# Project Manual
# Book 3 of 3

## New Facility
## Boys and Girls Clubs of Greater Cincinnati
## Price Hill Teen Center