under no circumstances will trench bottoms be prepared, pipes laid, or appurtenances installed in water. Water is not allowed to rise in unbackfilled excavations after pipe or structures have been placed.

**Blasting:** Explosives are to be used only within legal limitations. Before explosives are used, necessary permits for this work must be secured and precautions taken in the blasting operations to prevent damage to private or public property or to persons. Full liability is assumed for damage that occurs during the use of explosives. No blasting is allowed within 50 feet of pipe already laid in the trench.

**Tree Protection:** Take caution to protect the roots of trees to be left standing. Within the branch spread of the tree, trench is to be opened only when the work will be installed immediately. Prune injured roots cleanly and place backfill as soon as possible.

### 3.02 BACKFILLING:

- A. Do not backfill in trenches and other excavations until required tests are performed and the work has been approved by the Design Professional. Carefully backfill trenches with the excavated materials approved for backfilling consisting of earth, loam, sandy clay, sand and gravel, soft shale, or other approved materials. No material is to be used for backfilling that contains mulch, other unstable materials, stones, blasted rock, broken concrete or pavement, or other hard materials having a dimension greater than 4 inches; or large clods of earth, debris, frozen earth or earth with an exceptionally high void content.
- B. For backfill up to a level 1 foot over the top of pressure pipelines and 2 feet above the top of gravity pipelines, only selected materials are to be used. Select materials shall be finely divided material free from debris, organic material and stone, which is suitable job excavated material or provided from other sources. Place the backfill in uniform layers not exceeding 6 inches in depth. Each layer will be moistened and carefully and uniformly tamped with mechanical tampers or other suitable tools. Place and tamp each layer under the pipe haunches with care and thoroughness so as to eliminate the possibility of voids or lateral displacement.
- C. Then place and compact the remainder of the backfill material above the level specified above. In areas not subject to traffic, place the backfill in 12 inch layers and each layer moistened and compacted to a density approximating that of the surrounding earth. Under roadways, driveways, paved areas, parking lots, along roadway shoulders and other areas subject to traffic, place the backfill in 6 inch layers and each layer must be moistened and compacted to a density of at least 95% standard proctor so that traffic will be resumed immediately after backfilling is completed. Reopen trenches which are improperly backfilled, or where settlement occurs, to the depth required for proper compaction, then refill and compact with the surface restored to the required grade compaction. Along portions of the trenches not located in roadways, the ground is to be graded to a reasonable uniformity and the mounding over the trenches left in a neat condition satisfactory to the Design Professional.
- D. Sheeting not specified to be left in place is to be removed as the backfilling progresses. Remove sheeting in a manner as to avoid caving of the trench. Voids left by the removal of sheeting and shoring will be carefully filled and compacted. Where, in the opinion of the Design Professional, damage is liable to result from

withdrawing sheeting, the sheeting will be ordered to be left in place.

**3.03 BORING AND JACKING:**

- A. Where required by the drawings, the pipeline will be installed in a steel casing, placed by boring and jacking. Where boring is required under highways, the materials and workmanship will be in accordance with the standards of the Georgia Department of Transportation or the City of Augusta, Georgia. Boring and jacking under railroads will be governed by the 2008 A.R.E.A. standards and those of the railroad involved. The steel casing will be in accordance with ASTM A252 to the thicknesses shown on the drawings.

**3.04 PAVEMENT REMOVAL AND REPLACEMENT:**

- A. Where necessary existing pavements shall be removed and replaced, the applicable standards of the Georgia Department of Transportation or the City of Augusta, Georgia are to govern this work. Saw joints, unless joints equally uniform in the opinion of the Design Professional result from other means. Pavement repairs will consist of a concrete slab no less than 6 inches thick or compacted graded aggregate at least 9 inches thick, as indicated on the drawings. Where the parent pavement is concrete, the slab surface will be smoothly finished flush with the surrounding pavement. Where the parent pavement is asphalt, the concrete slab will be raked finished and topped with 1 inch of surface mix asphalt paving rolled flush with the surrounding pavement.

**END OF SECTION 31 23 00**

## **SECTION 31 25 00**

### **EROSION, SEDIMENTATION & POLLUTION CONTROL MEASURES**

#### **PART 1 - GENERAL**

1.01 This section covers erosion, sedimentation and storm water pollution control measures as shown on the plan or required on the job and is intended to comply with the requirements of the Georgia Environmental Protection Division's General Permit No. GAR 100001, 2013 edition. For the purpose of this project and as referenced in the General Permit, the Owner is considered the "Primary Permittee," and the Contractor and all his subcontractors shall be considered the "Operator."

1.02 The measures shown on the plans and specified are minimum requirements and are subject to be augmented by the Design Professional if positive control is not established for storm magnitudes up to and including a 25 year rainfall event. These specifications and the corresponding plans do not, in any way, relieve the obligations with respect to permits for wetlands, storm water, stream buffers, flood plains or other local, state or federal requirements.

#### 1.03 CONSTRUCTION SCHEDULE

A. The construction schedule is as shown on the Erosion, Sedimentation and Pollution Control Plan.

#### 1.04 DEFINITIONS

A. Terms used in this section are to be interpreted in accordance with the definitions set forth in the General Permit, some of which are restated as follows:

1. "Best Management Practices (BMP's)" means schedule of activities, prohibitions of practices, maintenance procedures and other management practices to prevent or reduce the pollution of waters of the state. BMP's also include treatment requirements, operating procedures and practices to control site runoff, spillage or leaks, sludge or waste disposal or drainage from raw material storage.
2. "Buffer" means the area of land immediately adjacent to the banks of state waters in its natural state of vegetation, which facilitates the protection of water quality and aquatic habitat.
3. "Construction Activity" means the disturbance of soils associated with clearing, grading, excavating, filling of land or other similar activities which result in soil erosion.
4. "Final Stabilization" means that soil disturbing activities on the site have been completed and that unpaved areas have a minimum of 95% uniform coverage by permanent vegetation or equivalent permanent stabilization measures.
5. "Grading" means altering ground surfaces to specified elevations, dimensions and slopes; this includes stripping, cutting, filling, stockpiling and shaping or a

combination thereof.

6. "Qualified Personnel" means a person who has successfully completed an erosion and sediment control short course or an equivalent course approved by the Environmental Protection Division (EPD) and the State Soil and Water Conservation Commission.
7. "Waters of the State" means rivers, streams, creeks branches, lakes, reservoirs, ponds, drainage systems, springs wells, wetlands and other bodies of surface or subsurface water, natural or artificial, lying within or forming a part of the boundaries of the State which are not entirely confined and retained completely upon the property of a single individual, partnership or corporation.

## **PART 2 - PRODUCTS**

2.01 Silt Fence: Silt fence shall meet the minimum requirements of Section 171 – Temporary Silt Fence of the Department of Transportation, State of Georgia, Standard Specification, latest edition.

2.02 Construction Exit: The construction exit shall be constructed with the materials shown on the plans. The geotextile underliner shall be woven or nonwoven geotextile fabric made of either polypropylene, polyethylene, ethylene, or polyamide material. Geotextile fabric shall have a minimum grab strength of 270 psi in any principal direction (ASTM D-4632), and the equivalent opening size between 50 and 140. The geotextile shall be resistant to chemical attack, mildew, and rot and shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of 6 months of expected usable life at a temperature range of 0/F to 120/F. Mirafi, Tensar, and Contech are acceptable manufacturers.

## **PART 3 - EXECUTION**

### **3.01 GENERAL PROCEDURES**

A. Utilize, at a minimum, Best Management Practices, including sound construction practices to prevent and minimize erosion and resultant sedimentation, which are consistent with and no less stringent than those practices contained in the "Manual for Erosion and Sediment Control in Georgia," published by the State Soil and Water Conservation Commission as of January 1 of the year in which the land disturbing activity was permitted, as well as the following:

1. Stripping of vegetation, grading and other development activities are to be conducted in a manner to minimize erosion. Earth areas which are not to be paved are to be grassed at the earliest possible time during the construction phase, so as to minimize exposure to rainfall and run-off.
2. Keep unnecessary cut and fill operations to a minimum, except that temporary berms, wherever possible, are to be constructed at the end of each day of grading, in order to contain sediment and slow down erosion, under the circumstances that rainfall occur during the night. Berms will also be constructed, where needed, to prevent sediment from being transported onto areas outside the actual construction limits.

3. Whenever feasible, existing natural vegetation must be retained, protected and supplemented.
4. Keep disturbed areas and the duration of exposure to erosive elements to a practicable minimum.
5. Temporary vegetation and mulching will be employed to protect exposed critical areas during development.
6. Provide permanent vegetation and structural erosion control measures as soon as practicable.
7. To the extent necessary, trap sediment in run-off water by the use of debris basins, silt traps, silt barriers, or similar measures until the disturbed area is stabilized.
8. Provide adequate provisions to minimize damage from surface water to the cut face of excavations and the sloping surfaces of fills.
9. Cuts and fills must not endanger adjoining property.
10. Fills will not encroach upon natural water courses or constructed channels in a manner so as to adversely affect other property owners.
11. Construction equipment must cross flowing streams by means of bridges or culverts, except when said methods are not feasible, provided that crossings will be kept to a minimum and provided that the appropriate stream buffer variances and wetlands approvals have been obtained from the Environmental Protection Division (EPD) and the Corps of Engineers, respectively.
12. If the specified erosion, sedimentation and pollution control measures prove to be inadequate, additional measures as directed by Design Professional will be provided for treatment or control of the source of sediments. Additional adequate sedimentation control facilities to retain sediments on site or to preclude sedimentation of adjacent waters will be implemented.
13. Except when a prior variance has been obtained from EPD or where a drainage structure must be constructed with adequate erosion control measures, no construction activities are to be conducted within a 25 foot buffer along the tops of banks on state waters nor within a 50 foot buffer along the tops of banks on state waters classified as "trout streams." If required for construction purposes, a buffer variance will be applied for by the Owner.
14. Whenever possible, proposed storm water piping systems and detention ponds are to be constructed prior to other earth disturbing operations. The storm water piping and detention system will then be used as a means to control erosion and sediment on the site.
15. Sediment basins of the temporary nature are to be constructed as shown on plans and as required to retain sediment on the site. Temporary sediment basins are to be maintained in accordance with the "Manual for Erosion and Sediment Control in Georgia," Fifth Edition and then removed when final stabilization is attained.



16. Where erosion due to wind is likely to be of concern, trees or groups of trees and bushes are to be left standing, wherever possible, to serve as windbreaks.

### 3.02 ELEMENTS OF THE PLAN:

- A. The minimum requirements for the prevention of erosion and sedimentation for this site are depicted on the plans and specified within these documents. The elements of the plan are discussed as follows, and are listed in chronological order, as far as is practical. The construction activities are to proceed in the order listed.
  1. Remove marketable timber from the limits of construction, rights-of-way, utility easements, designated fill areas, and other areas to be cleared.
  2. Begin clearing and grubbing operations only after silt barriers are provided. Immediately after the area has been cleared for their placement, provide dams, berms and other remaining erosion and sedimentation control measures as shown on the drawings and as specified. Take caution not to clear and grub beyond the construction limit.
  3. Notify Design Professional within 24 hours after the installation of the initial soil erosion control measures so that the Design Professional is able to inspect the measures in accordance with the EPD General Permit.
  4. As grading operations commence, the topsoil is to be stripped and stockpiled in mounds surrounded by berms. As mentioned above, berms or windrows are to be constructed each afternoon at approximately 100 foot intervals across the graded areas, except in the low-lying areas of the project. This action will tend to check erosion if rainfall is experienced during the night.
  5. Construction on the sanitary and storm sewer lines will be commenced as soon as grading operations have been substantially completed. The disturbed strip along each line which is located outside of a street right-of-way will be grassed immediately upon the completion of trench backfilling, as described below.
  6. A graded depression around each catch basin on the site will be used to contain sediment during construction in accordance with the "Manual for Erosion and Sediment Control in Georgia," Fifth Edition.
  7. As soon as the graded areas which are not to be paved, to be built upon, or receive underground utilities have been brought to final grade, spread three or four inches of topsoil over these areas. Grassing operations will begin immediately, as described in the grassing specifications. Roadway shoulders and slopes are to receive a similar treatment as soon as the installation of the utilities is complete.
  8. Grassing will be performed in accordance with the section of the specifications titled "Grassing." If seasonal limitations prevent the establishment of the permanent grass cover, the area to be grassed is to be covered with temporary grass cover; then the permanent grass will be established as soon as its growing season is reached.
  9. The hay bale dams and silt fencing described above will not be removed until the

surrounding pavement base material has been placed and is ready for priming and areas are properly stabilized.

10. In no instance, will pollutants, hazardous waste or solid materials including petroleum products, and building materials be discharged to waters of the State.
11. Work will be in accordance with good grading practice and conform to accepted practices in Erosion Control.

### 3.03 INSPECTIONS, SAMPLING & MONITORING

- A. Be aware that the Owner has the freedom to contract with a third party to perform additional site inspections of erosion, sedimentation and pollution control measures and also procure samples of storm water runoff for testing in accordance with the requirements of the EPD General Permit No. GAR 100001. Third party inspections and samplings will not relieve obligations with respect to these specifications of that required by the EPD General Permit GAR 100001. If inspections determine that there are deficiencies in the work, then corrective action will be required as directed by the Design Professional or Owner.
- B. Requirements. With respect to inspections, sampling and monitoring for compliance with EPD General Permit, the following are minimum responsibilities:
  1. Each day construction activity has taken place on site, qualified personnel will inspect: a) areas on the site where petroleum products are stored, used or handled for spills and leaks from vehicles and equipment; b) locations on the site where vehicles enter or exit the site for evidence of off-site sediment tracking; and c) silt retention basins, traps, barriers, and other control measures for evidence of failures, potential failures or excess silt accumulation.
  2. These inspections must also occur after each rainfall event on the site and must be continued until the project is complete and the site has achieved final stabilization. The Contractor must document these daily inspections on a form provided by or approved by the Design Professional and must submit these forms weekly and after each rainfall event to the Owner's designated representative. Additionally, if a deficiency in one of the erosion control measures is noted, notify the Design Professional within 24 hours.
  3. Erosion and sedimentation control measures will be inspected by a representative of the Owner beginning with the first earth disturbing activity and continuing through final stabilization of the project site. Storm water monitoring, sampling and testing will be accomplished by personnel representing the Owner beginning with the first earth disturbing activity and continuing through final stabilization of the project site. Allow the monitoring agency access to the site 24 hours a day by providing a key to locked gates and also coordinate these services by notifying the monitoring agency when: a) the first rainfall event of 0.5 inch or more in 24 hours occurs on the site after the soil erosion and sedimentation control measures have been provided; and b) whenever a rainfall event greater than 1 inch in 24 hours occurs on the site thereafter.

- C. Subcontractor's Requirements: Subcontractors are to be considered as acting under the direction of the Contractor in his role as the Operator under the EPD General Permit. The Contractor will insure that subcontractors comply with the Permit. Subcontractors will be responsible, at a minimum, for the following:
1. Each day construction activity has taken place on his portion of the site, the Subcontractor will inspect: a) areas on the site where petroleum products are stored, used or handled for spills and leaks from vehicles and equipment; b) locations on the site where vehicles enter or exit the site for evidence of off-site sediment tracking; and c) silt retention basins, traps, barriers, and other control measures for evidence of failures, potential failures or excess silt accumulation.
  2. These inspections must also occur after each rainfall event on the site and must be continued until the project is complete and the site has achieved final stabilization.
  3. The Subcontractor must immediately report noted deficiencies to the Contractor, who will take appropriate corrective action.

**END OF SECTION 31 25 00**

## **SECTION 31 63 33**

### **MICROPILES**

#### **PART 1 - GENERAL**

##### **1.1 SCOPE**

This work shall consist of Micropiles; designed, furnished, installed and tested in accordance with these specifications and as shown on the contract drawings.

##### **1.2 LOAD-CARRYING CAPACITY**

Unless otherwise directed, the contractor shall select the Micropile type and the installation method and determine the length and diameter. The contractor shall be responsible for installing in accordance with the testing subsection of this specification. Contractor's proposal for said work shall explain in detail the materials, methods, and design assumptions he will employ.

##### **1.3 QUALIFICATION**

The contractor performing the work described in the specification shall have installed Micropiles for a minimum of five years. At the time of bid, the contractor shall submit a list containing at least five projects on which the contractor has installed Micropiles. A brief description of each project and a reference shall be included for each project listed. As a minimum, the reference shall include an individual's name and current phone number.

Prior to the start of work, the contractor shall submit a list identifying the engineer, drill operators and on-site supervisors who will be assigned to the project. The list shall contain a summary of each individual's experience and it shall be complete enough for the Engineer to determine whether or not each individual has satisfied the following qualification.

The contractor shall assign an engineer to supervise the work with at least three years of experience in the design and construction of Micropiles. The use of consultants or manufacturer's representatives does not satisfy the requirements of this section. Drill operators and on-site supervisors shall have a minimum of one year experience installing Micropiles with the contractor's organization.

Contractor shall be capable of installing shoring systems with very low headroom clearance.

The engineer shall approve or reject the contractor's qualifications and staff within 15 working days after receipt of the submission. Work shall not be started on any piling nor any materials ordered until approval of the contractor's qualifications is given. The engineer may suspend the Micropile work if the contractor substitutes unqualified personnel for approved personnel; the contractor shall be fully liable for additional costs resulting from the suspension of work and no adjustment in contract time resulting from the suspension of work will be allowed.

Also, the contractor shall submit a detailed narrative within his proposal describing the construction method he intends to employ and encompassing all aspects, peripheral or

otherwise, of his site operation.

Please note the owner (and his contracts manager as appropriated) reserves the right to reject any or all bids on the basis of price or in the belief that the narrative content does not reveal that the contractor has given due thought to the construction process.

#### 1.4 SUBMITTALS

The contractor shall prepare and submit to the engineer for review and approval, working drawings and design submission describing the Micropile system or systems intended for use. The working drawings and design submission shall be submitted 30 calendar days prior to the commencement of the Micropile work. The working drawing and design submission shall include the following:

A drawing showing the location and orientation of each Micropile and a Micropile schedule giving:

- Micropile number
- Micropile design load
- Type and size of Micropile.

The engineer shall approve or reject the contractor's working drawings and design submission within 20 working days after receipt of the submission.

The contractor shall submit to the engineer for review and approval or rejection mill test reports for the steel piling components.

The contractor shall submit to the engineer for review and approval or rejection calibration data for each test jack, pressure gauge and master pressure gauge to be used. The calibration tests shall have been performed by an independent testing laboratory and test shall have been performed within 60 calendar days of the date submitted. The engineer shall approve or reject the calibration data within five working days after receipt of the data. Testing cannot commence until the engineer has approved the jack, pressure gauge and master pressure gauge calibration.

The contractor shall submit to the engineer within 30 calendar days after completion of the Micropile work a report containing:

- As-built drawings showing the locations of the Micropiles and the piles length.
- Steel manufacturer's mill test reports for the steel pile components incorporated in the installation.
- Detailed drilling records including depth to rock quality.
- Grouting records indicating the cement type, and quantity injected.

- Micropile test results and graphs.

## **PART 2 - PRODUCTS**

### 2.1 Cement

Type I, II or III conforming to AASHTO M85 shall be used for grout. In some applications where voids exist, sand may be added to the grout.

### 2.2 Admixtures

Admixtures which control bleed, improve flowability, reduce water content and retard set may be used in the grout subject to the approval of the engineer. Admixtures, if used, shall be compatible manufacturer's recommendation.

### 2.3 Water

Water for mixing grout shall be potable.

### 2.4 Steel Pile Components

Mill test reports for the all-thread bar: pipe wall thickness, pipe diameter, and steel type.

## **PART 3 - EXECUTION**

### 3.1 INSTALLATION

#### Drilling

Unless otherwise directed, core drilling, rotary drilling, percussion drilling, auger drilling, driven casing or other acceptable means can be used. The Micropile can be installed in the drill hole after drilling or it can be advanced by the drill.

#### Grouting

The contractor shall use a neat cement grout or a sand-cement grout with a minimum 28-day unconfined compressive strength of 4,000 psi. The cement shall not contain lumps or other indications of hydration. Admixtures, if used, shall be mixed in accordance with the manufacturer's recommendation.

The grouting equipment shall produce a grout free of lumps and undispersed cement. The pump shall be equipped with a pressure gauge to monitor grout pressures. The pressure gauge shall be capable of measuring pressure of at least 150 psi or twice the actual grout pressures used by the contractor, whichever is greater. The grouting equipment shall be sized to enable

the grout to be pumped in one continuous operation. The mixer should be capable of continuously agitating the grout.

The grout shall be injected from the lowest point of the drill hole. The grout may be pumped through grout tubes, casing, hollow-stem-augers or drill rods. The quantity of the grout and the grout pressures shall be recorded. The grout pressures and grout takes shall be controlled to prevent excessive heave in cohesive soils or fracturing of rock formations. The entire Micropile shall be filled with grout.

Upon completion of grouting, the grout tube may remain in the hole but it shall be filled with grout.

After grouting, the Micropile shall not be loaded for a minimum of three days.

### 3.2 TESTING

A minimum of one test pile shall be loaded to twice the design load. The load test shall be evaluated by the contractor and engineer to assume compliance with job performance requirements.

In lieu of reaction piles, two rock anchors can be installed to provide the reaction load. A structural beam shall be set and attached to the anchors to complete the reaction assembly.

The load shall be applied with a calibrated hydraulic jack. A leveling plate shall be attached to the surface of the test pile and the jack shall be set in position with the load centered on the pile.

The tests shall be performed in accordance with ASTM D 1143-81, Testing of Piles under Axial Compressive Load.

The test load shall be applied in compliance with ASTM D 1143-81, Paragraph 5.6 Quick Pile Test. In essence the load shall be applied in intervals in increments of 20 percent of the anticipated working load to maximum of a least 200 percent of the working load. The maximum load shall be maintained for 1 hour or until the settlement is less than or equal to 0.001 foot per hour. Load increments shall be maintained as applied as described in ASTM D 1143.81, Paragraph 5.4. Load increments shall be maintained as applied as described in ASTM D1143-81, Paragraph 5.4. Readings of settlements and rebounds shall be referred to a constant elevation benchmark and shall be recorded to 1/1000 of a foot for each increment or decrement of load.

Following the 1-hour hold on the maximum load, the test piles shall be rebound as described in ASTM D 1143.81, Paragraph 6.2. Six settlement and rebounded readings shall be made in addition to the initial and final readings (total of 8) during each load or rebound cycle.

The rebound curve shall be established by unloading in decrements of 75, 50, 25 and 10 percent of the total applied load.

The test pile may be a production pile.

Contractor guarantees that should the test pile fail to give acceptable results, he will modify his

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design and install and test another pile at his expense. He also guarantees that he will repair or replace at his own expenses all structural damage caused by inability of his piles to support the working loads satisfactorily for a period of two years.

**END OF SECTION 31 63 33**



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## **SECTION 32 11 23**

### **GRADED AGGREGATE BASE COURSE**

#### **PART 1 - GENERAL**

1.01 This section covers a graded aggregate base course to receive bituminous paving under another section, complete.

1.02 The graded aggregate base course must conform to applicable specifications of Section 300 of the Standard Specification for Roads and Bridges of the Georgia Department of Transportation, latest edition.

#### **PART 2 - PRODUCTS**

##### 2.01 MATERIALS

###### A. Materials for Base Course

1. Materials for the graded aggregate base course are to be in accordance with Section 310 of the Standard Specification for Roads and Bridges of the Georgia Department of Transportation. No blast furnace slag is allowed.

#### **PART 3 - EXECUTION**

##### 3.01 SUBGRADE

- A. The subgrade to receive the graded aggregate base course will be constructed in accordance with requirements of Section 209 of the Standard Specification for Roads and Bridges of the Georgia Department of Transportation.
- B. The aggregate base course is to be compacted to 100% of the maximum dry density in accordance with Section 310 of the Standard Specification for Roads and Bridges of the Georgia Department of Transportation.

##### 3.02 CONSTRUCTION OF BASE COURSE

- A. Construction for the graded aggregate base course must be in accordance with Section 310 of the Standard Specification for Roads and Bridges of the Georgia Department of Transportation.

**END OF SECTION 32 11 23**

## **SECTION 32 12 16**

### **ASPHALT PAVING**

#### **PART 1 - GENERAL**

##### 1.01 SUBMITTALS:

- A. Material Certificates signed by material producer and Contractor, certifying that each material item complies with or exceeds specified requirements.

##### 1.02 SITE CONDITIONS

- A. Weather Limitations: Apply prime and tack coats when ambient temperature is above 50 deg f (10 deg C) and when temperature has not been below 35 deg F (1 deg C) for 12 hours immediately prior to application. Do not apply when base is wet or contains an excess of moisture.
- B. Construct hot-mixed asphalt surface course when atmospheric temperature is above 40 deg F (4 deg C) and when base is dry. Placing the base course is acceptable if the air temperature is above 30 deg F (minus 1 deg C) and rising.
- C. Grade Control: Establish and maintain required lines and elevations.

#### **PART 2 - PRODUCTS**

##### 2.01 Materials:

- A. General: Use locally available materials and gradations that exhibit a satisfactory record of previous installations. The asphalt concrete mixtures must conform to the Georgia Department of Transportation (D.O.T.) Standard Specifications for Roads and Bridges, latest edition.
- B. Coarse Aggregate: Sound, angular crushed stone, or crushed gravel complying with ASTM D 692-88.
- C. Fine Aggregate: Sharp-edged natural sand or sand prepared from stone, gravel, or combinations thereof, complying with ASTM D 1073.
- D. Mineral Filler: Rock or slag dust, hydraulic cement, or other inert material complying with ASTM D 242.
- E. Asphalt Cement: GDOT Performance Graded (PG) as per Section 820 of the 2013 Georgia Department of Transportation (D.O.T.) Standard Specifications for Roads and Bridges.
  - 1. Prime Coat: Cut-back asphalt type, ASTM D 2027; MC-30, MC-70 or MC-250.
  - 2. Tack Coat: Emulsified asphalt; ASTM D 977.

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3. Lane Marking Paint: Alkyd-resin type, ready-mixed complying with AASHTO M 248, Type I.

- (a) Color: White.
- (b) Color: Blue.

F. Reclaimed Asphalt Pavement (RAP): RAP will be allowable when used in strict accordance with the Georgia Department of Transportation's Standard Specifications, Section 402-Hot Mix Recycled Asphaltic Concrete for reclaimed asphalt pavement (RAP)

- 1. RAP shall only be used in pavements for parking areas reserved for passenger cars. RAP is not to be used in pavements in areas of large truck traffic or high traffic volumes.

### **PART 3 - EXECUTION**

#### 3.01 Surface Preparation:

A. General: Remove loose material from compacted base surface immediately before applying prime coat. Proof-roll prepared subgrade surface to check for unstable areas and areas requiring additional compaction.

B. Prime Coat: Apply at rate of 0.20 to 0.50 gal. per sq. yd., over compacted base. Apply material to penetrate and seal, but not flood, surface. Cure and dry as long as necessary to attain penetration and evaporation of volatiles.

C. Tack Coat: Apply to contact surfaces of previously constructed asphalt and surfaces abutting or projecting into hot-mixed asphalt pavement. Distribute at rate of 0.05 to 0.15 gal. per sq. yd. of surface. Allow to dry until at proper condition to receive paving. Exercise care in applying bituminous materials to avoid smearing onto adjoining concrete surfaces. Remove and clean damaged surfaces.

#### D. Placing Mix:

- 1. General: Place hot-mixed asphalt mixture on prepared surface, spread, and strike off. Spread mixture at minimum temperature of 250 deg F (121 deg C). Place areas inaccessible to equipment by hand. Place each course to required grade, cross-section, and compacted thickness.
- 2. Paver Placing: Place in strips not less than 10 feet wide, unless otherwise acceptable to Design Professional. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete base course for a section before placing surface course. Immediately correct surface irregularities in finish course behind paver. Remove excess material forming high spots with shovel or lute.
- 3. Joints: Make joints between old and new pavements, or between successive days' work, to ensure continuous bond between adjoining work. Construct joints to have same texture, density, and smoothness as other sections of hot-mixed asphalt course. Clean contact surfaces and apply tack coat.

E. Rolling:

1. General: Begin rolling when mixture will bear roller weight without excessive displacement. Compact mixture with hot hand tampers or vibrating plate compactors in areas inaccessible to rollers.
2. Breakdown Rolling: Accomplish breakdown or initial rolling immediately following rolling of joints and outside edge. Check surface after breakdown rolling and repair displaced areas by loosening and filling, if required, with hot material.
3. Second Rolling: Follow breakdown rolling as soon as possible, while mixture is hot. Continue second rolling until mixture has been evenly compacted.
4. Finish Rolling: Perform finish rolling while mixture is still warm enough for removal of roller marks. Continue rolling until roller marks are eliminated and course has attained 92 percent maximum specific gravity.
5. Patching: Remove and replace paving areas mixed with foreign materials and defective areas. Cut out said areas and fill with fresh, hot-mixed asphalt. Compact by rolling to specified surface density and smoothness.
6. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
7. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

F. Paint Striping:

1. Cleaning: Sweep and clean surface to eliminate loose material and dust.
2. Striping: Use chlorinated-rubber base traffic lane-marking paint, factory-mixed, quick-drying, and nonbleeding. Do not apply traffic and lane marking paint until layout and placement have been verified with Design Professional. Apply paint with mechanical equipment to produce uniform straight edges. Apply at manufacturer's recommended rates to provide minimum 12 to 15 mils dry thickness.

G. Field Quality Control:

1. General: Testing in-place hot-mixed asphalt courses for compliance with requirements for thickness and surface smoothness will be done by Owner's testing laboratory. Repair or remove and replace unacceptable paving as directed by Design Professional.
2. Thickness: In-place compacted thickness tested in accordance with ASTM D 3549 will not be acceptable if exceeding the following allowable variations:
  - (a) Base Course: Plus or minus 1/2 inch.
  - (b) Surface Course: Plus or minus 1/4 inch.

3. Surface Smoothness: Test finished surface of each hot-mixed asphalt course for smoothness, using 10-foot straightedge applied parallel with and at right angles to centerline of paved area. Surfaces will not be acceptable if exceeding the following tolerances for smoothness:
  - (a) Base Course Surface: 1 inch.
  - (b) Wearing Course Surface: 1/8 inch.
  - (c) Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 3 inch.
4. Check surface areas at intervals as directed by Design Professional.

**END OF SECTION 32 12 16**

## **SECTION 32 13 13**

### **CONCRETE PAVING**

#### **PART 1 - GENERAL**

##### 1.1 SUMMARY

- A. Section Includes Concrete Paving Including the Following:
  - 1. Driveways.
  - 2. Roadways.
  - 3. Parking lots.
  - 4. Curbs and gutters.
  - 5. Walks.
- B. Related Requirements:
  - 1. Section 03 30 00 "Cast-in-Place Concrete" for general building applications of concrete.
  - 2. Section 32 13 73 "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within concrete paving and in joints between concrete paving and asphalt paving or adjacent construction.
  - 3. Section 32 14 00 "Unit paving" for concrete pavers.

##### 1.2 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.
- B. W/C Ratio: The ratio by weight of water to cementitious materials.

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Initial Selection: For each type of product, ingredient, or admixture requiring color selection.
- C. Samples for Verification: For each type of product or exposed finish, prepared as Samples of size indicated below:
  - 1. Exposed Aggregate: 10-lb Sample of each mix.
- D. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.



#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified ready-mix concrete manufacturer and testing agency.
- B. Material Certificates: For the following, from manufacturer:
  - 1. Cementitious materials.
  - 2. Steel reinforcement and reinforcement accessories.
  - 3. Fiber reinforcement.
  - 4. Admixtures.
  - 5. Curing compounds.
  - 6. Applied finish materials.
  - 7. Bonding agent or epoxy adhesive.
  - 8. Joint fillers.
- C. Material Test Reports: For each of the following:
  - 1. Aggregates: Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.
- D. Field quality-control reports.

#### 1.5 QUALITY ASSURANCE

- A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.
  - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").
- B. Testing Agency Qualifications: Qualified according to ASTM C1077 and ASTM E329 for testing indicated.
  - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

#### 1.6 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on concrete paving mixtures.

#### 1.7 FIELD CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
- B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 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 design mixtures.
- C. Hot-Weather Concrete 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 in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
  2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
  3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

## **PART 2 - PRODUCTS**

### 2.1 CONCRETE, GENERAL

- A. ACI Publications: Comply with ACI 301 unless otherwise indicated.

### 2.2 FORMS

- A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.
1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less. Do not use notched and bent forms.
- B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.
- C. STEEL REINFORCEMENT
- D. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, fabricated from as-drawn steel wire into flat sheets.
- E. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, flat sheet.
- F. Epoxy-Coated Welded-Wire Reinforcement: ASTM A884/A884M, Class A, plain steel.
- G. Reinforcing Bars: ASTM A615/A615M, Grade 60; deformed.

- H. Galvanized Reinforcing Bars: ASTM A767/A767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A615/A615M, Grade 60 deformed bars.
- I. Epoxy-Coated Reinforcing Bars: ASTM A775/A775M or ASTM A934/A934M; with ASTM A615/A615M, Grade 60 deformed bars.
- J. Steel Bar Mats: ASTM A184/A184M; with ASTM A615/A615M, Grade 60 deformed bars; assembled with clips.
- K. Plain-Steel Wire: ASTM A1064/A1064M, as drawn.
- L. Deformed-Steel Wire: ASTM A1064/A1064M.
- M. Epoxy-Coated-Steel Wire: ASTM A884/A884M, Class A; coated, plain.
- N. Joint Dowel Bars: ASTM A615/A615M, Grade 60 plain-steel bars; zinc coated (galvanized) after fabrication according to ASTM A767/A767M, Class I coating. Cut bars true to length with ends square and free of burrs.
- O. Epoxy-Coated, Joint Dowel Bars: ASTM A775/A775M; with ASTM A615/A615M, Grade 60 plain-steel bars.
- P. Tie Bars: ASTM A615/A615M, Grade 60; deformed.
- Q. Hook Bolts: ASTM A307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.
- R. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded-wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:
  - 1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
  - 2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
- S. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.
- T. Zinc Repair Material: ASTM A780/A780M.

## 2.3 CONCRETE MATERIALS

- A. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:
  - 1. Portland Cement: ASTM C150/C150M, white Portland cement Type I.
  - 2. Fly Ash: ASTM C618, Class C or Class F.
  - 3. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
- B. Normal-Weight Aggregates: ASTM C33/C33M, uniformly graded. Provide aggregates from a single source with documented service-record data of at least 10 years'

satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials.

1. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
  2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
  3. Use 30% minimum Recycled Concrete Aggregate
- C. Exposed Aggregate: Selected, hard, and durable; washed; free of materials with deleterious reactivity to cement or that cause staining; from a single source, with gap-graded coarse aggregate as follows:
1. Aggregate Sizes: 3/8 to 5/8 inch nominal.
  2. Aggregate Source, Shape, and Color: Per Project Drawings.
  3. Use 30% minimum Recycled Concrete Aggregate.
- D. Air-Entraining Admixture: ASTM C260/C260M.
- E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
  2. Retarding Admixture: ASTM C494/C494M, Type B.
  3. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
  4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
  5. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.
  6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.
- F. Color Pigment: ASTM C979/C979M, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, nonfading, and resistant to lime and other alkalis.
1. Color: As selected by Architect from manufacturer's full range.
- G. Water: Potable and complying with ASTM C94/C94M.
- 2.4 FIBER REINFORCEMENT
- A. Synthetic Fiber: Monofilament polypropylene fibers engineered and designed for use in decorative concrete paving, complying with ASTM C1116/C1116M, Type III, 1/2 to 1-1/2 inches long.
- B. Synthetic Fiber: Fibrillated polypropylene fibers engineered and designed for use in decorative concrete paving, complying with ASTM C1116/C1116M, Type III, 1/2 to 1-1/2 inches long.
- 2.5 CURING MATERIALS
- A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry or cotton mats.

- B. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.
- D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B, dissipating.
- F. White, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 2, Class B, dissipating.

## 2.6 RELATED MATERIALS

- A. Joint Fillers: ASTM D1751, asphalt-saturated cellulosic fiber or ASTM D1752, cork or self-expanding cork in preformed strips.
- B. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.
- C. Bonding Agent: ASTM C1059/C1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- D. Epoxy-Bonding Adhesive: ASTM C881/C881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:
  - 1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
- E. Chemical Surface Retarder: Water-soluble, liquid, set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of 1/8 to 1/4 inch.
- F. Pigmented Mineral Dry-Shake Hardener: Factory-packaged, dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.
  - 1. Color: As selected by Architect from manufacturer's full range.
- G. Rock Salt: Sodium chloride crystals, kiln dried, coarse gradation with 100 percent passing 3/8-inch sieve and 85 percent retained on a No. 8 sieve.

## 2.7 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.
  - 1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.

2. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that comply with or exceed requirements.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
  1. Fly Ash or Pozzolan: 15 percent.
  2. Slag Cement: 50 percent.
  3. Combined Fly Ash or Pozzolan, and Slag Cement: 50 percent, with fly ash or pozzolan not exceeding 15 percent.
- 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: 4-1/2 percent plus or minus 1-1/2 percent.
- 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 high-range, water-reducing admixture in concrete as required for placement and workability.
  2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
- F. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.0 lb./cu. yd.
- 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.
- H. Concrete Mixtures: Normal-weight concrete.
  1. Compressive Strength (28 Days): 3500 psi.
  2. Maximum W/C Ratio at Point of Placement: 0.45.
  3. Slump Limit: 4 inches, plus or minus 1 inch.

## 2.8 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M and ASTM C1116/C1116M. Furnish batch certificates for each batch discharged and used in the Work.
  1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.
- B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For concrete batches of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For concrete batches larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

### **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 paving 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 pneumatic-tired and half-loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
  3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Section 31 20 00 "Earth Moving."
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 PREPARATION**

- A. Remove loose material from compacted subbase surface immediately before placing concrete.

#### **3.3 EDGE FORMS AND SCREED CONSTRUCTION**

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

#### **3.4 STEEL REINFORCEMENT INSTALLATION**

- A. 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. Zinc-Coated Reinforcement: Use galvanized-steel wire ties to fasten zinc-coated reinforcement. Repair cut and damaged zinc coatings with zinc repair material.
- F. 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 D3963/D3963M.
- G. 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 edges 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 paving, place transverse joints to align with previously placed joints unless otherwise indicated.
- B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
  - 1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
  - 2. Provide tie bars at sides of paving strips where indicated.
  - 3. Butt Joints: Use epoxy-bonding adhesive at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
  - 4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
  - 5. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
- C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
  - 1. Locate expansion joints at intervals of 50 feet 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 1 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. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
- D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows, to match jointing of existing adjacent concrete paving:
1. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
    - a. Tolerance: Ensure that sawed joints are within 3 inches either way from centers of dowels.
  2. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
- E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 3/8-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

### 3.6 CONCRETE PLACEMENT

- A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.
- B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.
- C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
- E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.
- F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels and joint devices.
  - H. Screed paving surface with a straightedge and strike off.
  - I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.
  - J. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.
  - K. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.
    1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.
- 3.7 FLOAT FINISHING
- A. General: Do not add water to concrete surfaces during finishing operations.
  - B. Float Finish: Begin the second floating operation when bleedwater 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. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
    2. 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. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8-inch-deep with a stiff-bristled broom, perpendicular to line of traffic.
- 3.8 SPECIAL FINISHES
- A. Monolithic Exposed-Aggregate Finish: Expose coarse aggregate in paving surface as follows:
    1. Immediately after float finishing, spray-apply chemical surface retarder to paving according to manufacturer's written instructions.
    2. Cover paving surface with plastic sheeting, sealing laps with tape, and remove when ready to continue finishing operations.
    3. Without dislodging aggregate, remove mortar concealing the aggregate by lightly brushing surface with a stiff, nylon-bristle broom. Do not expose more

- than one-third of the average diameter of the aggregate and not more than one-half of the diameter of the smallest aggregate.
4. Fine-spray surface with water and brush. Repeat cycle of water flushing and brushing until cement film is removed from aggregate surfaces to depth required.
- B. Seeded Exposed-Aggregate Finish: Immediately after initial floating, spread a single layer of aggregate uniformly on paving surface. Tamp aggregate into plastic concrete and float finish to entirely embed aggregate with mortar cover of 1/16 inch.
1. Spray-apply chemical surface retarder to paving according to manufacturer's written instructions.
  2. Cover paving surface with plastic sheeting, sealing laps with tape, and remove sheeting when ready to continue finishing operations.
  3. Without dislodging aggregate, remove mortar concealing the aggregate by lightly brushing surface with a stiff, nylon-bristle broom. Do not expose more than one-third of the average diameter of the aggregate and not more than one-half of the diameter of the smallest aggregate.
- C. Fine-spray surface with water and brush. Repeat cycle of water flushing and brushing until cement film is removed from aggregate surfaces to depth required.
- D. Slip-Resistive Aggregate Finish: Before final floating, spread slip-resistive aggregate finish on paving surface according to manufacturer's written instructions and as follows:
1. Uniformly spread the drawing-specified rate the drawing-specified rate of dampened, slip-resistive aggregate over paving surface in two applications. Tamp aggregate flush with surface using a steel trowel, but do not force below surface.
  2. Uniformly distribute approximately two-thirds of slip-resistive aggregate over paving surface with mechanical spreader, allow to absorb moisture, and embed by power floating. Follow power floating with a second slip-resistive aggregate application, uniformly distributing remainder of material at right angles to first application to ensure uniform coverage, and embed by power floating.
  3. Cure concrete with curing compound recommended by slip-resistive aggregate manufacturer. Apply curing compound immediately after final finishing.
  4. After curing, lightly work surface with a steel-wire brush or abrasive stone and water to expose nonslip aggregate.
- E. Pigmented Mineral Dry-Shake Hardener Finish: After initial floating, apply dry-shake materials to paving surface according to manufacturer's written instructions and as follows:
1. Uniformly spread dry-shake hardener at the drawing-specified rate unless greater amount is recommended by manufacturer to match paving color required.
  2. Uniformly distribute approximately two-thirds of dry-shake hardener over the concrete surface with mechanical spreader; allow hardener to absorb moisture and embed it by power floating. Follow power floating with a second application of pigmented mineral dry-shake hardener, uniformly distributing remainder of

material at right angles to first application to ensure uniform color and embed hardener by final power floating.

3. After final power floating, apply a hand-troweled finish followed by a broom finish.
4. Cure concrete with curing compound recommended by dry-shake hardener manufacturer. Apply curing compound immediately after final finishing.

### 3.9 DETECTABLE WARNING INSTALLATION

- A. Blockouts: Form blockouts in concrete for installation of detectable paving units specified in Section 32 17 26 "Tactile Warning Surfacing."
  1. Tolerance for Opening Size: Plus 1/4 inch, no minus.
- B. Cast-in-Place Detectable Warning Tiles: Form blockouts in concrete for installation of tiles specified in Section 32 17 26 "Tactile Warning Surfacing." Screed surface of concrete where tiles are to be installed to elevation, so that edges of installed tiles will be flush with surrounding concrete paving. Embed tiles in fresh concrete to comply with Section 32 17 26 "Tactile Warning Surfacing" immediately after screeding concrete surface.

### 3.10 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. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
    - a. Water.
    - b. Continuous water-fog spray.
    - c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
  2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, 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 occurring during installation or curing period, using cover material and waterproof tape.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

### 3.11 PAVING TOLERANCES

- A. Comply with tolerances in ACI 117 and as follows:
  1. Elevation: 1/2 inch.
  2. Thickness: Plus 3/8 inch, minus 1/4 inch.
  3. Surface: Gap below 10-foot-long; unlevelled straightedge not to exceed 1/2 inch.
  4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches of tie bar.
  5. Lateral Alignment and Spacing of Dowels: 1 inch.
  6. Vertical Alignment of Dowels: 1/4 inch.
  7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches of dowel.
  8. Joint Spacing: 3 inches.
  9. Contraction Joint Depth: Plus 1/4 inch, no minus.
  10. Joint Width: Plus 1/8 inch, no minus.

### 3.12 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Testing Services: Testing and inspecting of composite samples of fresh concrete obtained according to ASTM C172/C172M shall be performed according to the following requirements:
  1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.
    - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
  2. Slump: ASTM C143/C143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
  3. Air Content: ASTM C231/C231M, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
  4. Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.

5. Compression Test Specimens: ASTM C31/C31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C39/C39M; test one specimen at seven days and two specimens at 28 days.
  - a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.
- C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
- 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. Concrete paving will be considered defective if it does not pass tests and inspections.
- H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- I. Prepare test and inspection reports.

### 3.13 REPAIR AND PROTECTION

- A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.
- B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.
- C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
- D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

**END OF SECTION**

Bell Auditorium Expansion & Renovations  
Augusta, Georgia  
Issue for Permit / Bid

Perkins&Will  
222028.000  
16 January 2023

## **SECTION 32 13 16**

### **DECORATIVE CONCRETE PAVING**

#### **PART 1 - GENERAL**

##### 1.1 SUMMARY

- A. Standard concrete paving with surface retardant finish.
- B. Related Requirements:
  - 1. Section 03 30 00 "Cast-in-Place Concrete" for general building applications of concrete.
  - 2. Section 32 13 13 "Concrete Paving" for cast-in-place concrete paving with other finishes, curbs and gutters, and stamped detectable warnings.
  - 3. Section 32 13 73 "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within decorative concrete paving and in joints between decorative concrete paving and other paving or adjacent construction.

##### 1.2 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.
- B. W/C Ratio: The ratio by weight of water to cementitious materials.

##### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Review methods and procedures related to decorative concrete paving, including but not limited to, the following:
    - a. Concrete mixture design.
    - b. Quality control of concrete materials and decorative concrete paving construction practices.
  - 2. Require representatives of each entity directly concerned with decorative concrete paving to attend, including the following:
    - a. Contractor's superintendent.
    - b. Independent testing agency responsible for concrete design mixtures.
    - c. Ready-mix concrete manufacturer.
    - d. Decorative concrete paving Installer.
    - e. Manufacturer's representative of decorative concrete paving system.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Initial Selection: For each type of product, ingredient, or admixture requiring color, pattern, or texture selection.



- C. Samples for Verification: For each type of exposed color, pattern, or texture indicated.
- D. Design Mixtures: For each decorative concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Certificates: For the following, from manufacturer:
  - 1. Curing compounds- evaporation retarder

#### 1.6 QUALITY ASSURANCE

- A. Comply with requirements of Section 32 13 13 "Concrete Paving."
- B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
  - 1. Build mockups of full-thickness sections of decorative concrete paving to demonstrate typical joints; surface color, pattern, and texture; curing; and standard of workmanship.
  - 2. Build mockups of decorative concrete paving in the location and of the size indicated or, if not indicated, build mockups where directed by Architect and not less than 96 inches by 96 inches.
  - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  - 4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

#### 1.7 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on decorative concrete paving mixtures.

#### 1.8 FIELD CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
- B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
  - 1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 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 design mixtures.
- C. Hot-Weather Concrete 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 in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
  2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
  3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

## **PART 2 - PRODUCTS**

### 2.1 CONCRETE, GENERAL

- A. ACI Publications: Comply with ACI 301 unless otherwise indicated.

### 2.2 FORMS

- A. Comply with requirements of Section 32 13 13 "Concrete Paving."

### 2.3 STEEL REINFORCEMENT

- A. Comply with requirements of Section 32 13 13 "Concrete Paving."

### 2.4 CONCRETE MATERIALS

- A. Comply with requirements of Section 32 13 13 "Concrete Paving."
- B. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

### 2.5 CURING AND SEALING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. BASF Corporation.
    - b. Bon Tool Co.

- c. Brickform; a division of Solomon Colors.
  - d. ChemMasters, Inc.
  - e. Dayton Superior.
  - f. Euclid Chemical Company (The); an RPM company.
  - g. Kaufman Products, Inc.
  - h. Lambert Corporation.
  - i. Laticrete International, Inc.
  - j. Metalcrete Industries.
  - k. Nox-Crete Products Group.
  - l. Sika Corporation.
  - m. SpecChem, LLC.
  - n. TK Products.
  - o. Vexcon Chemicals Inc.
  - p. W.R. Meadows, Inc.
- B. Clear Acrylic Sealer, Low-to-Medium Gloss: Manufacturer's standard, waterborne, non-yellowing and UV-resistant, membrane-forming, acrylic copolymer emulsion or epoxy-modified acrylic emulsion, manufactured for colored concrete, containing not less than 15 percent solids by volume.
- 1. Product: L.M. Scofield Company; Cureseal W, matte or approved equal.

## 2.6 RELATED MATERIALS

- A. Comply with requirements of Section 32 13 13 "Concrete Paving."

## 2.7 CONCRETE MIXTURES

- A. Comply with requirements of Section 32 13 13 "Concrete Paving."

## 2.8 CONCRETE MIXING

- A. Comply with requirements of Section 32 13 13 "Concrete Paving."

# **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 decorative concrete paving 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 pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
  - 3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of [1/2 inch] according to requirements in Section 31 20 00 "Earth Moving."

- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Remove loose material from compacted subbase surface immediately before placing concrete.
- B. Protect adjacent construction from discoloration and spillage during application of color hardeners, release agents, stains, curing compounds, and sealers.

### 3.3 EDGE FORMS AND SCREED CONSTRUCTION

- A. Comply with requirements of Section 32 13 13 "Concrete Paving."

### 3.4 STEEL REINFORCEMENT INSTALLATION

- A. Comply with requirements of Section 32 13 13 "Concrete Paving."

### 3.5 JOINTS

- A. Comply with requirements of Section 32 13 13 "Concrete Paving."

### 3.6 CONCRETE PLACEMENT

- A. Comply with requirements of Section 32 13 13 "Concrete Paving."

### 3.7 FLOAT FINISHING

- A. Comply with requirements of Section 32 13 13 "Concrete Paving."

### 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, or a combination of these as follows:
  - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the water, or water-fog spray.
  - 2. Moisture-Retaining Cover Curing: Cover concrete surfaces with moisture-retaining cover, 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 SEALER APPLICATION

- A. Clear Acrylic Sealer: Apply uniformly in two coats in continuous operations according to manufacturer's written instructions. Allow first coat to dry before applying second coat, at 90 degrees to the direction of the first coat, using same application methods and rates.
  - 1. Begin sealing dry surface no sooner than 14 days after concrete placement.

### 3.10 PAVING TOLERANCES

- A. Comply with tolerances in ACI 117.

### 3.11 FIELD QUALITY CONTROL

- A. Comply with requirements of Section 32 13 13 "Concrete Paving."

### 3.12 REPAIR AND PROTECTION

- A. Remove and replace decorative concrete paving that is broken or damaged or does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.
- B. Protect decorative concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
- C. Maintain decorative concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

## **END OF SECTION**

## **SECTION 32 13 73**

### **CONCRETE PAVING JOINT SEALANTS**

#### **PART 1 - GENERAL**

##### 1.1 SUMMARY

- A. Section Includes:
  - 1. Cold-applied joint sealants.
  - 2. Joint-sealant backer materials.
  - 3. Primers.

##### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch-wide joints formed between two 6-inch-long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- C. Paving-Joint-Sealant Schedule: Include the following information:
  - 1. Joint-sealant application, joint location, and designation.
  - 2. Joint-sealant manufacturer and product name.
  - 3. Joint-sealant formulation.
  - 4. Joint-sealant color.

##### 1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, testing agency.
- B. Product Certificates: For each type of joint sealant and accessory.

##### 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Product Testing: Test joint sealants using a qualified testing agency.

##### 1.5 FIELD CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
  - 1. When ambient and substrate temperature conditions are outside limits permitted by joint- sealant manufacturer or are below 40 deg F.
  - 2. When joint substrates are wet.

3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

## **PART 2 - PRODUCTS**

### 2.1 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

### 2.2 COLD-APPLIED JOINT SEALANTS

- A. Single-Component, Self-Leveling, Silicone Joint Sealant: ASTM D5893/D5893M, Type SL.

### 2.3 JOINT-SEALANT BACKER MATERIALS

- A. Joint-Sealant Backer Materials: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by joint-sealant manufacturer, based on field experience and laboratory testing.
- B. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.
- C. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.
- D. Backer Strips for Cold-Applied Joint Sealants: ASTM D5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

### 2.4 PRIMERS

- A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated.

## **PART 3 - EXECUTION**

### 3.1 EXAMINATION

- A. Examine joints to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint- sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Surface Cleaning of Joints: Before installing joint sealants, clean out joints immediately to comply with joint-sealant manufacturer's written instructions.
  - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
- B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

### 3.3 INSTALLATION OF JOINT SEALANTS

- A. Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.
- B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions.
- C. Install joint-sealant backings to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
  - 1. Do not leave gaps between ends of joint-sealant backings.
  - 2. Do not stretch, twist, puncture, or tear joint-sealant backings.
  - 3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install joint sealants immediately following backing installation, using proven techniques that comply with the following:
  - 1. Place joint sealants so they fully contact joint substrates.
  - 2. Completely fill recesses in each joint configuration.
  - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- E. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:
  - 1. Remove excess joint sealant from surfaces adjacent to joints.
  - 2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.
- F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.



### 3.4 CLEANING AND PROTECTION

- A. Clean off excess joint sealant as the Work progresses, by methods and with cleaning materials approved in writing by joint-sealant manufacturers.
- B. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

### 3.5 PAVING-JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Joints within concrete paving.
  - 1. Joint Location:
    - a. Expansion and isolation joints in concrete paving.
    - b. Other joints as indicated.
  - 2. Joint Sealant: Single-component, self-leveling, silicone joint sealant.
  - 3. Joint-Sealant Color: Manufacturer's standard.

**END OF SECTION**

## **SECTION 32 14 00**

### **UNIT PAVING**

#### **PART 1 - GENERAL**

##### 1.1 SUMMARY

###### A. Section Includes:

1. Concrete pavers.
2. Curbs and edge restraints.

###### B. Related Requirements:

1. Section 32 13 13 "Concrete Paving" for concrete base under unit pavers and for cast-in-place concrete curbs and gutters serving as edge restraints for unit pavers.

##### 1.2 ACTION SUBMITTALS

###### A. Product Data:

1. For materials other than water and aggregates.
2. For the following:
  - a. Concrete Pavers.
  - b. Sand for joints

###### B. Sieve Analyses: For aggregate setting-bed materials, according to ASTM C136.

###### C. Samples for Verification: For full-size units of each type of unit paver indicated:

1. Concrete Pavers

##### 1.3 INFORMATIONAL SUBMITTALS

###### A. Qualification Data: For Installer.

###### B. Material Certificates: For unit pavers. Include statements of material properties indicating compliance with requirements, including compliance with standards. Provide for each type and size of unit.

###### C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for unit pavers, indicating compliance with requirements.

##### 1.4 QUALITY ASSURANCE

###### A. Installer Qualifications: A qualified unit paving installer. Installer's field supervisor must have Concrete Paver Installer Certification from the Interlocking Concrete Pavement Institute (ICPI) with the following designations:

1. Commercial Paver Technician Designation.

- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
  - 1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- D. Store liquids in tightly closed containers protected from freezing.

#### 1.6 FIELD CONDITIONS

- A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

### **PART 2 - PRODUCTS**

#### 2.1 MANUFACTURERS

- A. Source Limitations: Obtain each type of unit paver, joint material, and setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

#### 2.2 CONCRETE PAVERS

#### 2.3 Detectable Warning Paver: Product: Subject to compliance with requirements, provide Hanover Architectural Pavers.

- 1. Tactile Warning Paver
- 2. Thickness: 3"
- 3. Face Size and Shape: 11 7/8" x 11 7/8"
- 4. Color: Charcoal

#### 2.4 CURBS AND EDGE RESTRAINTS

- A. Job-Built Concrete Edge Restraints: Comply with requirements in 32 13 13 "Concrete Paving" for normal-weight, air-entrained, ready-mixed concrete with minimum 28-day compressive strength of 3000 psi.

## 2.5 ACCESSORIES

- A. Compressible Foam Filler: Preformed strips complying with ASTM D1056, Grade 2A1.

## 2.6 AGGREGATE SETTING-BED MATERIALS

- A. Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C33/C33M for fine aggregate.
- B. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing No. 16 sieve and no more than 10 percent passing No. 200 sieve.
  - 1. Provide sand of color needed to produce required joint color.
- C. Herbicide: Commercial chemical for weed control, registered with the EPA. Provide in granular, liquid, or wettable powder form.

## **PART 3 - EXECUTION**

### 3.1 EXAMINATION

- A. Examine surfaces indicated to receive unit paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Remove substances from concrete substrates that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.
- B. Sweep concrete substrates to remove dirt, dust, debris, and loose particles.
- C. Proof-roll prepared subgrade according to requirements in Section 31 20 00 "Earth Moving" to identify soft pockets and areas of excess yielding. Proceed with unit paver installation only after deficient subgrades have been corrected and are ready to receive subbase course for unit pavers.

### 3.3 INSTALLATION, GENERAL

- A. Do not use unit pavers with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in finished work.
- B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.
- C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
  - 1. For concrete pavers, a block splitter may be used.

- D. Tolerances:
  - 1. Do not exceed 1/32-inch unit-to-unit offset from flush (lippage) or 1/8 inch in 10 feet from level, or indicated slope, for finished surface of paving.
- E. Expansion and Control Joints:
  - 1. Provide for sealant-filled joints at locations and of widths indicated. Provide compressible foam filler as backing for sealant-filled joints. Install joint filler before setting pavers. Sealant materials and installation are specified in Section 07 92 00 "Joint Sealants."
- F. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.
  - 1. Install job-built concrete edge restraints to comply with requirements in Section 03 30 00 "Cast-in-Place Concrete."

### 3.4 AGGREGATE SETTING-BED APPLICATIONS

- A. Place leveling course and screed to a thickness of 3/4 inches, taking care that moisture content remains constant and density is loose and uniform until pavers are set and compacted.
- B. Treat leveling course with herbicide to inhibit growth of grass and weeds.
- C. Set pavers with a minimum joint width of 1/16 inch and a maximum of 1/8 inch (3 mm), being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines. Fill gaps between units that exceed 3/8 inch with pieces cut to fit from full-size unit pavers.
  - 1. When installation is performed with mechanical equipment, use only unit pavers with spacer bars on sides of each unit.
  - 2. Compact pavers when there is sufficient surface to accommodate operation of vibrator, leaving at least 36 inches of uncompacted pavers adjacent to temporary edges.
  - 3. Before ending each day's work, compact installed concrete pavers except for 36-inch width of uncompacted pavers adjacent to temporary edges (laying faces).
  - 4. As work progresses to perimeter of installation, compact installed pavers that are adjacent to permanent edges unless they are within 36 inches of laying face.
  - 5. Before ending each day's work and when rain interrupts work, cover pavers that have not been compacted and cover leveling course on which pavers have not been placed with nonstaining plastic sheets to protect them from rain.
- D. Spread dry sand and fill joints immediately after vibrating pavers into leveling course. Vibrate pavers and add sand until joints are completely filled, then remove excess sand. Leave a slight surplus of sand on the surface for joint filling.
- E. Do not allow traffic on installed pavers until sand has been vibrated into joints.

- F. Repeat joint-filling process 30 days later.

### 3.5 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.
- B. Pointing: During tooling of joints, enlarge voids or holes and completely fill with grout. Point joints at sealant joints to provide a neat, uniform appearance, properly prepared for sealant application.
- C. Cleaning: Remove excess grout from exposed paver surfaces; wash and scrub clean.

**END OF SECTION**

## **SECTION 32 40 00**

### **CONCRETE CONSTRUCTION - CIVIL**

#### **PART 1 - GENERAL**

##### 1.01 DESCRIPTION

- A. The work included under this section will be plain and reinforced concrete work of every description throughout the site work portion of the project and including pavement slabs resting on earth grade, curb and gutter, and storm and sanitary sewer structures.

#### **PART 2 - PRODUCTS**

##### 2.01 REINFORCED STEEL MATERIALS

- A. Reinforcing steel is to be deformed bars meeting ASTM A615/A615M-08a for open hearth, intermediate grade, new billet bars, or ASTM A996/A996M-06a for rail steel bars. Bars must be free from flaws, cracks or other defects of rolling, must be true to size and shape, and must be free from heavy dirt, paint, grease, oil or other destroyers of bond. They are to be prefabricated to detail and delivered on the job plainly tagged and ready to set. Furnish shop detail drawings, according to ACI 315-05, latest, in quadruplicate and obtain approval before fabricating bars.
- B. Reinforcing steel will be unless otherwise noted inside this document, of size and spacing as called for on the drawings.
- C. Reinforcing when delivered to the job must be systematically piled and kept free from dirt or grease, if reinforcement becomes dirty or greasy or objectionably rusty, it must be thoroughly cleaned before being placed in the work.

##### 2.02 PORTLAND CEMENT MATERIALS

- A. General: Cement used for structural and architectural concrete work is to be Portland cement conforming to the American Society for Testing Materials specification C150-07, Types I, or III, or air entrained cement Type IA or IIIA.
- B. Cement is to be delivered on the job in bags containing one cubic foot (approximately 94 lbs.) each (unless a special arrangement to use bulk cement has been developed.). Each consignment of cement must be so piled as to be segregated from every other consignment and must be housed in a waterproof shed and stored on a floor or platform above the general ground level and must be well protected from dampness. No cement which has partially hardened or been otherwise damaged is to be used on this job. Re-tempering of cement will not be permitted.

##### 2.03 FINE AGGREGATE MATERIALS

- A. Fine aggregate is to preferably be sand and particles are to be coarse, sharp and clean. Limestone screenings, pulverized rock, or fine gravel will not be accepted.

Sand is to be free from dust, loam, dirt, vegetable matter, or other foreign or deleterious material. When dry, sand must pass a screen having 3" square mesh and not more than 6 percent will pass a 100 mesh screen. Decantation tests are acceptable methods to limit the amount of loam.

#### 2.04 COARSE AGGREGATE MATERIALS

- A. Aggregate used in concrete work must be either screened, crushed rock, or natural gravel, washed and graded. Coarse aggregate is to be regularly graded from a maximum of 1" down to a minimum of 3/8", and must be clean, hard and durable, free from any long splintery pieces (or a maximum of 5% by weight), and free from dust, dirt, vegetable or organic matter. Mixed aggregate will not be permitted (i.e. crushed run stone or bank run gravel) because of the uneven ratio of fine to coarse materials. Coarse aggregates are to be cleaned, screened and regarded for uniformity.

#### 2.05 AIR ENTRAINMENT

- A. Concrete exposed to freeze-thaw conditions must be air-entrained with air content from 3 percent to 5 percent total air as determined by the method of ASTM C231. No other admixture is to be used without prior approval of Design Professional.

#### 2.06 WATER

- A. It is anticipated that tap-run water will be used for mixing concrete, but water that is potable must be deemed suitable for this purpose.

### **PART 3 - EXECUTION**

#### 3.01 SUBGRADE

- A. The subgrade must be well drained and compacted and prepared in accordance with other sections of specifications.

#### 3.02 FORMS

- A. Forms, including those for edge slabs, must be constructed to accurate dimension of smooth, dressed and seasoned lumber, which must be free of defects and knots.
- B. Forms must be substantially and solidly placed to prevent movement or deflection.
- C. Forms are to be carefully plumbed immediately before the concrete is poured and must be constantly checked during time of pouring, so that movements and deflections are observed and corrected.
- D. The forms must be constructed that the finished concrete surface when forms are removed, are to be free of honeycombs.
- E. The forms must be vigorously rapped during the placing of the concrete to eliminate air pockets and honeycombs.
- F. Projecting corners are to be chamfered. Wood for chamfered corners must be



clear white pine. Earth trenches are not be used without forms unless by the special permission of the Design Professional.

### 3.03 PLACING OF REINFORCEMENT

- A. Place reinforcing carefully and accurately and exactly as detailed, and properly secure against displacement during the pouring of concrete. Bars must be evenly spaced and work must be well wired in place with non-slip ties and properly supported. Where reinforcing rests upon earth grade, it must be properly and securely wired together at each intersection and supported on brick bats to permit concrete to flow under the same.
- B. Before being covered with concrete, reinforcement is to be adjusted to proper height and location and maintained so until covered.

### 3.04 CONCRETE

- A. Measuring Concrete Materials: The method of measuring the materials including water for concrete or mortar, is to be one which will insure separate and uniform proportion of each of the materials continuously, controlling by weight.
- B. Proportion: Conforming to ACI Standards, concrete must be proportioned by the water-cement ratio method. The proportioning of materials must be based on the requirements for a plastic and workable mix with the use of not less than 52 sacks of cement per cubic yard and not more than 6.2 gallons of water per sack of cement, including the surface water carried by the aggregate. The proportion of fine to coarse aggregate must be adjusted to produce maximum workability, but in no case is the ratio of fine to coarse aggregate be outside the limits of a to 2 and the coarse aggregate 2 to b of the total fine and coarse aggregate. Concrete must be placed with a slump of approximately 4" if manually spaded into place and 3" if internal vibrators are used.
- C. Concrete must develop an ultimate compressive strength of at least 4,000 pounds per square inch in standard 6" x 12" or 4" x 8" cylinders at 28 days moist cured in the laboratory.
- D. Placing Concrete: Concrete must be placed in a manner that will permit the most thorough compacting and must be worked into the recesses. Concrete is to be placed in its final position as soon as possible after mixing and must be in place within 12 hours after the water has been added to the dry materials. It is to be placed in one continuous operation from construction joint to construction joint.
- E. Joints: Joints must be formed, not simply stopped off, and said forms are to generally be perpendicular to stress lines. Construction joints are best made at joints of minimum shear, as for example midspan of slabs, joist, and beams. If joints are made at another point, the Design Professional will design a shear-key of concrete with crossed reinforcing bars to develop the shear.
- F. Internal vibration is desirable, providing that it is not overdone. Take caution to keep the vibrators off the reinforcing steel. If internal vibrators are not available, hand spading of the concrete into recesses will be required.

- G. Where work is stopped so that the concrete has hardened before placing is resumed, the surface must be left level or square by roughened and covered with wet burlap. When starting again to place, clean the surface of foreign matter and laitance, slush with a thin layer of mortar mix made with one part cement and two parts of sand. Furnish and set dowels in construction joints as called for on the plans or as directed by the Design Professional.

### 3.05 FINISHING

A. Floors must be finished as follows:

1. Interior floor slabs must have a "Steel Troweled Finish."
2. Exterior slabs, sidewalks, curbs and pads are to have a "Medium Broom or Belt Finish."
  - (a) Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.
3. Ramps are to be finished with "Detectable Warnings" as specified in ADA (American with Disabilities Act) paragraph 4.29.
  - (a) Provide contrasting color with adjoining surfaces.
4. Exterior pavement, drive or parking lot approaches are to have a uniform gritty texture produced by two (2) passes of a damp burlap or cotton fabric, unless otherwise directed by City of Augusta or Georgia state authorities.
5. Light pole bases must have an architectural concrete "As-Cast" finish, patches shall match surrounding color and texture.

B. Refer to Cast-In-Place Concrete, Section 033000, for all other concrete finishes.

C. Should Section 033000 and this Section conflict, Section 033000 shall govern.

### 3.06 CURING

- A. Concrete trim must be protected by wet burlap or canvas covering from sun, wind, and rain and this must be frequently wetted in dry and hot weather so that the entire surface is kept wet for a period of one week, or liquid curing compound satisfactory to the Design Professional must be used, applied as directed.

### 3.07 PROTECTION FROM WEATHER

- A. Concrete work is to be discontinued during freezing weather. Work recently built must be properly protected. Work injured by the weather must be taken down and rebuilt at the contractor's expense.

### 3.08 CLEANING

- A. On completion of this contract, clean down exposed concrete work and remove from the premises form lumber, cement sacks, scutan paper and other debris caused by this work.

**END OF SECTION 32 40 00**

## **SECTION 32 84 00**

### **PLANTING IRRIGATION**

#### **PART 1 - GENERAL**

##### 1.1 SCOPE OF WORK

- A. Furnish all labor, materials and equipment for the proper design and installation of an irrigation system to service the landscaped areas designated to have permanent irrigation of the Bell Auditorium project. The system is to be designed by a Professional Irrigation Consultant and installed by a qualified Irrigation Contractor. The design criteria of the system will be directed by the client and the Owner. The General Contractor shall submit to the Owners Representative a complete set of Construction Documents along with a Schedule of Values itemizing the major components of the system, along with the labor required to install said materials.

##### 1.2 SUMMARY OF WORK

- A. Extent of underground irrigation system is to be shown on the Drawings and in Schedules.
- B. Provide all documents, labor, materials and equipment required by or inferred from the Drawings and Specifications to complete the Work of this section.
- C. Provide additional work and materials required by local authorities at no extra cost to Owner.

##### 1.3 QUALITY ASSURANCE

- A. Industry Reference Standards: Refer to Division 1 Reference Standards Section.
  - 1. American Society for Testing and Materials (ASTM).
    - a. D 3139-89, Specification for Joints for Plastic Pressure Piping Using Flexible Elastomeric Seals.
  - 2. National Electric Code (NEC), 1990 Edition.
- B. Qualifications:
  - 1. Installer Qualifications: Engage a company specializing in irrigation installation. Installer shall have successfully completed five projects similar in scope and size, as indicated in
    - a. Firm Experience Period: Five years of experience.
    - b. Field Foreman Experience: Five years of experience with installing firm.
  - 2. Codes and Standards: Perform Irrigation Work in compliance with applicable requirements of governing authorities having jurisdiction. County regulations supersede these specifications. Notify Landscape Architect in writing of all discrepancies immediately.
  - 3. Do not make substitutions: If the Contractor desires to make substitutions of materials, sufficient descriptive literature and material samples must be furnished to establish the material as an equal substitute. In addition, the

Contractor must state his reasons for desiring substitute materials. Submit this request and information to Landscape Architect.

4. Approval and Selection of Materials and Work: The selection of all materials and the execution of all operations required under the Drawings and Specifications is subject to the approval of the Owner and Landscape Architect. They have the right to reject any and all materials and any and all Work which, in their opinion, does not meet the requirements of the Contract Documents at any stage of the operations. Remove rejected Work and or materials from Project Site and replace promptly.
5. Workmanship: Install materials and equipment in a neat and professional manner following manufacturer's recommendations.
6. Irrigation system designer shall be:
  - a. A professional firm whose primary source of income is derived from the professional irrigation design services they offer to the clients they represent.
  - b. A professional consulting firm without any affiliation to contractors, product suppliers, manufacturers or any interest that could be construed as a conflict of interest to the proposed project.
  - c. A professional firm that has experience in the design and administration of projects of similar scope and size as described in the Scope section.
  - d. A professional firm covered by all the necessary insurance's including general liability, and Error's & Omissions coverage. (provide proof of insurance documentation)
7. Conference: Before any work is started a conference shall be held between the Contractor and the Owner concerning the work under this contract.
8. The Contractor shall maintain continuously a competent superintendent, satisfactory to the Owner, on the work during progress with authority to act or him in all matter pertaining to the work.
9. It is the Irrigation Contractor's responsibility to coordinate and cooperate with the other Contractors to enable work to proceed rapidly and efficiently.
10. The Contractor shall confine his operations to the area to be improved and to the areas allotted him by the Designer and General Contractor for material and equipment.
11. Contractor shall take all necessary to protect the existing site conditions and vegetation.

#### 1.4 ACTION SUBMITTALS

- A. Approval: Obtain approval from Landscape Architect for all submittals prior to the beginning of Work, unless otherwise approved.
- B. Design Drawings: Construction documents shall be prepared in AutoCAD format.
- C. Drawings shall be clearly and neatly plotted on a mylar sepia, and submitted along with three (3) sets of blue lines for review and comment by representatives of the Owner. All automatic and manual valves, quick couplers, sprinklers, and ancillary equipment shall be shown at scale to determine actual field dimensions.

- D. Construction Documents submittals must be approved by an Owner's representatives prior to an official notice to proceed
- E. As-Built Drawings: upon completion of installation, Contractor shall produce as-built drawings in Autocad 2017 format and furnish one set of reproducible and one set of printed record drawings showing all sprinkler heads, valves, drains, and pipelines to scale with dimensions. These drawings shall have dimensions from easily located stationary points (cross measured) as they relate to all valves, mainlines, and wire. Clearly note all approved substitutions of size, material, etc. Complete, concise instruction sheets and parts lists covering all operating equipment and weathering techniques shall be bound into folders and furnished to the Owner in three (3) copies. Submission of this information is a requirement for final acceptance.
- F. Product Data: Submit, for information only, manufacturer's specifications, product data, installation instructions and general recommendations for all components of the irrigation system. Each submittal is to clearly identify the product, series/model number by use of a high lighter.
- G. Installer Certification: Submit written documentation certifying that Irrigation Contractor and Irrigation Consultant complies with requirements of "Installer Qualifications" above.

#### 1.5 SITE CONDITIONS

- A. The Contractor shall examine the site, plans and specifications (i.e. system requirements).
- B. It shall be the Contractor's responsibility to report in writing to the Designer any deviations between drawings, specification, and actual site conditions. Failure to do so prior to the installing of equipment shall be done at the Contractor's expense.
- C. Adjustment of the sprinkler heads and automatic equipment will be done by the Contractor, upon completion of installation, to provide optimum performance.
- D. After completion, testing, and acceptance of the system, the Contractor shall verbally instruct the Owner's personnel in the operation and maintenance of the system. All written instruction shall be included in the bound maintenance package as stated in Section 1-04 - Submittals.

#### 1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials and equipment in such a manner as to not damage the parts or decrease the useful life of equipment.
- B. Store materials away from detrimental elements. Coordinate with General Contractor to secure a safe staging area.
- C. Handle, load, unload, stack and transport materials for irrigation system carefully to avoid damage. Handle pipe in accordance with manufacturer's recommendations.

#### 1.7 PROJECT CONDITIONS

- A. The site irrigation system is comprised of two major components, an irrigation distribution and sprinkler system. The Contractor shall connect the distribution network to the irrigation point of connection. The Contractor will reimburse the Owner for all work deleted and not completed.

- B. The Irrigation System is designed to operate under the following conditions: a minimum of 75 psi water pressure (determine actual requirements at time of design), and at least 90 gpm available water supply. Contractor shall be responsible to determine actual flow (and meter size) required at size to ensure manageable water window for Owner.
- C. Insurance on irrigation materials or equipment stored or installed is the responsibility of the Irrigation Contractor. Such insurance shall cover fire, theft and vandalism. Should the Contractor elect not to provide for such insurance, he will in no way hold the Owner responsible for any losses incurred by the aforementioned acts. The Irrigation Contractor is responsible for all costs incurred in replacing damaged or stolen materials or equipment prior to Substantial Completion of the Work.
- D. Obtain all required permits and pay all required fees, at no additional cost to the Owner. Any penalties imposed due to failure to obtain permits or pay fees are the responsibility of the Contractor.
- E. Provide and maintain all passageways, guard fences, warning lights and other protection devices required by the local authorities.
- F. Existing Grades: Existing grades will be within .2 feet of grades shown on the Civil Engineering Drawings at time of irrigation work. Determine condition of existing grades prior to beginning the Work. When irregular or incomplete grading conditions are encountered, notify the Owner in writing before beginning the Work. Perform Work in a manner which will avoid damage to finished grading and drainage resulting from the work covered in these Contract Documents shall be repaired at the Contractor's expense.
- G. Existing Site Improvements: Perform Work in a manner which will avoid possible damage. The Contractor is responsible for any damage of mechanical nature as well as damage resulting from leaks in the irrigation system whether due to negligence or otherwise.
- H. Test water conditions: The Contractor shall check the pressure at the irrigation point of connection and confirm minimum operating pressure noted in this Specification. If minimum operating pressure cannot be obtained, notify Landscape Architect.
  - 1. In the event the water pressure does not meet minimum operating pressure at the irrigation point of connections noted in this Specification, notify Landscape Architect.
  - 2. The Irrigation Consultant will make recommendations concerning the development of a booster pump station capable of providing the flow and pressure required as indicated in the Specifications Section 1-06, Paragraph B.
  - 3. In the event the water pressure significantly exceeds the operating pressure noted in this Specification, provide a pressure regulator down stream of the backflow preventer.
- I. Sleeves, if required, are to be installed by the General Contractor. Irrigation sleeves shall be installed as per details. If sleeving horizontal depth exceeds the detailed requirement by 6 inches (6"), it will be the responsibility of the General Contractor to expose the horizontal ends below finish grade. The General Contractor is to expose irrigation sleeves for Irrigation Contractor prior to start of Irrigation Work in all areas where sleeving is not installed as per details. Coordination and scheduling for excavation of sleeve ends is the responsibility of the Irrigation Contractor.

- J. Coordinate and schedule all Work with General Contractor.
- K. Damages resulting from irrigation installation to work of other trades must be repaired at the expense of the Irrigation Contractor in a timely fashion.
- L. Make minor adjustments to system layout as may be required and requested at no additional cost to the Owner.
- M. Keep Project Site clean and orderly at all times during construction

#### 1.8 WARRANTY

- A. Warranty all Work for a period of one year, starting on the Date of Substantial Completion, against defects in materials, equipment, workmanship, and any repairs required resulting from leaks or other defects of workmanship, material or equipment.
- B. Repair unsatisfactory conditions promptly at no cost to the Owner.
- C. Emergency repairs may be made by the Owner without relieving the Irrigation Contractor of his warranty obligations.
- D. Repair settling of backfilled trenches occurring during the warranty period, including restoration of damaged plantings, paving or improvements resulting from settling of trenches or repair operations.
- E. Respond to Owner's request for repair work within ten (10) days. If not, Owner may proceed with such necessary repairs at the Contractor's expense.
- F. Provide written warranty executed by pump station manufacturer that all system equipment and components will be free from all defects in material and workmanship for a period of one year after the date of Substantial Completion.

#### 1.9 CODES AND ORDINANCES

- A. All materials, installation parameters, and operations shall conform to all applicable codes and ordinances. It is the Contractor's responsibility to investigate and follow all regulations. Contractor is responsible to verify applicable codes and ordinances prior to submitting bid. Before bid submittal, it is the Contractor's responsibility to notify the Irrigation Consultant/Designer at least 5 days before bid submittal, of any changes due to code or ordinance discrepancies. If the Contractor does not comply with this process and notification, the Contractor shall be responsible for the necessary installation change and redesign costs for non-compliance.

#### 1.10 PERMITS AND FEES

- A. The Contractor shall obtain, at his expense, all required permits and shall pay all required fees. Any penalties imposed due to failure to obtain any permit or pay any fee shall be the responsibility of the Contractor.

## **PART 2 - PRODUCTS**

#### 2.1 PIPE AND FITTING

- A. All Mainline piping 2-1/2" and larger shall be Class 200, SDR 21, unplasticized rigid PVC pipe with integral bell and rubber ring gasket unless otherwise specified.



- B. All Mainline 2" and smaller and all lateral piping piping shall be Class 200, SDR 21, solvent weld P.V.C. pipe. 1/2" pipe shall be Class 315 solvent weld P.V.C. Pipe. All pipe shall be supplied in 20' standard lengths.
- C. All pipe that is exposed or not below grade shall be Schedule 80 PVC.
- D. Fittings for integral bell rubber ring gasketed pipe shall have the gasket type fittings, PVC type.
- E. Fittings for all Mainline Piping 4" shall be Harco Ductile Iron Gasketed Fittings. All mainline 4" and larger shall utilize approved thrust blocking and or restraints. Thrust Blocking and restraints to be installed as per manufacturer's recommendations for pipe type, pipe size and local environmental conditions.
- F. All fittings for 2-1/2" and small mainline and all lateral piping shall be Schedule 40 solvent weld fittings rated for 200 psi (ASTM D-3139).
- G. Solvent weld PVC pipe shall be rigid PVC pipe and shall be assembled using appropriate PVC pipe cleaner/primer and solvent cement in accordance with the manufacturer's recommendations. Solvent cement shall be # 715 Gray NSF approved.
- H. All solvent weld fittings shall conform to Schedule 40 or Schedule 80 PVC dimensions and specifications for solvent weld fittings.
- I. Expansion Joints: Shall consist of integral bell and rubber gasket coupling, install every 300 feet of solvent weld piping.
- J. Runs of pipe over 20' length must be installed with standard 20' length sections.
- K. PVC Pipe Couplings Located Within Sleeves: 4" and smaller to be solvent weld. 6" and larger to be mechanical joints. Upon exiting sleeves, pipe solvent weld or integral bell and rubber gasket, as specified.
- L. All plastic fittings to be installed shall be molded fittings manufactured of the same material as the pipe and shall be suitable for solvent weld, slip joint ring tight seal, or screwed connections NO fitting made of other material shall be used except as hereinafter specified.
- M. Slip fitting socket tapers shall be so sized that a dry unsoftened pipe end conforming to these special provisions can be inserted no more than halfway into the socket. Plastic saddle and flange fittings will not be permitted. Only Schedule 80 pipe may be threaded.

## 2.2 SLEEVES

- A. All sleeves shall be Class 200 PVC or stronger. All sleeves are required at every crossing indicated on drawings. (Size Noted)
- B. All sleeves shall be installed under proposed pavement areas prior to subgrade and base construction.
- C. Sleeves shall have a minimum horizontal separation of 18" and a maximum of twenty-four (24) inch clearance below bottom of curb.
- D. All sleeves shall have a minimum horizontal separation of twenty-four (24) and maximum of thirty-six inches from center to center.

- E. Stub up sleeve pipe twelve (12) inches above ground surface and cap. Paint cap with fluorescent orange paint for easy identification.
- F. The location of all sleeves shown on the plans is schematic. The contractor shall make any adjustments necessary to accommodate existing vegetation, utilities, or other existing conditions.
- G. If the road crossings are designated as being bore locations the bore must be ample size to accommodate the size sleeve specified.

### 2.3 ELECTRIC WIRING

- A. 120 Volt AC Wiring: 120-volt service to controller shall consist of three wires: one black, one white, and one ground. Electrical service to be provided by Contractor.
- B. Splices in controller wiring shall be waterproof.
  - 1. Acceptable Manufacturers and Products:
    - a. Manufacturer: 3M
      - 1) Product: DBR/Y-6
    - b. Manufacturer: Paige
      - 1) Product: DBR/Y-6
- C. Control Wiring shall be 600 volt solid wire U.L. approved for direct burial in ground. Minimum wire size: 14 gauge (two-wire). Wire shall be sized as per controller manufacturer's specification for wire sizing based on wire run distance and number of valves.
  - 1. Acceptable Manufacturers and Products:
    - a. Manufacturer: Paige Electric Co.
    - b. Manufacturer: Rain Bird
    - c. Manufacturer: Baseline

### 2.4 SPRINKLER HEADS

- A. Spray and rotary sprinklers: Provide where indicated on the drawings. All spray heads (6" & 12" pop up) shall be provided with an internal pressure regulating device. All sprinkler heads (sprays and rotary) shall have an internal check valve to minimize low head drainage and be installed on (4) four elbow swing joints. Heads shall perform to Manufacturer's Specifications concerning diameter of throw and gallonage at provided pressure.
  - 1. Acceptable Manufacturers and Products:
    - a. Manufacturer: Rain Bird
      - 1) Product: Sprays # 1806-SAM and # 1812-SAM
      - 2) Product: Rotor # 5000 (stainless steel riser)
      - 3) Product: Root Watering System (RWS) for trees with 1gpm bubbler nozzle (2 per tree)
    - b. Manufacturer: Toro
      - 1) Product: Sprays # 570Z-6P-COM and # 570Z-12P-COM
    - c. Manufacturer: Hunter
      - 1) Product: Rotor I-20 ADS (stainless steel riser)
      - 2) Product: Rotary Nozzle MP Rotator
- B. Drip Irrigation Emitters shall be of the in-line self cleaning, pressure compensating or insertable variety where indicated on drawings.

1. Acceptable Manufacturers:
  - a. Manufacturer: Rain Bird
    - 1) Product: XFS Drip Tubing
    - 2) .6 gph inline emitters, 12" inline emitter spacing, tubing spacing to be 12"

## 2.5 AUTOMATIC CONTROLLER

- A. Each controller location must be easily accessible for maintenance. Provide for the possibility of making minor timing adjustments to the controller in the field.
- B. Provide controllers capable of fully automatic, as well as manual operation of the system. Controller housing is to be a wall or pedestal mounted, where noted on the drawings, in weatherproof, lockable cabinet.
- C. Provide controller which operates on a minimum of 110 volts AC power input and is capable of operating 24 vole AC electric remote control valves, with a reset circuit breaker to protect from overload. Contractor is responsible for connection to 120 VAC power to controller.
- D. Each station shall have a time setting which can be set for variable timing in increments from 0 to 60 minutes, or set to omit the station from the irrigation cycle.
- E. The controller shall have a master "on-off" switch shall allow the valve power output to be interrupted without affecting the controller.
- F. The controller shall be constructed so that all internal parts are accessible through the controller door without disturbing the cabinet installation.
- G. Contractor shall a include a wireless Rain and Freeze-Clik sensor for each field controller (Rain/Freeze Sensor)
- H. Each Controller shal be grounded as per the Controller Manufacturer's and the American Society of Irrigation Consultants specifications.
- I. Acceptable Manufacturers and Products:
  1. Manufacturer: Rain Bird
    - a. Product: ESP-LXD Series (Modular)
  2. Manufacturer: Baseline Systems
    - a. Product: 3200 Series

## 2.6 METER

- A. Owner to provide domestic irrigation water meter as indicated on drawings and which will comply with Manufacturer's Specifications and applicable local codes. Irrigation Contractor shall be responsible to coordinate with Owner to ensure that meter is sized to accommodate required flow.

## 2.7 BACKFLOW PREVENTER:

- A. The Contractor shall provide a backflow device at the domestic irrigation water meter. The backflow preventer(s) shall be a reduced pressure assembly type, capable of having a flow rate of equal to system design flow gwith a pressure loss not to exceed 7 pounds per square inch (PSI) and shall be suitable for supply pressure up to 150 PSI. The backflow preventer body to be bronze, internal parts stainless

steel, and the check valve assemblies tight seating rubber. The backflow preventer assembly must include two gate valves for isolating unit, and two ball valve test cocks for testing unit to insure proper operations. All backflow devices should conform to all local codes and regulations.

- B. Acceptable Manufacturers:
  - 1. Manufacturer: Watts
  - 2. Manufacturer: Febco
  - 3. Manufacturer: Wilkins
- C. Backflow Preventer shall be type approved by local water authority (i.e. RPA vs DCA). Contractor shall submit backflow preventer information to local water authority for approval before starting construction.

## 2.8 VALVE BOXES

- A. Control Valves: Shall be in a 12" x 18" Super Jumbo Valve Box with non-hinged cover.
- B. Backflow Preventer: Shall be in a 20" x 34" Valve Box with non hinged cover (if DCA).
- C. Isolation Valves and Wire Splices and Quick Coupling Valves: Shall be in a 10" round valve box with cover.
- D. All Valve Boxes are to be green in color with green colored covers, unless local code dictates otherwise or otherwise directly by Owner.
- E. Acceptable Manufacturers:
  - 1. Manufacturer: Carson Industries.
  - 2. Manufacturer: Ametek

## 2.9 QUICK COUPLING VALVES AND KEYS

- A. Quick coupling valves shall be used as a source to the pressurized main line so that a hose can be attached for manual hand watering. The quick coupling valve will be constructed of brass with a spring loaded seal that will keep the valve in a closed position until the key is inserted into the valve. The valve will also have a hinged locking purple rubber cover to prevent any debris getting into the internal mechanism of the valve. The cover shall be marked with "Do Not Drink" in English and Spanish. All quick coupling valves will be installed on a triple elbow swing joint. Provide size as indicated on drawings.
- B. Quick coupling keys shall be of the single lug variety. Attached to the key will be a hose swivel adapter sized to the commonly used hose on the project. The key and swivel will both be constructed of brass. Installation Contractor shall provide (5) Hose Swivels and Keys matching Quick Couplers installed.
- C. Acceptable Manufacturers:
  - 1. Manufacturer: Rain Bird #5 Series, 1"
  - 2. Manufacturer: Toro 100-SLVC Series, 1"
  - 3. Manufacturer: Hunter #5 Series, 1"

## 2.10 CONTROL VALVES

### A. Plastic Body

1. Provide electric remote control valves (size as indicated on drawings). Valves are to be constructed of a glass-filled nylon material with a self cleaning stainless steel screen. Low flow/low pressure operating capabilities. Flow: .25 to 200 GPM; Pressure: 20 to 200 PSI. Valves to conform to Manufacturer's Specifications concerning performance and at pressures provided.

### B. Brass Body

1. Provide electric remote control valves (size as indicated on drawings). Valves are to be constructed with a brass body and bonnet assembly having a self cleaning screen. Flow and pressure operating capabilities. Flow: 5 to 200 GPM; Pressure: 20 to 200 PSI. Valves to conform to Manufacturer's Specifications concerning performance and at pressures provided.

C. All remote control valves shall be installed with pressure regulation devices

D. All remote control valves shall be installed with single station decoders (from same manufacturer as controller).

### E. Acceptable Manufacturers:

1. Manufacturer: Rain Bird
  - a. Product (Plastic): PEB-PRS
  - b. Product (Brass): EFP-CP-PRS
2. Manufacturer: Toro
  - a. Product (Plastic): P-220-27
  - b. Product (Brass): 220-27
3. Manufacturer: Hunter
  - a. Product (Plastic): ICV-AS
  - b. Product (Brass): IBV-AS

## 2.11 SURGE PROTECTION EQUIPMENT

- A. Provide lightning arrestor for controllers not equipped with primary surge protection. See notes in controller specification section related to specific controller grounding requirements.

## 2.12 ISOLATION VALVES

- A. Provide all gate valves for isolation purposes, allowing full diameter opening when in full open position.
- B. Manually operated valves: same size as line.
- C. Lateral Isolation Valves (at remote control valves): Sch 80 PVC True Union Ball Valves
- D. Mainline Valves 3" or larger: cast iron fitted with rubber ring, slab-type gasket.
1. Acceptable Manufacturers:
    - a. Manufacturer: Clow (or equivalent)

### 2.13 MISCELLANEOUS SYSTEM COMPONENTS

- A. Provide risers, reducers, couplings, adapters, fittings as necessary to complete the irrigation system.
- B. Installation Contractor will be responsible to install any other irrigation components required by local codes and ordinances.

## **PART 3 - EXECUTION**

### 3.1 GENERAL

- A. Inspection of Work in progress: During the installation, the Landscape Architect will make regular inspections and reject any work and materials which do not meet the requirements called for in the Contract Documents.
- B. Inspect project site prior to start of Work to determine that all site conditions are acceptable for Irrigation Work to begin. Inform Landscape Architect of unsuitable conditions. Do not proceed with installation of irrigation system until unsatisfactory conditions have been corrected in a manner acceptable to installer.
- C. Locate all existing underground utilities prior to trenching and/or boring operations. Obtain utility locations from Owner and/or General Contractor and utilize utility locating services when necessary.

### 3.2 EXCAVATION

- A. All excavation is unclassified and includes all materials encountered that are not classified as rock excavation.
- B. Report exceptions to the Landscape Architect before excavation. An adjustment in price will be established which includes removal and disposal of the unsuitable material, and the acquiring of additional backfill material.
- C. Excavation in newly sodded areas: Prior to excavation, remove sod, preserve and replace after backfilling is completed.
- D. Excavation in established grass or newly seeded areas: After excavation and backfilling is completed, re-grade trenched area consistent with surrounding area and re-seed with 100% pure seed of type grass existing. Mulch with straw and water.
- E. Excavation through existing asphalt, cutting, removal and replacement of asphalt, as noted on the drawing, is the responsibility of the Irrigation Contractor.
- F. Trenches for pipe sprinkler lines shall be excavated of sufficient depth and width to permit proper handling and installation by any other method the Contractor may desire if approved by the Owner, pipe manufacturer, and Designer. The backfill shall be thoroughly compacted and evened off with the adjacent soil level. Selected fill dirt or sand shall be used if soil conditions are rocky. In rocky areas the trenching depth shall be two (2) inches below normal trenching depth to allow for this bedding. The fill dirt or sand shall be used in filling (4) inches above the pipe. The remainder of the backfill shall contain no lumps or rocks larger than three (3) inches. The top twelve (12) inches of backfill shall be topsoil, free of rocks, subsoil, or trash. Any open trenches or partially backfilled trenches left overnight or left unsupervised shall be barricaded to prevent undue hazard to the public.

- G. The Contractor shall backfill in six (6) inch compacted lifts as needed to bring the soil to its original density.
- H. In the spring following the year of installation, the Contractor shall repair any settlement of the trenches by bringing them to grade with topsoil, and seeding with the existing lawn type(s). Watering and maintenance of the repaired areas shall be the Owner's responsibility.

### 3.3 LEAKAGE TEST

- A. The system shall be subjected to a leakage test. Leakage shall be defined as the quantity of water that must be supplied into the pipe to maintain the design working pressure after all air in the pipeline has been expelled and the pipe has been filled with water. Leakage shall not exceed the quantity determined by the formula given below:

$$L = \frac{ND(\text{Square root of } P)}{3700}$$

Where **L** = allowable leakage in gallons per hour

**N** = number of joints in pipeline

**D** = nominal diameter of the pipe in inches

**P** = average test pressure during the leakage test in psig

If leakage exceed the allowable rate, leaks shall be found and repaired and the test repeated until successful.

### 3.4 BACKFILL

- A. Backfill material shall be free from rocks, large stones, and other unsuitable substance which could damage the pipe or create unusual settling problems. Backfill in 6" layers and tamp after each layer to prevent excessive settling.
- B. Backfill trenches containing plastic pipe when pipe is cool to avoid excessive contraction in cold water. Such backfilling can be done in early morning hours or the pipe may be water cooled prior to backfilling procedures.
- C. Minimum depth of cover of all pipe is as follows:
  - 1. Lateral piping: 12" (unless local codes require deeper)
  - 2. Mainline piping: 18" (unless local codes require deeper)

### 3.5 SLEEVING

- A. Location of sleeving shown on the drawings is schematic. General Contractor to make adjustments necessary to accommodate existing vegetation, utilities and other existing conditions.
- B. Repair of damage to existing utilities, structures or other construction resulting from installation of sleeves is the responsibility of the General Contractor.
- C. Irrigation sleeves shall be installed as per details. If sleeving horizontal depth exceeds the detailed requirement by (6") 6 inches, it will be the responsibility of the General Contractor to expose the horizontal ends below finish grade. In all areas where sleeving is not installed as per details the General Contractor is to expose irrigation sleeves for Irrigation Contractor prior to start of the Irrigation Work

### 3.6 PIPE

#### A. Pipe Joints:

1. Solvent Weld PVC Pipe: Assemble according to Manufacturer's Recommendations, using appropriate PVC pipe cleaner/primer and solvent cement.

#### B. Main Line: Install according to Manufacturer's Recommendations. Provide concrete thrust blocks at all directional changes on all pipe 2-1/2" and larger that is of the gasketed variety, as per drawings. Restraints to be utilized where required.

#### C. Pipes and Fittings:

1. Install according to manufacturer's Recommendations including snaking-in of PVC pipe to prevent excessive strain when contracting in cold weather.

#### D. Lateral Lines and Risers:

1. Install according to Manufacturer's Recommendations using standard techniques.
2. Combine lateral lines and main supply lines in common trenches wherever possible.
3. Install risers such that no excessive movement occurs while sprinkler head is in operation. Height of risers to be in accordance with planned and existing plant material. Height of all risers is subject approval of Landscape Architect.
4. Plug lines immediately upon installation to minimize infiltration of foreign matter.
5. Flush lateral lines and risers prior to installation of sprinkler heads.
6. Above ground risers must be dark gray or black in color.

### 3.7 SPRINKLER HEADS

#### A. Low Pop-up Sprinkler Heads: Install in such manner that top is 1" above finish grade. Where finish grade has not been established extend a riser minimum of 12" above existing grade to mark location of head. After finish grade is established install heads as shown on the drawings.

#### B. High Pop-Up Shrub Heads: Finish height to be determined by Landscape Architect.

#### C. Backfill around sprinkler head assembly in such manner as to stabilize the sprinkler head so that no lateral motion is exhibited during operation.

#### D. Sprinkler heads on risers: Install as shown on the drawings. High-pop sprinkler heads shall be installed in landscape areas to retract out of sight when non-operational. Height of all heads in bed areas to be determined in the field by the Landscape Architect.

#### E. Drip irrigation emitters are to be located in a manner that will provide optimum concentration of water to the plant material. Drip irrigation shall be installed in a grid pattern with manifolds to insure hydraulic balance.



### 3.8 ELECTRIC CONTROL WIRES

- A. Install control wires in orderly fashion, locate in main line trench. Bundle wires together and tape at 10' intervals. Position wires to the right of the water supply line in the direction of the water flow.
- B. Provide looped slack at directional changes in supply line to allow for contraction of wires.
- C. Keep wire splices to a minimum and provide 10" round valve box at each splice location. Splices shall only occur at valve boxes.
- D. Pass wires under existing or future paving, construction, etc., through PVC sleeves.
- E. For each open station on any given controller, there shall be spare wires to the furthest (2) two control valves located in diametrically opposed directions from the controller, plus one additional spare wire.

### 3.9 CONTROL EQUIPMENT

- A. Install automatic valves and controllers according to Manufacturer's Recommendation.
- B. All remote control valves to be installed with Sch 80 PVC ball valves in the same valve box upstream of the valves.
- C. Leave twenty-four inch loop of wire at each valve for expansion/contraction and servicing.

### 3.10 VALVE BOXES

- A. All valves are to be housed in valve boxes. Install according to Manufacturer's Recommendations, and as shown on the drawings. Position boxes at a height that will not cause them to interfere with maintenance machinery (e.g., movers) and such that soil and mulch do not wash into the box. Locate valve box in mulched or natural areas one foot inside the bed line. Where no mulched areas or natural areas exist within forty feet of valve box locations install valve box in turf area. Install no more than two valve boxes together when installed in turf areas.

### 3.11 SURGE PROTECTION EQUIPMENT

- A. Install surge protection equipment on primary (110 VAC) power lines in accordance with the electrical grounding instructions included with each controller. Connect each surge protection unit to at least one 5/8" diameter by 9' long copper clad grounding electrode driven into the soil to its full depth. Place electrodes no closer than two (2) feet from the controller cabinet or any control or power wire. Be consistent in locating ground rods throughout the installation with respect to controller positions.
- B. Ground wire between surge protection device and grounding electrode to be single strand bare copper wire at least one size greater than the wire supplying power to the control unit. Route ground wire away from power and control wires where possible. When it is necessary to pass through the controller cabinet wall use two (2) #L-70 copper grounding lugs and a brass bolt as noted on the drawings. Use a #WE 5/8 ground rod clamp (single piece and bolt) to make connection between ground rod and ground wire. Bury ground wire passing between controller and ground rod a minimum of ten inches. Cover the top of the rod and the clamp itself with a 4" round cover with lid at grade level.

3.12 BALANCING AND ADJUSTMENT

- A. Balance and adjust the various components of the sprinkler system so that the overall operation of the system is most efficient. This includes synchronization of the controllers, adjustments to pressure regulators, part circle sprinkler heads, and individual station adjustments on the controllers.
- B. Upon completion of the irrigation system, perform a coverage test with the Owner's representative to determine if the irrigation coverage is adequate. Correct any inadequacies.

3.13 IRRIGATION DISTRIBUTION AND SPRINKLER OPERATION TESTING

- A. Upon completion of the irrigation system, and after head installation, test the entire system for proper operation. Flush all air from the system and check components for proper operation.

3.14 OWNER ORIENTATION

- A. Upon completion of the Work and at a time and place acceptable to the Landscape Architect and Owner, the Irrigation Contractor is responsible for the orientation of the Owner's maintenance personnel in the operation, maintenance, and repair of the system. Furnish copies of all available parts lists, troubleshooting lists and specification sheets, to the Landscape Architect.
  - 1. Operating and Maintenance Manuals shall constitute the basis of orientation.
- B. Set the initial watering schedules and programming of the automatic controllers at direction of Landscape Contractor.

3.15 WINTERIZING THE SYSTEM

- A. The irrigation system shall be winterized the first winter season following Substantial Completion of the Project in total. The irrigation piping shall be winterized by first blowing the system clear of water using compressed air (80 psi maximum) admitted into the piping at a quick coupling valve or hose bib located at a higher elevation on the system piping. Activate individual zones, higher zones first, then proceed successively through the system towards lower elevations. Proceed through all zones twice. The air compressor must be sized to provide the volume requirements necessary to completely evacuate the irrigation piping system. The air compressor used to winterize the system must have an engine separate from the compressor tanks to prevent high temperature air from being injected directly into the PVC piping.

3.16 CLEAN UP AND PROTECTION:

- A. During irrigation Work, keep Project Site clean and orderly.
- B. Upon completion of Work, clear grounds of debris, superfluous materials and all equipment. Remove from site to the satisfaction of the Landscape Architect.
- C. Protect Irrigation Work and materials from damage due to irrigation operations, operations by other contractor and trades and trespassers. Maintain protection until Date of Substantial Completion.

- D. Cover all openings in to the system as it is being installed to prevent obstructions in the pipe and the breakage, misuse or disfigurement of the equipment.
- E. Theft: Irrigation Contractor is responsible for theft of equipment and material at the job site before, during and after installation, until Date of Substantial Completion of the Work in total.

### 3.17 INSPECTION AND ACCEPTANCE

- A. Periodic Inspections will be made by the Landscape Architect to review the quality and progress of the work. Work found to be unacceptable must be corrected within five calendar days. Remove rejected materials promptly from the project.
- B. Upon completion of Work, the Contractor shall notify the Landscape Architect and Owner at least ten (10) days prior to requested date of inspection for Substantial Completion of all portions of the Work. Landscape Architect will issue a punch list for work to be corrected. All work on the punch list must be completed within five (5) working days form the date of inspection. Where inspected Irrigation Work does not comply with requirements, replace rejected Work. If such replacements are not completed within the time specified, the Irrigation Contractor may be considered to be in default of the Contract, and the Owner may use the Contract Retainage to hire other Contractors to finish the Work.
- C. It will be the responsibility of the Irrigation Contractor to provide a reliable communication system (i.e.: Two-way radios or remote radio control activation system) for Substantial Completion and all periodic inspections.
- D. If an inspection to verify Substantial Completion has been scheduled and the Landscape Architect arrives at the site and determines that the Irrigation System is not substantially complete (all system components in place, operational and checked) the Contractor shall be responsible for all costs incurred by the Landscape Architect to inspect the site. Reimbursable expenses include but are not limited to the following: Mileage, airfare, consultants time, parking fee, meals, rental car, etc. All incurred expenses will be deducted from the final contract amount.
- E. Certificate of Substantial Completion will be issued for acceptable work and completion of "As-Built" Drawings, the Landscape Architect will verify the system for Substantial Completion. If punch list items are issued with the Certificate, they must be corrected within five (5) working days.

### **END OF SECTION**

## **SECTION 32 91 15**

### **SOIL PREPARATION (PERFORMANCE SPECIFICATION)**

#### **PART 1 - GENERAL**

##### 1.1 SUMMARY

A. Section includes:

1. Planting soils specified according to performance requirements of the mixes.
2. Compost top dressing.

B. Related Requirements:

1. Section 31 10 00 "Site Preparation" for topsoil stripping and stockpiling.
2. Section 32 92 00 "Turf and Grasses" for placing planting soil for turf and grasses.
3. Section 32 93 00 "Plants" for placing planting soil for plantings.
4. See Civil Engineering Drawings for bioretention soil media.

##### 1.2 DEFINITIONS

- A. AAPFCO: Association of American Plant Food Control Officials.
- B. Backfill: The earth used to replace or the act of replacing earth in an excavation. This can be amended or unamended soil as indicated.
- C. CEC: Cation exchange capacity.
- D. Compost: The product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth.
- E. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.
- F. Imported Soil: Soil that is transported to Project site for use.
- G. Layered Soil Assembly: A designed series of planting soils, layered on each other, that together produce an environment for plant growth.
- H. NAPT: North American Proficiency Testing Program. An SSSA program to assist soil-, plant-, and water-testing laboratories through interlaboratory sample exchanges and statistical evaluation of analytical data.
- I. Organic Matter: The total of organic materials in soil exclusive of undecayed plant and animal tissues, their partial decomposition products, and the soil biomass; also called "humus" or "soil organic matter."
- J. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

- K. RCRA Metals: Hazardous metals identified by the EPA under the Resource Conservation and Recovery Act.
- L. SSSA: Soil Science Society of America.
- M. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- N. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.
- O. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.
- P. USCC: U.S. Composting Council.

### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include recommendations for application and use.
  - 2. Include test data substantiating that products comply with requirements.
  - 3. Include sieve analyses for aggregate materials.
  - 4. Material Certificates: For each type of imported soil, soil amendment and fertilizer before delivery to the site, according to the following:
    - a. Manufacturer's qualified testing agency's certified analysis of standard products.
    - b. Analysis of fertilizers, by a qualified testing agency, made according to AAPFCO methods for testing and labeling and according to AAPFCO's SUIP #25.
    - c. Analysis of nonstandard materials, by a qualified testing agency, made according to SSSA methods, where applicable.
- B. Samples: For each bulk-supplied material, 1-quart volume of each in sealed containers labeled with content, source, and date obtained. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of composition, color, and texture.

### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For each testing agency.
- B. Preconstruction Test Reports: For preconstruction soil analyses specified in "Preconstruction Testing" Article.
- C. Field quality-control reports.

## 1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.
1. Laboratories: Subject to compliance with requirements, provide testing by one of the following:
    - a. University of Georgia Soil Testing Laboratory.
    - b. A&L Eastern Laboratories; 7621 Whitepine Road, Richmond, VA 23237; 804-743-9401.
    - c. Leaf Yard Waste Compost Stability Test and Pathogens/ Metals/ Vector Attraction: Woods End Research Laboratory, P.O. Box 297, Mt. Vernon, ME, 04352, tel: 201.293.2457, fax: 201.293.2488.
    - d. Leaf Yard Waste Compost/ All other tests except those listed above: University of Massachusetts, West Experiment Station, Amherst, MA 01003, tel: 413.545.2311, fax: 413.545.1931.
    - e. Mechanical Gradation and Chemical Analysis, All Components and Soil Mixes: Penn State Extension, 2 Penn Center Plaza, Suite 200 Philadelphia, PA 19102, tel 215-471-2200 Ext 100
    - f. Approved Equal.
  2. Multiple Laboratories: At Contractor's option, work may be divided among qualified testing laboratories specializing in physical testing, chemical testing, and fertility testing.

## 1.7 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction soil analyses on existing, on-site soil and imported soil to be utilized on the project.
1. Notify Architect seven days in advance of the dates and times when laboratory samples will be taken.
- B. Preconstruction Soil Analyses: For each unamended soil type, perform testing on soil samples and furnish soil analysis and a written report containing soil-amendment and fertilizer recommendations by a qualified testing agency performing the testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.
1. Have testing agency identify and label samples and test reports according to sample collection and labeling requirements.
- C. All testing will be at the expense of the Contractor. The architect may request additional planting mix tests on different mix component ratios in order to attain results that more closely meet the mix requirements.
- D. Testing for Planting Soil is required at the following intervals:
1. Testing of individual components for all soil mixes.
  2. After test results for components have been accepted, create sample mixes of each planting soil mix and perform tests described in this Section.
  3. After the test results for planting soil mixes have been accepted, and following the placement of planting soils on site, provide one test per 10,000 SF of

planting area for Planting Soil delivered to the job site, the results of which are to be reviewed and approved by the architect prior to any plant material being placed.

#### 1.8 SOIL-SAMPLING REQUIREMENTS

- A. General: Extract soil samples according to requirements in this article.
- B. Sample Collection and Labeling: Have samples taken and labeled by soil scientist (CPSS) certified by SSSA, soil classifier (CPSC) certified by SSSA, soil scientist (RPSS) registered by the National Society of Consulting Soil Scientists, or state-certified, -licensed, or -registered soil scientist under the direction of the testing agency.
  - 1. Number and Location of Samples: Minimum of seven representative soil samples from varied locations for each soil to be used or amended for landscaping purposes.
  - 2. Procedures and Depth of Samples: According to USDA-NRCS's "Field Book for Describing and Sampling Soils.
  - 3. Division of Samples: Split each sample into two, equal parts. Send half to the testing agency and half to Owner for its records.
  - 4. Labeling: Label each sample with the date, location keyed to a site plan or other location system, visible soil condition, and sampling depth.

#### 1.9 TESTING REQUIREMENTS

- A. General: Perform tests on soil samples according to requirements in this article.
- B. Physical Testing:
  - 1. Soil Texture: Soil-particle, size-distribution analysis by the following methods according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods":
    - a. Sieving Method: Report sand-gradation percentages for very coarse, coarse, medium, fine, and very fine sand; and fragment-gradation (gravel) percentages for fine, medium, and coarse fragments; according to USDA sand and fragment sizes.
    - b. Hydrometer Method: Report percentages of sand, silt, and clay.
  - 2. Total Porosity: Calculate using particle density and bulk density according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
  - 3. Water Retention: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
  - 4. Saturated Hydraulic Conductivity: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods"; at 85 percent compaction according to ASTM D 698 (Standard Proctor).
- C. Chemical Testing:
  - 1. CEC: Analysis by sodium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."

2. Clay Mineralogy: Analysis and estimated percentage of expandable clay minerals using CEC by ammonium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
  3. Metals Hazardous to Human Health: Test for presence and quantities of RCRA metals including aluminum, arsenic, barium, copper, cadmium, chromium, cobalt, lead, lithium, and vanadium. If RCRA metals are present, include recommendations for corrective action.
  4. Phytotoxicity: Test for plant-available concentrations of phytotoxic minerals including aluminum, arsenic, barium, cadmium, chlorides, chromium, cobalt, copper, lead, lithium, mercury, nickel, selenium, silver, sodium, strontium, tin, titanium, vanadium, and zinc.
- D. Fertility Testing: Soil fertility analysis according to standard laboratory protocol of SSSA NAFT NEC-67 including the following:
1. Percentage of organic matter.
  2. CEC, calcium percent of CEC, and magnesium percent of CEC.
  3. Soil reaction (acidity/alkalinity pH value).
  4. Buffered acidity or alkalinity.
  5. Nitrogen ppm.
  6. Phosphorous ppm.
  7. Potassium ppm.
  8. Manganese ppm.
  9. Manganese-availability ppm.
  10. Zinc ppm.
  11. Zinc availability ppm.
  12. Copper ppm.
  13. Sodium ppm.
  14. Soluble-salts ppm.
  15. Presence and quantities of problem materials including salts and metals cited in the Standard protocol. If such problem materials are present, provide additional recommendations for corrective action.
  16. Other deleterious materials, including their characteristics and content of each.
- E. Organic-Matter Content: Analysis using loss-by-ignition method according to SSSA's "Methods of Soil Analysis - Part 3-Chemical Methods."
- F. Recommendations: Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated to produce satisfactory planting soil suitable for healthy, viable plants indicated. Include, at a minimum, recommendations for nitrogen, phosphorous, and potassium fertilization, and for micronutrients.
1. Fertilizers and Soil Amendment Rates: State recommendations in weight per 1000 sq. ft. for 6-inch depth of soil.



2. Soil Reaction: State the recommended liming rates for raising pH or sulfur for lowering pH according to the buffered acidity or buffered alkalinity in weight per 1000 sq. ft. for 6-inch depth of soil.

#### 1.10 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and compliance with state and Federal laws if applicable.
- B. Material shall not be handled or hauled, placed or compacted when it is wet as after a heavy rainfall, early spring or if frozen. Soil shall be handled only when the moisture content is compliant with soil moisture content requirements. The Architect shall be consulted to determine if the soil is too wet to handle.
- C. Store and handle packaged materials in strict compliance with manufacturer's instructions and recommendations. Protect all materials from weather, damage, injury and theft.
- D. Sequence deliveries to avoid delay. On-site storage space is permissible only with written notice from Owner. Deliver materials only after preparations for placement of planting soil have been completed.
- E. Prohibit vehicular and pedestrian traffic on or around stockpiled planting soil.
- F. Planting Soil that is to be stockpiled longer than two weeks, whether on or off site, shall not be placed in mounds greater than six feet high.
- G. Vehicular access to the site is restricted. Before construction, the Contractor shall submit for approval a plan showing proposed routing for deliveries and site access.
- H. Soil Moisture Content:
  1. Contractor shall not move, blend or grade soil when moisture content is so great that free moisture is apparent, nor when it is so dry that dust will form in the air or that clods will not break readily, nor when it is frozen. Apply water, if necessary, or allow drying to bring soil moisture between 60% of optimum moisture content and optimum moisture content as determined by ASTM D698 for compaction, grading and plantings.
  2. Field Soil Moisture Test:
    - a. Form soil in palm of hand, if soil retains shape and crumbles upon touching, the soil may be worked.
    - b. If the soil will not retain shape it is too dry and should not be worked.
    - c. If the soil retains shape and will not crumble, it is too wet and should not be worked.
    - d. If the soil glistens or free water is observed when the sample is patted in the palm of hand the soil is too wet and should not be worked.
- I. Bulk Materials:
  1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
  2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.

3. Do not move or handle materials when they are wet or frozen.
4. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

**PART 2 - PRODUCTS**

2.1 PLANTING SOILS SPECIFIED ACCORDING TO PERFORMANCE REQUIREMENTS

- A. Amended Planting-Soil Type Existing, on-site surface soil, with the duff layer, if any, retained; modified to produce viable planting soil. Using preconstruction soil analyses and materials specified in other articles of this Section, amend existing, on-site surface soil to become planting soil complying with the following requirements:
  1. Particle Size Distribution by USDA Textures: Classified as sandy loam soil according to USDA textures.
  2. Engage a qualified testing agency to analyze samples of the existing soil and propose amendments based upon the intended plantings for a given bed.
- B. Manufactured Planting-Soil Type: Manufactured soil consisting of manufacturer's basic sandy loam according to USDA textures, blended in a manufacturing facility with sand, stabilized organic soil amendments, and other materials as specified in other articles of this Section to produce viable planting soil.
  1. Planting Bed Soil shall consist of a combination of approximately equal parts by volume Base Loam, Coarse Sand and Organic Amendment/Compost (1L:1S:1C). The following gradation for material passing a Number 10 Sieve shall be achieved in the final mix.

U.S. Sieve Size No.	% Passing by Weight Minimum	% Passing by Weight Maximum
10	100	--
18	85	95
35	60	85
60	42	65
140	21	44
270	18	24
0.002mm	2	4

2. Maximum size shall be one half-inch largest dimension. The maximum retained on the #10 sieve shall be 10% by weight of the total sample.
3. The ratio of the particle size for 80% passing (D80) to the particle size for 30% passing (D30) shall be 8 or less ( $D_{80}/D_{30} < 8$ ).
4. The final mix shall have an organic content between 5 and 7 percent by weight.
5. The final mix shall have a hydraulic conductivity of not less than 1.5 inches per according to test procedure ASTM D5856-95 (2000) hour when compacted to a minimum of 86 percent Standard Proctor ASTM D 698. Tests shall be by combined hydrometer and wet sieving in compliance with ASTM D422 after destruction of organic matter by ignition.

6. Chemical analysis shall be undertaken for Nitrate Nitrogen, Ammonium Nitrogen, Phosphorus, Potassium, Calcium Magnesium, Aluminum, Iron, Manganese, Lead, Cation Exchange Capacity, Soluble Salts, acidity (pH) and buffer pH.

## 2.2 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
  1. Class: O, with a minimum of 95 percent passing through No. 8 sieve and a minimum of 55 percent passing through a No. 60 sieve.
  2. Form: Provide lime in form of ground dolomitic limestone.
- B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent elemental sulfur, with a minimum of 99 percent passing through a No. 6 sieve and a maximum of 10 percent passing through a No. 40 sieve.
- C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
- D. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through a No. 50 sieve.
- E. Uniformly Graded Coarse Sand:
  1. Sand for Planting Soil Blends, protection of filter fabric and for drainage as required, shall be uniformly graded medium to coarse sand consisting of clean, inert, rounded to sub-angular grains of quartz or other durable rock free from loam or clay, mica, surface coatings and deleterious materials with the following grain size distribution for material passing the #10 sieve:

U.S. Sieve Size Number	Percent Passing Minimum	Percent Passing Maximum
10	100	--
18	60	80
35	25	45
60	8	20
140	0	8
270	0	3
0.002mm	0	0.5

2. Maximum size shall be one-inch largest dimension. The maximum retained on the #10 sieve shall be 20% by weight of the total sample.
3. The ratio of the particle size for 70% passing (D<sub>70</sub>) to the particle size for 20% passing (D<sub>20</sub>) shall be 2.8 or less (D<sub>70</sub>/D<sub>20</sub> < 2.8). Tests shall be by combined hydrometer and wet sieving in compliance with ASTM D422.
4. pH shall be less than 7.5.

## 2.3 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter produced by composting feedstock, and bearing USCC's "Seal of Testing Assurance," and as follows:

1. Feedstock: Limited to leaves; shall be a stable, humus-like material produced from the aerobic decomposition and curing of Leaf Yard Waste Compost, composted for a minimum of nine months.
2. Reaction: The pH shall be between 6.5 to 7.4 as determined from a 1:1 soil-distilled water suspension using a glass electrode pH meter American Society of Agronomy *Methods of Soil Analysis, Part 2, 1986*.
3. Soluble-Salt Concentration: Electrical conductivity of a one to five soil to water ratio extract shall not exceed 2.5 mmhos/cm (dS/m).
4. Moisture Content: 35 to 55 percent by weight.
5. Organic-Matter Content: Minimum 30 percent of dry weight.
6. Particle Size: Minimum of 100 percent passing through a 1/2-inch or smaller sieve. The compost shall be screened to 1/2 inch maximum particle size and shall contain not more than 3 percent material finer than 0.002mm as determined by hydrometer test on ashed material.

#### 2.4 FERTILIZERS

- A. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
- B. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
  1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.
- C. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
  1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.
- D. Chelated Iron: Commercial-grade FeEDDHA for dicots and woody plants, and commercial-grade FeDTPA for ornamental grasses and monocots.

### **PART 3 - EXECUTION**

#### 3.1 GENERAL

- A. Place planting soil and fertilizers according to requirements in other Specification Sections.
- B. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in planting soil.
- C. Proceed with placement only after unsatisfactory conditions have been corrected.

### 3.2 PRE-INSTALLATION EXAMINATION AND PREPARATION

- A. Reference other sections as necessary.
- B. Coordinate activities with other project contractors so that there is no soil disturbance from traffic or other construction activities subsequent to placement.
- C. Pre-Installation Examination Required: The Contractor shall examine previous work, related work, and conditions under which this work is to be performed and shall notify Architect in writing of all deficiencies and conditions detrimental to the proper completion of this work. Beginning work means Contractor accepts substrates, previous work, and conditions. The Contractor shall not place any planting soil until all work in adjacent areas is complete and approved by the Architect.
- D. Kickoff Meeting: At least 10 working days prior to the start of work, the contractor shall request a landscape construction kickoff meeting with the owner's representative, landscape architect and any other parties involved with landscape construction. The contractor must demonstrate familiarity with this Section, and other relevant sections of the construction documents. The contractor shall articulate the means and methods of soil blending, subgrade preparation, soil placement and other steps outlined in the Specification.
- E. Examination of Subgrade: The subgrade shall be examined by the Contractor prior to the start of subgrade preparation, soil placement and planting. Any deficiencies shall be noted and related to the Architect in writing prior to acceptance of the subgrade by the Contractor. Deficiencies include, but shall not be limited to the following:
  - 1. Construction debris present within the planting areas.
  - 2. The subgrade is at incorrect depths for installing the designed soil profile and drainage layer.
  - 3. Incomplete irrigation and/or subsurface drainage installation.
  - 4. Incomplete lighting and exterior electrical installation.
  - 5. Conflict with underground utilities.
  - 6. Subgrade contaminated with oils, compressible material, silt or clay
  - 7. Subgrade must infiltrate water at the rate of at least one inch per hour.
- F. Confirm that the subgrade is at the proper elevation and compacted as required. Subgrade elevations shall slope parallel to the finished grade and/or toward the subsurface drain lines as shown on the drawings.
  - 1. Slope sides of excavations to comply with local codes and ordinances having jurisdiction. Shore and brace slopes where required and maintain sides of slopes of excavations in safe condition until completion of backfilling. Provide protection measures as required for public safety.
  - 2. All subgrade areas to be filled with Planting Soil shall be free of construction debris, refuse, vegetation, compressible or decay able materials, all stones greater than 1 inches, concrete washout or soil crusting films of silt or clay that reduces or stops drainage from the Planting Soil into the subsoil; and/or standing water. Such material shall be removed from the site.

3. The subgrade must slope at a minimum of two percent towards the bottom of slopes and subdrains. Subgrade levels shall be adjusted as required to ensure that all planting and lawn areas have adequate drainage.
4. Sub-grade shall be lowered to an elevation that allows for the installation of Planting Soil at the depths outlined below:
  - a. Prior to the placing of planting soil to be tilled into the sub-grade, the sub-grade shall be loosened to a depth of 4".
  - b. 4" of planting soil shall be tilled into the upper 4" of the loosened sub-grade.
  - c. 11" of planting soil shall then be added and correctly graded and compacted to meet finished elevations.
- G. Do not proceed with the installation of Planting Soil, until all utility work in the area has been installed.
  1. The Contractor shall identify the locations of underground utilities prior to proceeding with soil work and shall protect all utilities from damage.
- H. Planting Soil Preparation: Refer to Section 32 91 13, 2.2 for planting soil and mixtures. Examine soil and remove foreign materials, stones and organic debris over 1/2" in size. Remove all vegetation from stockpiles prior to blending. Mix-in fertilizers and amendments as required by tests and as approved by the Architect. All preparation and mixing shall be accomplished when the soil moisture content is compliant with soil moisture content requirements and at a moisture content approved by the Architect. If lime is to be added, it shall be mixed with dry soil before fertilizer is added and mixed.

### 3.3 SUBGRADE INSPECTIONS AND PERCOLATION TESTING

- A. After subgrade levels have been reached, the Architect shall inspect soil conditions to evaluate subsurface drainage conditions. The Contractor shall carry out percolation tests according to the following procedures in locations identified by the Architect. These tests shall be performed before the planting soil is placed on site. The Contractor shall conduct one test per 5,000 square feet throughout the entire site, and provide written test results to the Architect.
- B. Percolation tests shall be performed according to the following test procedures.
  1. Utilize perforated canisters or buckets seven to ten inches in diameter and a minimum of six inches high.
  2. A test hole shall be hand dug at the soil horizon to be tested approximately one-inch larger than the diameter of the test canister and approximately six inches deep. The sides of the test hole shall not be smoothed.
  3. Place one-half inch of clean coarse sand in the bottom of the hole and place the canister firmly into the hole. The space around the canister shall then be filled with coarse sand. Tamp the coarse sand to firmly fill any void space around the test canister.
  4. Fill the canister with water to the soil horizon level and allow to drain until approximately one inch of water remains, or a minimum of 1 hour.
  5. Refill the canister to the soil horizon level. After the water level drops approximately one inch, start the test. Record time versus water level as the water level drops. The percolation rate is the length of time for the water level

to drop per inch. The field scientist shall record the rate of percolation for a minimum of two hours or until the water level has dropped a minimum of three inches after the start of measurements.

### 3.4 WORKING AROUND UTILITIES

- A. Carefully examine the civil, record, and survey drawings to become familiar with the existing underground conditions before digging.
- B. Known underground and surface utility lines are indicated on the utilities drawings. Contact the local Dig Safe organization and give them their required time to respond and mark the property. Determine location of underground utilities and perform work in a manner that will avoid possible damage. Hand excavate, as required. Maintain grade stakes set by others until parties concerned mutually agree upon removal.
- C. Perform work in a manner that will protect utilities from damage. Hand excavate as required and provide adequate means of support and protection of utilities during soil installation operations. Maintain grade stakes set by others until parties concerned mutually agree upon removal. The Contractor shall repair all utilities damaged by soil operations at the Contractor's expense.

### 3.5 SUBGRADE COMPACTION MITIGATION MEASURES

- A. Coordinate the following scarification work to eliminate subgrade compaction resultant from Construction Operations when located in lawn and planting areas. Maintain 12" clearance from any underground utilities during subgrade de-compaction.
  - 1. Heavy Site Subgrade Compaction Mitigation:
    - a. Heavily compacted subgrade areas such as, but not limited to, temporary parking areas, material stockpile areas, temporary roadways, construction areas and areas around structures and other similar areas.
    - b. Prior to establishing the final subgrade of Earthwork material, these areas shall be dug up or ripped to a depth of (18) inches to break up the soil hard pan, then re-compacted with two passes of the tracks of a wide track bulldozer size D-6 or smaller, or other approved equipment. Vibratory compaction of subgrade in planted areas is prohibited.
  - 2. General Site Subgrade Compaction Mitigation for all general lawn and planting areas that are not heavily compacted and would be mitigated as specified in Item 1 above:
    - a. Immediately prior to placing Planting Soil, the entire subgrade shall be loosened to a minimum depth of 6-inches using the teeth of a backhoe or other suitable equipment, then re-compacted with the tracks of small construction equipment, the bucket of a backhoe, or other approved equipment. Vibratory compaction of subgrade in planted areas is prohibited.
    - b. After the subgrade soils have been loosened, re-compressed and inspected, Planting Soil may be spread by using a wide track bulldozer size D-5 or smaller or may be dumped and spread with the bucket of a backhoe from the edge of the loosened area. No rubber-tired equipment or heavy equipment except for a small bulldozer shall pass over the subsoils (subgrade) after they have been loosened and recompressed. If the Contractor plans to utilize such areas for any use of heavy equipment,

this work should be carried out prior to beginning the process of loosening soils or filling in that area.

### 3.6 PREPARATION OF UNAMENDED, ON-SITE SOIL BEFORE AMENDING

- A. Excavation: Excavate soil from designated area(s) to a depth of 6 inches and stockpile until amended.
- B. Unacceptable Materials: Clean soil of concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
- C. Unsuitable Materials: Clean soil to contain a combined maximum of 8 percent by dry weight of stones, roots, plants, sod, clay lumps, and pockets of coarse sand.
- D. Screening: Pass unamended soil through a 3-inch sieve to remove large materials.

### 3.7 PLACING AND MIXING PLANTING SOIL OVER EXPOSED SUBGRADE

- A. General: Apply and mix unamended soil with amendments on-site to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Subgrade Preparation: Till subgrade to a minimum depth of 4 inches. Remove stones larger than 1-1/2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
  - 1. Apply, add soil amendments, and mix approximately half the thickness of unamended soil over prepared, loosened subgrade according to "Mixing" Paragraph below. Mix thoroughly into top 4 inches of subgrade. Spread remainder of planting soil.
- C. Mixing: Spread unamended soil to total depth 4 inches, but not less than required to meet finish grades after mixing with amendments and natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.
  - 1. Amendments: Apply soil amendments and fertilizer, if required, evenly on surface, and thoroughly blend them with unamended soil to produce planting soil.
    - a. If required, mix lime and sulfur with dry soil before mixing fertilizer.
    - b. Mix fertilizer with planting soil no more than seven days before planting.
  - 2. Lifts: Apply and mix unamended soil and amendments in lifts not exceeding 8 inches in loose depth for material compacted by compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- D. Compaction: Compact each blended lift of planting soil to 82 to 85 percent of maximum Standard Proctor density according to ASTM D 698.
- E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.



3.8 APPLYING COMPOST TO SURFACE OF PLANTING SOIL

- A. Application: Apply 3 inches of compost to surface of in-place planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Finish Grading: Grade surface to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.
- C. Uniformly mix compost with the topsoil/subgrade below per details.

3.9 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform the following tests and inspections:
  - 1. Performance Testing: For each amended planting-soil type, demonstrating compliance with specified performance requirements. Perform testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.
- C. Soil will be considered defective if it does not pass tests.
- D. Prepare test reports.
- E. Label each sample and test report with the date, location keyed to a site plan or other location system, visible conditions when and where sample was taken, and sampling depth.

3.10 CLEANING

- A. Protect areas adjacent to planting-soil preparation and placement areas from contamination. Keep adjacent paving and construction clean and work area in an orderly condition.
- B. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owner's property unless otherwise indicated.
  - 1. Dispose of excess subsoil and unsuitable materials on-site where directed by Owner.

**END OF SECTION**

## **SECTION 32 92 00**

### **TURF AND GRASSES**

#### **PART 1 - GENERAL**

##### 1.1 SUMMARY

###### A. Section Includes:

1. Seeding.
2. Hydroseeding.
3. Sodding.

###### B. Related Requirements:

1. Section 32 91 15 "Soil Preparation (Performance Specification)" for planting soil in turf areas.
2. Section 32 93 00 "Plants" for trees, shrubs, ground covers, and other plants as well as mulches and edgings.

##### 1.2 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 32 91 15 "Soil Preparation (Performance Specification)" and drawing designations for planting soils.
- E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

##### 1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For landscape Installer.
- B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

1. Certification of each seed mixture for turfgrass sod. Include identification of source and name and telephone number of supplier.

C. Product Certificates: For fertilizers, from manufacturer.

D. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

#### 1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required maintenance periods.

#### 1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.

2. Experience: Three years' experience in turf installation.

3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:

a. Landscape Industry Certified Technician - Exterior.

b. Landscape Industry Certified Lawncare Manager.

c. Landscape Industry Certified Lawncare Technician.

5. Pesticide Applicator: State licensed, commercial.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.

B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod within 24 hours of harvesting and in time for planting promptly. Protect sod from breakage and drying.

C. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.

2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

#### 1.7 FIELD CONDITIONS

- A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of planting completion.
  1. Fall Planting: From October 15 to March 15.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

### **PART 2 - PRODUCTS**

#### 2.1 SEED

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.
- B. Seed Species:
  1. Bermudagrass (*Cynodon dactylon*).

#### 2.2 TURFGRASS SOD

- A. Turfgrass Sod: Certified, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture that is strongly rooted and capable of vigorous growth and development when planted.
- B. Turfgrass Species: Tifway 419 Bermudagrass (*Cynodon dactylon* 'Tifway 419').

#### 2.3 FERTILIZERS

- A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
  1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.
- B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
  1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

#### 2.4 MULCHES

- A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

#### 2.5 PESTICIDES

- A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

### **PART 3 - EXECUTION**

#### 3.1 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.
  - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
  - 2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
  - 3. Uniformly moisten excessively dry soil that is not workable or which is dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

#### 3.2 PREPARATION

- A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
  - 1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.

#### 3.3 TURF AREA PREPARATION

- A. General: Prepare planting area for soil placement and mix planting soil according to Section 32 91 15 "Soil Preparation (Performance Specification)."

- B. Placing Planting Soil: Place and mix planting soil in place over exposed subgrade.
- C. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- D. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

### 3.4 SEEDING

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph.
  - 1. Before sowing, mix seed with seed carrier at a ratio of not less than three parts seed carrier to one part seed.
  - 2. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
  - 3. Do not use wet seed or seed that is moldy or otherwise damaged.
  - 4. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.
- B. Sow seed at a total rate recommended by seed supplier.
- C. Rake seed lightly into top 1/16 inch of soil, roll lightly, and water with fine spray.
- D. Protect seeded areas from hot, dry weather or drying winds by applying straw mulch within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch, and roll surface smooth.

### 3.5 HYDROSEEDING

- A. Hydroseeding: Mix specified seed, commercial fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
  - 1. Spray-apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry coat at a rate so that mulch component is deposited at not less than 500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate. Apply slurry cover coat of fiber mulch (hydromulching) at a rate of 1000 lb./acre.

### 3.6 SODDING

- A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.
- B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to soil or sod during installation. Tamp and roll lightly to ensure contact with soil, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
  - 1. Lay sod across slopes exceeding 1:3.

- C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches (38 mm) below sod.

### 3.7 TURF RENOVATION

- A. Renovate turf damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.
  - 1. Reestablish turf where settlement or washouts occur or where minor regrading is required.
  - 2. Install new planting soil as required.
- B. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.
- C. Remove topsoil containing foreign materials, such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.
- D. Mow, dethatch, core aerate, and rake existing turf.
- E. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.
- F. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.
- G. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches (150 mm).
- H. Apply initial fertilizer required for establishing new turf and mix thoroughly into top 4 inches of existing soil. Install new planting soil to fill low spots and meet finish grades.
  - 1. Initial Fertilizer: Commercial fertilizer applied according to manufacturer's recommendations.
- I. Apply seed and protect with straw mulch as required for new turf.
- J. Water newly planted areas and keep moist until new turf is established.

### 3.8 TURF MAINTENANCE

- A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
  - 1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
  - 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.

3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.
  1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
  2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.
- C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
  1. Mow bermudagrass to a height of 1/2 to 1 inch.
- D. Turf Postfertilization: Apply commercial fertilizer after initial mowing and when grass is dry.
  1. Use fertilizer that provides actual nitrogen of at least 1 lb./1000 sq. ft. to turf area.

### 3.9 SATISFACTORY TURF

- A. Turf installations shall meet the following criteria as determined by Architect:
  1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
  2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
- B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

### 3.10 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents according to requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.



3.11 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.
- C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.
- D. Remove nondegradable erosion-control measures after grass establishment period.

3.12 MAINTENANCE SERVICE

- A. Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Turf Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable turf is established, but for not less than the following periods:
  - 1. Seeded Turf: One year from date of Substantial Completion.
    - a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.
  - 2. Sodded Turf: One year from date of Substantial Completion.

**END OF SECTION**

## **SECTION 32 93 00**

### **PLANTS**

#### **PART 1 - GENERAL**

##### 1.1 SUMMARY

###### A. Section Includes:

1. Plants.
2. Tree stabilization.
3. Tree-watering devices.
4. Watering procedures.

###### B. Related Requirements:

1. Section 32 92 00 "Turf and Grasses" for turf (lawn) and erosion-control materials.

##### 1.2 DEFINITIONS

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with a ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.
- C. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.
- D. Finish Grade: Elevation of finished surface of planting soil.
- E. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.
- F. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- G. Planting Area: Areas to be planted.
- H. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil

mixture best for plant growth. See Section 32 91 15 "Soil Preparation (Performance Specification)" for drawing designations for planting soils.

- I. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.
- J. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.
- K. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.
- L. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

### 1.3 COORDINATION

- A. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.
  - 1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
- B. Samples for Verification: For each of the following:
  - 1. Organic Mulch: 1-pint volume of organic mulch required; in sealed plastic bag labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.

### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.
- B. Tree Planting Schedule: Submit schedule of timing planting for each tree species within the construction schedule demonstrating that timing species procurement and planting avoid times of year that are determined to be hazardous for a particular tree type (e.g. ensure that fall-hazard trees are not planted in fall).
- C. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:
  - 1. Manufacturer's certified analysis of standard products.

2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

D. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

E. Sample Warranty: For special warranty.

#### 1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before expiration of required maintenance periods.

#### 1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.

2. Experience: Five years' experience in landscape installation in addition to requirements in Section 01 40 00 "Quality Requirements."

3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

4. Personnel Certifications: Installer's personnel assigned to the Work shall have certification in one of the following categories from the Professional Landcare Network:

a. Landscape Industry Certified Technician - Exterior.

b. Landscape Industry Certified Horticultural Technician.

5. Pesticide Applicator: State licensed, commercial.

B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

C. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.

1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches above the root flare for trees up to 4-inch caliper size, and 12 inches above the root flare for larger sizes.

2. Other Plants: Measure with stems, petioles, and foliage in their normal position.

D. Plant Material Observation: Architect may observe plant material either at place of growth and/or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Architect may also observe plants further for size and condition of balls and root systems, pests, disease symptoms,

injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

1. At least one month prior to the expected planting date, the contractor shall coordinate with the Owner's Representative to select and tag stock to be planted under this section.
2. The Contractor shall be responsible to certify the availability of quality plants in specified sizes from sources of supply prior to requesting that the Owner's Representative make plant source inspections. In the event that plants at the inspection location are found to be unavailable or of insufficient size, the Contractor shall be liable to reimburse the Owner's Representative for all costs of the Owner's Representative's hourly services which are incurred during unproductive inspection trips.
3. Unless specifically designated otherwise, a representative of the Contractor shall accompany the Owner's Representative on all plant material selection field trips.
4. Representative samples only of shrubs and ground cover plants may be tagged or marked for approval as an "Approved Typical Sample" and shipped to the site. Any shrub or groundcover plant that arrives at the construction site that does not meet the Approved Typical Sample will be rejected by the Owner's Representative.
5. Plants to be inspected shall be in locations and conditions that allow direct and unobscured inspection by the Owner's Representative. Container grown or balled and burlapped shrubs shall be pulled from holding blocks by the nursery for scrutiny by the Owner's Representative at no additional cost to the Owner.
6. Inspection and approval of plants at the source shall not impair the right of subsequent inspection and rejection upon delivery to the site or during the progress of the work if the Owner's Representative finds that plants do not meet the requirements in the Specifications, Plant Schedule or Plant Legend shown on Drawings, have declined noticeably due to handling abuse, lack of maintenance, or other causes. Cost of replacements, as required, shall be borne by the Contractor.
7. In the event that the Architect or Owner's representative cannot inspect plants at the nursery, provide color photographs in digital format of each required species and size of plant material as it will be furnished to the Project. Photographs should be a minimum resolution of 150 dpi at a 4 in. by 6 in. size, so that details of plants can be discerned. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. For species where more than 20 plants are required, include a minimum of three photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.
8. Notify Architect and Owner of sources of planting materials seven days in advance of delivery to site.

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.
- B. Bulk Materials:
  - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
  - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
  - 3. Accompany each delivery of bulk materials with appropriate certificates.
- C. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.
- D. Handle planting stock by root ball.
- E. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F until planting.
- F. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.
  - 1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.
- G. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.
- H. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.
  - 1. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
  - 2. Do not remove container-grown stock from containers before time of planting.
  - 3. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.

## 1.9 FIELD CONDITIONS

- A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.
- B. Planting Restrictions:

1. Coordinate planting periods with species-specific requirements. Plant at times that ensure the health and performance of the plant. Notify Architect immediately of any conflicts between project schedule and requirements for selected plants.
  2. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Planting Completion or Substantial Completion, whichever comes later.
- C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

#### 1.10 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
1. Failures include, but are not limited to, the following:
    - a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
    - b. Structural failures including plantings falling or blowing over.
    - c. Faulty performance of tree stabilization, edgings, and tree grates
    - d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
  2. Warranty Periods: From date of planting completion or Substantial Completion, whichever comes later.
    - a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.
    - b. Ground Covers, Biennials, Perennials, and Other Plants: 12 months.
  3. Include the following remedial actions as a minimum:
    - a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
    - b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
    - c. A limit of one replacement of each plant is required except for losses or replacements due to failure to comply with requirements.
    - d. Provide extended warranty for period equal to original warranty period, for replaced plant material.

### **PART 2 - PRODUCTS**

#### 2.1 PLANT MATERIAL

- A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots are unacceptable.
  2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.
- B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.
- C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare according to ANSI Z60.1. Root flare shall be visible before planting.
- D. Labeling: Label at least one plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant.
- E. If formal arrangements or consecutive order of plants are indicated on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.
- 2.2 MULCH
- A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of the following:
1. Type: Pine straw.
- 2.3 PESTICIDES
- A. General: Pesticide registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.
- 2.4 TREE-STABILIZATION MATERIALS
- A. Proprietary Staking and Guying Devices: Proprietary stake or anchor and adjustable tie systems to secure each new planting by plant stem; sized as indicated and according to manufacturer's written recommendations.
1. Product: Subject to compliance with requirements, provide one of the following:



- a. Arborbrace; ArborBrace Tree Guying System.
- b. Better Bilt Products, Inc; Tree Anchor Kit.
- c. DeepRoot Green Infrastructure, LLC; ArborTie AT LD100 Professional Anchoring Kit.
- d. Foresight Products, LLC; Duckbill Professional Tree Guy System.

## 2.5 MISCELLANEOUS PRODUCTS

- A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.
- B. Burlap: Non-synthetic, biodegradable.
- C. Planter Filter Fabric: Nonwoven geotextile manufactured for separation applications and made of polypropylene, polyolefin, or polyester fibers or combination of them.

## **PART 3 - EXECUTION**

### 3.1 EXAMINATION

- A. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.
  1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
  2. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
  3. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
  4. Uniformly moisten excessively dry soil that is not workable or which is dusty.
- B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.

- D. Lay out plants at locations directed by Architect. Stake locations of individual trees and shrubs and outline areas for multiple plantings.

### 3.3 PLANTING AREA ESTABLISHMENT

- A. General: Prepare planting area for soil placement and mix planting soil according to Section 32 91 15 "Soil Preparation (Performance Specification)."
- B. Placing Planting Soil in accordance with Section 32 91 15 "Soil Preparation (Performance Specification)."
- C. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

### 3.4 EXCAVATION FOR TREES AND SHRUBS

- A. Planting Pits and Trenches: Excavate circular planting pits.
  - 1. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
  - 2. Excavate approximately three times as wide as ball diameter for all planting stock.
  - 3. Excavate at least 12 inches wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
  - 4. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
  - 5. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
  - 6. Maintain angles of repose of adjacent materials to ensure stability. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
  - 7. Maintain supervision of excavations during working hours.
  - 8. Keep excavations covered or otherwise protected overnight.
  - 9. If drain tile is indicated on Drawings or required under planting areas, excavate to top of porous backfill over tile.
- B. Backfill Soil: Subsoil and topsoil removed from excavations may not be used as backfill soil unless otherwise indicated.
- C. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.
- D. Drainage: Notify Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.
- E. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

### 3.5 TREE, SHRUB, AND VINE PLANTING

- A. Inspection: At time of planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.
- B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.
- C. Balled and Burlapped Stock: Set each plant plumb and in center of planting pit or trench with root flare 2 inches above adjacent finish grades.
  - 1. Backfill: Planting soil in accordance with Section 32 91 15 "Soil Preparation (Performance Specification)."
  - 2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
  - 3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
  - 4. Continue backfilling process. Water again after placing and tamping final layer of soil.
- D. Container-Grown Stock: Set each plant plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.
  - 1. Backfill: Planting soil in accordance with Section 32 91 15 "Soil Preparation (Performance Specification)."
  - 2. Carefully remove root ball from container without damaging root ball or plant.
  - 3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
  - 4. Continue backfilling process. Water again after placing and tamping final layer of soil.
- E. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

### 3.6 TREE, SHRUB, AND VINE PRUNING

- A. Remove only dead, dying, or broken branches. Do not prune for shape; retain natural character.
- B. Prune, thin, and shape trees, shrubs, and vines as directed by Architect.
- C. Do not apply pruning paint to wounds.

### 3.7 TREE STABILIZATION

- A. Tree Stabilization: Install devices per manufacturer's written instructions.
- B. Fill planter with planting soil in accordance with Section 32 91 15 "Soil Preparation (Performance Specification)." Place soil in lightly compacted layers to elevations indicated on Drawings, with filter fabric wrapped up all sides.

### 3.8 GROUND COVER AND PLANT PLANTING

- A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated on Drawings in even rows with triangular spacing.
- B. Use planting soil in accordance with Section 32 91 15 "Soil Preparation (Performance Specification)." for backfill.
- C. Dig holes large enough to allow spreading of roots.
- D. For rooted cutting plants supplied in flats, plant each in a manner that minimally disturbs the root system but to a depth not less than two nodes.
- E. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.
- F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
- G. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

### 3.9 PLANTING AREA MULCHING

- A. Mulch backfilled surfaces of planting areas and other areas indicated.
  - 1. Organic Mulch in Planting Areas: Apply 3-inch average thickness of organic mulch over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches of trunks or stems.

### 3.10 PLANT MAINTENANCE

- A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.
- B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.
- C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

### 3.11 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and manufacturer's written

recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

- B. Pre-Emergent Herbicides (Selective and Nonselective): Apply to tree, shrub, and ground-cover areas according to manufacturer's written recommendations. Do not apply to seeded areas.
- C. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

### 3.12 REPAIR AND REPLACEMENT

- A. General: Repair or replace existing or new trees and other plants that are damaged by construction operations, in a manner approved by Architect.
  - 1. Submit details of proposed pruning and repairs.
  - 2. Perform repairs of damaged trunks, branches, and roots within 24 hours, if approved.
  - 3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Architect.
- B. Remove and replace trees that are more than 25 percent dead biomass (leaves, stems, etc.) or in an unhealthy condition or are damaged during construction operations that Architect determines are incapable of restoring to normal growth pattern.
  - 1. Provide new trees of same size as those being replaced for each.
  - 2. Species of Replacement Trees: Same species being replaced.

### 3.13 CLEANING AND PROTECTION

- A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.
- C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.
- D. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.
- E. At time of Substantial Completion, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.

### 3.14 MAINTENANCE SERVICE

- A. Watering of Plants: If no permanent or temporary irrigation is provided, provide all trees with a minimum of 10 gallons of water per week for every one inch of tree caliper. State the amount of days that watering will be provided in bids. Contractor

is responsible for providing water for all plants as necessary to maintain healthy and well-established plants for entire warranty period.

- B. Maintenance Service for Trees and Shrubs: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:
  - 1. Maintenance Period: 12 months from date of planting completion or Substantial Completion, whichever comes later.
- C. Maintenance Service for Ground Cover and Other Plants: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:
  - 1. Maintenance Period: 12 months from date of planting completion or Substantial Completion, whichever comes later.

**END OF SECTION**

## **SECTION 33 40 00**

### **STORM DRAINAGE UTILITIES**

#### **PART 1 - GENERAL**

- 1.01 This section covers the storm drainage system, including pipe culverts and appurtenant structures, complete.

#### **PART 2 - PRODUCTS**

2.01 PIPE FOR CULVERTS AND STORM DRAINS:

- A. Reinforced concrete pipe must be of the class or D-load strength indicated and will conform to ASTM C76 or AASHTO M 170 with the following additional requirements. Pipe must have a readily visible line at least 12 inches in length painted or otherwise applied on the inside and outside of the pipe at each end by the manufacturer, so that, when the pipe is laid on its proper position, the lines will be at the top of the pipe. The line must be accurately located to indicate the position where the pipe reinforcing steel is nearest to the exterior surface of the pipe. Non-reinforced concrete pipe must conform to ASTM C14-07.
- B. High density polyethylene corrugated plastic pipe must conform with the requirements for test methods, dimensions, and markings found in AASHTO Designations M252 and M294. Pipe and fittings are to be made from virgin polyethylene compounds which conform with the requirements of cell class 324420C as defined and described in ASTM D3350. Sizes must conform to the AASHTO Classification "Type S" (which describes pipe with a smooth waterway). Joints must be water tight according to the requirements of ASTM D3212.

2.02 TESTS FOR PIPE:

- A. Responsibility and Certifications: The Contractor must be responsible for having the pipe he proposes to provide tested to demonstrate conformance to the applicable specifications. Certified copies of the test reports must accompany each load of pipe and must be delivered to the Design Professional for approval before the pipe is provided.
- B. Strength tests for reinforced concrete pipe must be the tests of ASTM C-76.
- C. Strength tests for concrete pipe must be the tests of ASTM C-14.
- D. Strength tests for corrugated metal pipe must be the tests of AASHTO M-36.

#### **PART 3 - EXECUTION**

3.01 INSTALLATION OF PIPE:

- A. Each pipe is to be carefully examined before being laid, and defective or damaged pipe will not be used. Pipe lines must be laid to the grades and alignment indicated. Proper facilities are to be provided for lowering sections of pipe into trenches. Under no circumstances will pipe be laid in water, and no pipe will be laid when trench conditions or weather are unsuitable for said work. Full responsibility must be taken for the diversion of drainage and for dewatering of trenches during construction. Pipe in place must have been approved before backfilling. When storm drain pipe terminates in a new ditch, the headwall or end section together with ditch pavement, if specified, must be constructed immediately as called for on the plans. Ditch slopes and disturbed earth areas must be grassed and mulched as required by the section "Grassing". Maintain these newly constructed ditches and take immediate action subject to approval to keep erosion of the ditch bottom and slopes to a minimum during the life of the contract. No additional compensation will be given for the required maintenances.
  - B. Provided high density polyethylene corrugated plastic pipe must be in accordance with ASTM Recommended Practice D2321.
    - 1. Jointing: Joints for concrete and reinforced concrete must be of the Bell and Spigot type and provided according to manufacturer's recommendations using Portland cement mortar. Corrugated metal pipe joints must be made by riveting or by means of connecting bands with bolted couplings in accordance with the manufacturer's recommendations.
    - 2. Alignment: Elliptical concrete pipe with circular reinforcing and circular concrete pipe with elliptical reinforcing must be so placed that the reference lines designating the top of the pipes will be not more than 5 degrees from the vertical plane through the longitudinal axis of the pipe. Assume responsibility in backfilling operations for preventing damage to or misalignment of the pipe.
- 3.02 EXCAVATION AND BACKFILLING FOR DRAINAGE STRUCTURES:
- A. Excavation and backfilling for drainage structures must conform to the applicable requirements specified in the section, "Excavation, Trenching and Backfilling for Pipe Lines." Trenches and pits must be of sufficient size to permit the placing and removal of forms for the full width and length of structure footings and foundation, as shown on the drawings. The dimensions and elevations indicated on the drawings are approximate only and will be changed when deemed necessary to secure satisfactory foundations. Bracing, sheeting and shoring must be provided where required.
- 3.03 DRAINAGE STRUCTURES:
- A. Drainage structures, where indicated in the plans must be of the following types, constructed of the materials specified for each type and in accordance with the details shown on the plans.



1. Inlets: Inlets must be constructed of reinforced concrete, plain concrete or brick, complete with frames and covers.
2. Headwalls: Headwalls must be constructed of brick, reinforced concrete or plain concrete as indicated.

#### 3.04 MATERIALS FOR DRAINAGE STRUCTURES:

- A. Concrete and Reinforced Concrete: Concrete and reinforced concrete must conform to the requirements specified for Class B concrete designed for a minimum compressive strength of 2,500 pounds in 28 days, based on test cylinders prepared and tested as specified under the section on CONCRETE CONSTRUCTION of these specifications. Aggregate must be as specified in the section on CONCRETE CONSTRUCTION. Maximum size of coarse aggregate will be not more than 1½ inches or less than 1 inch. Forms must be made of sound lumber and constructed to the shape, form, line, and grade required, and must be maintained sufficiently rigid to prevent deformation under load, and inspected for approval prior to placement of concrete. Water is to be removed from excavations before concrete is placed. Concrete must be conveyed from mixer to forms as rapidly as practicable without segregation or loss of ingredients. Concrete must be placed in layers not over 18 inches deep and must be spaded and compacted as directed. The concrete covering over steel reinforcing must be as shown on the plans, but where not shown, it will be not less than 1 inch for covers and not less than 1½ inches for walls and flooring. Concrete deposited directly against the ground must have a thickness of at least 3 inches between the steel and the ground. Expansion joint filler must be pre-formed bituminous fiberboard, or wood board except where specifically specified on the drawings. Surfaces exposed to view are to be a smooth finish with blemishes removed. Concrete surfaces must be cured for at least 7 days by covering with waterproof paper, or kept moist with cotton mats or burlap as approved.
- B. Mortar: Mortar for connections to drainage structures must be composed of one part by volume of Portland cement and two parts of sand. The Portland cement is to conform to ASTM C-150-65, Type I or II. The sand must conform to AASHTO Standard M-45, and shall be of an approved gradation. Adding hydrated lime to the mixture of sand and cement is allowed in an amount equal to 25 percent of the volume of cement used. Hydrated lime must conform to Federal Specification SS-L-351, Type M, or ASTM Standard C141-61, Type A. The quantity of water in the mixture must be sufficient to produce a stiff workable mortar but will in no case exceed 7 gallons of water per sack of cement. Water is to be clean and free of injurious acids, alkalis, and organic impurities. The mortar must be used within 30 minutes from the time the ingredients are mixed with water. The inside of the joint must be wiped clean and finished smooth. In pipes too small for a man to work inside, accomplish wiping by dragging an approved swab or long-handled brush through the pipe as work progresses. The mortar bead on the outside must be protected from air and sun with a proper covering until satisfactorily cured.

#### 3.05 TESTING:

- A. Displacement Test: Mains will be checked to determine whether displacement of the pipe has occurred (a) after the trench has been backfilled to two feet above the pipe and tamped as specified; and (b) upon completion of the project. The test will be as follows: A light will be flashed between manholes or, if the manholes have not as yet been constructed, between locations of the manholes, by means of a flashlight or by reflecting sunlight with a mirror. If the illuminated interior of the pipe shows misalignment, displaced pipe, or other defects, the defects designated by the contracting officer must be remedied by the contractor at his expense.

**END OF SECTION 33 40 00**

**SECTION 34 40 00**  
**WATER DISTRIBUTION SYSTEMS**

**PART 1 - GENERAL**

1.1 SCOPE

- A. This section covers the installation of all piping, fittings, valves and appurtenances for water distribution, complete.

**PART 2 - PRODUCTS**

2.1 MATERIALS

Except as otherwise indicated on the drawings, all underground water lines shall be constructed of ductile iron, galvanized steel or polyvinyl chloride (PVC) pipe suitable for the working pressures shown on the drawings.

A. PIPES AND JOINTS

1. Ductile Iron Pipe: Ductile iron pipe shall be designed in accordance with ANSI Specification A21.50, using 60,000 psi tensile strength, 42,000 psi yield strength and 10 percent elongation. All pipe shall be designed for a minimum 200 psi water pressure, 2½ foot to 8 foot cover, laying condition Type 2 and at least 100 psi surge allowance, and a 2 to 1 factor of safety.

Ductile iron pipe is to be manufactured in accordance with ANSI A21.51 with 60,000 psi minimum tensile strength, 42,000 psi minimum yield strength and 10 percent minimum elongation. Each pipe shall be pressure tested at 500 psi minimum at point of manufacture.

Pipe shall have bituminous coating outside and be cement lined and seal coated inside in accordance with ANSI Specification A21.4.

The class or nominal thickness, net weight without lining and name of manufacturer shall be clearly marked on each length of pipe. The letters "D.I." or "Ductile" shall be cast or stamped on the pipe.

Joints in ductile iron pipe shall be mechanical joint or push-on type, such as U.S. Pipe's "Tyton Joint," American's Fastite or Clow's Bell Tite.

Joints to be furnished according to ANSI Specifications A21.11, complete with all necessary accessories.

2. Galvanized Steel Pipe: Galvanized steel pipe shall conform to ASTM Specification A120. Fittings shall be galvanized, malleable iron, screwed, Class B, meeting Federal Specification WW-P-521e.

3. Polyvinyl Chloride (PVC) Pipe: PVC pipe shall conform to AWWA C900, and shall be unplasticized polyvinyl chloride pipe approved by the National Sanitation Foundation, Factory Mutual and the Society of the Plastics Industry for potable water use. Joints shall be of the O-ring, push-on type with standard laying lengths of 20 feet  $\pm$ 1 inch, suitable for working pressures shown on the drawings.

B. FITTINGS: Fittings for all underground piping, except steel shall be Ductile Iron Class 350 (4 inch through 24 inch) and Class 250 (30 inch and larger) in accordance with ANSI Specification A21.10. Fittings will be cement lined in accordance with A21.4 as shown above.

Four inch through 12 inch fittings may be made from Ductile Iron Grade 70-50-05 in accordance with ANSI/AWWA A21.53/C153. Fittings and accessories shall be mechanical joint or push-on joint in accordance with ANSI/AWWA A21.10/C110 and ANSI/AWWA A21.11/C111. The wall thickness of fittings shall be the equivalent of Ductile Iron Class 54. The working pressure rating shall be 350 psi. Fittings shall have a bituminous outside coating in accordance with ANSI/AWWA A21.10/C104. Fittings shall be equal to U. S. Pipe's "Trim-Tyte" or "Trim-Tyton" or Engineer's approved equal.

C. RESTRAINED JOINT PIPE AND FITTINGS: Restrained joints in pipe and fittings shall be of the single gasket push-on type, and shall conform to all applicable provisions of ANSI/AWWA Standard A21.11/C111. Thickness of the pipe barrel remaining at grooves cut, if required in the design of the restrained end joints, shall not be less than the nominal thickness of equal sized non-restrained pipe as specified hereinabove for the centrifugally cast ductile iron pipe. Restrained joints using set screws, or bolts, or expanding metal inserts will not be acceptable. The restraining components, when not cast integrally with the pipe and fittings, shall be ductile iron or a high strength non-corrosive alloy steel. Tee head bolts and hexagonal nuts for all restrained joints in pipe and fittings shall be of high strength cast iron with composition, dimensions and threading as specified in ANSI/AWWA Standard A21.11/C111, except that the length of the bolts shall meet the requirements for the restrained joint design. The proper number of gaskets, bolts, nuts and all necessary joint material shall be furnished. Each thrust-resistant joint and the pipe and fitting of which it is a part, shall be designed to withstand the axial thrust from an integral pipeline pressure of at least 350 psi, 4 inch through 24 inch, and 250 psi, 30 inch and above, at bulkhead conditions without reduction because of its position in the pipeline nor for support from external thrust blocks. Restrained push-on joint pipe and fittings shall be capable of being deflected after assembly. Fittings for restrained joints shall be manufacturer's standard to accommodate job conditions and shall be ductile iron.

Lining shall be as specified for balance of pipe and fittings as specified elsewhere.

Manufacturer shall furnish to the Owner, certification that two pipes joined by the restrained joint have been successfully tested to 700 psi, for sizes 4 inch through 24 inch and/or 500 psi, for sizes 30 inch through 54 inch, without any external support or blocking. Such testing and certification shall be witnessed and attested

by an outside testing laboratory such as PTL, Outlaw or approved testing laboratory.

Restrained joint pipe and fittings shall be U. S. Pipe TR Flex of American Lock-Fast.

- D. VALVES: Valves shall be set at the locations indicated on the drawings. Valves shall be of the gate type or of the butterfly type, as indicated.

Before setting each valve the interior shall be wiped clean and the opening and closing mechanism shall be treated. Valves shall be set with the stems plumb and at the exact locations shown. The required concrete footpiece shall be provided under each valve. Valve boxes shall be installed as shown on the drawing standard details, being plumb, with tops at finished grade and the trench backfill thoroughly tamped for a distance of three feet on each side of boxes.

1. Gate Valves: At the Contractor's option, either of the following types of gate valves can be used.
  - a. Resilient Seated Type Gate Valves: Gate valves, 4 inch to 12 inch, shall be of the iron body, non-rising bronze stem, resilient seated wedge type conforming to AWWA C509, latest revision. They shall have a working pressure rating of 200 psi with the valve body, bonnet, stuffing box and disc castings manufactured of ASTM A-126 Class B grey iron. Valves shall be provided with operating nut unless otherwise shown on the drawings and shall open by counterclockwise rotation of the valve stem. They shall have a full opening flow way of equal diameter of the normal size of connecting pipe. End connections shall be furnished with all necessary joint materials. Stuffing boxes shall have O-ring stem seals and shall be bolted and constructed so as to permit easy removal of parts for repair.
  - b. All internal ferrous metal surfaces shall be fully coated, holiday free, to a minimum thickness of 4 mils with a two part thermosetting epoxy coating. Said coating shall be non-toxic, impart no taste to water and protect all seating and adjacent surfaces from corrosion and prevent buildup of scale or tuberculation. The coating must be formulated from materials deemed acceptable per the FOOD AND DRUG ADMINISTRATION DOCUMENT TITLE 21 of the FEDERAL REGULATIONS ON FOOD ADDITIVES, SECTION 121.2514 entitled, RESINS AND POLYMERIC COATINGS.
  - c. Gate valves inside structures shall be supplied with handwheels, and shall have flanged ends. Valves to be installed underground shall have mechanical joints and be of one make. The manufacturer shall subject each valve to two hydrostatic pressure tests:
    - 1) Seat Test: There shall be no leakage past the seat from either side of the disc or at the bonnet flange or stem packing at 300 psi.
    - 2) Shall (bulkhead) Test: There shall be no leakage through the metal, bonnet flange or stem packing at 400 psi.
  - d. Double-Disc Type Gate Valves: Gate valves shall be of the double-disc type designed for working pressure of 200 psi. All gate valves shall have a clear waterway equal to the full nominal diameter of the pipe

and shall be opened by turning valve counterclockwise. Each valve shall have the initial of the maker, pressure rating and year of manufacture, cast on the body. Prior to shipment from the factory, each valve shall be tested by hydraulic pressure equal to twice the specified working pressure. Valves to be operated by handwheel or operating nut shall have an arrow cast in the metal indicating the direction of opening, which shall be counterclockwise.

- 1) Unless otherwise shown on the drawings, valves 3 inches and larger shall be iron body brass mounted and shall conform to the Specifications for Gate Valves, 3 through 48 inch NPS, For Water and Sewage Systems, AWWA, C500. Valves to be installed underground shall be non-rising stem type with 2 inch square operating nut with mechanical joint ends. Gate valves located inside structures shall be supplied with handwheels, and shall have flanged ends.
  - 2) Valves smaller than 3 inches shall be all brass and shall conform to the requirements of Federal Specification WW-V-54.
2. Butterfly Valves: All butterfly valves shall be of the rubber seated, tight closing type designed for a working pressure of 150 psi. The valve disc shall rotate 90 degrees from the full open to the full shut positions and shall be suitable for direct burial. Valves shall meet or exceed the requirements of AWWA Standard C504 for Class 150B. The manufacturer of the valves shall have been manufacturing direct burial butterfly valves for at least five years. Prior to shipment from the factory, each valve shall be bubble tight with flow in either direction according to the testing requirements of AWWA Standard 504.

Valve bodies shall be of cast iron according to ASTM Specification A-126 Class B and shall have integrally cast mechanical joint ends. The trunnions for the shaft bearing shall be integral with the body. Bearings shall be of the sleeve corrosion-resistant, and self-lubricating type. Shafts shall be polished stainless steel, extending the full diameter through the valve disc. Valve discs shall be an alloy cast iron according to ASTM Specifications A-436, Type 1. Valve seats shall be of rubber and shall be molded, vulcanized and bonded to the body of the valve or mechanically retained to the disc by a stainless steel retaining ring with set screws. The bond shall have a minimum tensile strength of 75 pounds when tested under ASTM D-429, Method B. Valve operators shall develop the minimum torques of Table 1 of AWWA Standard operating nut and shall be gasketed and grease packed. A mechanical limit device to prevent overtravel of the disc in the open and shut positions shall be provided. The valve shall open turning the operating nut counterclockwise.

3. Check Valves: Check valves shall be designed for a working pressure of not less than 150 psi, or as indicated or directed, with a clear waterway equal to the full nominal diameter of the valve.

Valves shall be designed to permit flow in one direction, when the inlet pressure is greater than the discharge pressure, and to close tightly to prevent return flow when discharge pressure exceeds inlet pressure.

Cast on the body of each valve shall be the manufacturer's name, initials, or trademark by which he can be identified readily, valve size, working pressure, and direction of flow.

Valves 2 inches and smaller shall be all bronze, designed for screwed fittings. Valves larger than 2 inches shall be iron body, bronze mounted, with flanged ends of the non-slam type, with Class 125 flanges complying with ANSI B-156.1.

- E. FIRE HYDRANTS: Fire hydrants connected to 6 inch or larger mains shall comply with the requirements of AWWA C-502 and shall be of the Traffic Model Type, incorporating a break-away feature. Hydrant shall be of the dry-barrel type suitable for 150 psi working pressure with 5½ inch valve opening and they shall be equal to Mueller Catalog No. A-423. Each hydrant shall have two 2½ inch hose nozzles and 1 steamer nozzle. Bury to bottom of ditch shall be 3'-6".

Fire hydrants connected to 4 inch or smaller mains shall be of the dry-barrel type with 2⅞ inch valve opening, suitable for 150 psi working pressure, similar to Mueller No. A-411 with single 2½ inch hose nozzle. Threads and other requirements shall be as for 42 inch hydrants.

- F. SERVICE STOPS: Service stops shall be of the ball or plug type having O-ring seals and seats. Replacement of plugs and seals shall be made from the top without disconnecting the valve from the line pipe or, where end-entry stops are used, shall be immediately followed by a union. Stops shall be constructed of standard waterworks brass or bronze. All stops shall be suitable for a working pressure of 200 psi.
- G. VALVE BOXES: A cast iron valve box similar and equal to Russco B-122 or B-127 shall be installed over each underground valve. The word "Water" shall be cast on the valve box cover.

### **PART 3 - EXECUTION**

#### **3.1 WATER DISTRIBUTION SYSTEM INSTALLATION**

- A. HANDLING AND STORING MATERIALS: Unload pipe so as to avoid deformation or other injury thereto. Place no pipe within pipe of a larger size. Store pipe and fittings on sills above storm drainage level and deliver for laying after the trench is excavated. Valves shall be drained and so stored as to protect them from freezing.
- B. PIPE LAYING - GENERAL: The interior of the pipe shall be clean and joint surfaces wiped clean and dry when the pipe is lowered into trench. Lower each pipe, fitting and valve into the trench carefully and lay true to line and without objectionable breaks in grade. The depth of cover below finished grade shall be not less than 3 feet, or as shown on the drawings. Give all pipes a uniform bearing on the trench bottom. Allow no trench water or dirt to enter the pipe after laying. Insert a watertight plug in the open end of the piping when pipe laying is not in progress.

- C. **BORING AND JACKING:** Where required by the drawings, the water line will be installed in a steel casing, placed by boring and jacking.

Where boring is required under highways, the materials and workmanship will be in accordance with the standards of the State Highway Department or local authority. Boring and jacking under railroads will be governed by the latest A.R.E.A. Standards, Part 5, "Pipelines" and those of the railroad involved.

1. **Casing Pipe:** The casing pipe shall conform to the materials standard of ASTM Designation A252, with minimum wall thickness of 0.219 inch. Steel pipe will have a minimum yield strength of 35,000 psi. Casing pipe shall be joined together with welded joints.
2. **Carrier Pipe:** The carrier pipe shall be ductile iron as specified herein.
3. **Installation:** The steel casing shall be installed by the "Dry Bore and Jack" method. If voids develop or if the bored hole diameter is greater than the outside diameter of the pipe by more than approximately 1 inch, remedial measures will be taken as approved by the Engineer.

When installing water line through casing, Contractor shall use mechanical joint pipe with retained glands through length of casing. The water main shall be strapped to 8 foot long treated wooden skids with metal straps throughout length of casing. The ends of the casing shall be sealed with brick and mortar.

- D. **REACTION BLOCKING:** All plugs, caps, tees, bends and other fittings shall be provided with adequate reaction blocking as shown on the drawings. Reaction blocking shall be made to bear directly against the undisturbed trench wall. Where trench conditions are, in the opinion of the Engineer, unsuitable for reaction blocking, the Contractor shall provide tied joints to adequately anchor the piping as shown on the drawings. All the rods and clamps shall be given a bituminous protective coating.
- E. **PRESSURE AND LEAKAGE TEST:** Before any work will be accepted for payment, the Contractor will fill the piping with water, open outlet as necessary for expelling the entrapped air. No fire hydrant shall be opened full force during charging operations. Thereafter, furnish the necessary equipment and test the piping under the supervision of the Engineer for a period of at least 2 hours at not less than 1.25 times the design pressure in pounds per square inch, based upon the highest elevation of the section under test. Pressure testing shall be in accordance with AWWA Standard C600, Section 4.1. at 1.5 times the working pressure at the point of testing. Inspect all joints, and remedy to the satisfaction of the Engineer any defects discovered. Continue the test until all visible leaks have been eliminated from the part of the system under test, and the pressure remains constant with a maximum pressure drop of 5 psi for the duration of the test.

Immediately following the pressure test, and before any work will be accepted for payment, the Contractor shall perform a leakage test. Leakage is defined as the quantity of water to be supplied into the newly laid pipe, or any valved section thereof necessary to maintain the specified leakage test filled with water to within 5 psi of the test pressure. No pipe installation will be accepted until the leakage is less than the number of gallons per hour as determined by the formula



$$L = \frac{SD\sqrt{P}}{133200}$$

L = Allowable leakage in gallons per hour.

S = The length of pipe in the section tested.

D = The nominal diameter of the pipe in inches.

P = The average test pressure during the leakage test in pounds per square inch gauge.

The leakage test shall be conducted in accordance with AWWA Standard C-600, Section 4.1.

### 3.2 STERILIZATION

- A. All piping complete with fittings and appurtenances shall be flushed until clean and sterilized as specified in the applicable sections of AWWA Specification C651. "Disinfecting Water Mains." Piping and appurtenances shall be thoroughly flushed then chlorinated with not less than fifty parts per million (50 ppm). Calcium hypochlorite can be used. Water from the existing distribution system or other source of supply should be controlled so as to flow slowly into the newly laid pipeline during the application of chlorine. The solution should be retained in the pipeline for not less than 24 hours and a chlorine residual of 10 ppm should be available at this time. The system shall then be flushed with potable water and the sampling program started. The provisions of this paragraph apply equally to new pipe and fittings and to existing pipelines into which connections have been made or which may have been otherwise disturbed to the extent that contamination may have occurred. All requirements of the health authorities shall be observed in executing this work.
- B. Two or more successive sets of samples, taken at 24 hour intervals and tested by a State approved private lab, shall indicate bacteriologically satisfactory water and the results submitted to the Engineer.

### 3.3 WATER/SEWER SEPERATION

- A. A 10 foot horizontal separation shall be maintained between water and sewer lines. Where the horizontal separation cannot be met or where water and sewer lines must cross, an 18 inch vertical separation, water over sewer must be maintained. Where the above conditions cannot be met, water and sewer lines shall be cast iron or ductile iron pipe with joints staggered such that maximum separation between joints exists. The water line shall be installed over the sewer line.

### 3.4 AS-BUILT DRAWINGS

- A. As the work progresses, record on one set of utility drawings all changes and deviations from the contract drawings in sizes, lines or grade. Record also the

exact final location of water lines by offset distances to surface improvements such as edge of existing pavement or to property lines, etc. at a maximum interval of 200 feet. Make sufficient measurements to locate definitely all water lines etc., to permanent points. The drawings will show references to all valves, fittings, pipe brand changes, etc. Transfer accurately all such records in red pencil to white prints of the utility drawings and deliver them to the Engineer with monthly payment estimate.

### 3.5 MEASUREMENT AND PAYMENT

Payment will be made only for elements in place and tested as follows:

- A. Pipelines, valves, and fire hydrants will be paid for at the lump sum amount as shown in the bid schedule for each size, type and class installed, complete including fittings. No deductions will be made for the laying length of valves and fittings installed within a pipeline.
- B. Service lines will be paid for at the amount shown in the bid schedule, complete as shown on the plans.

**END OF SECTION 34 40 00**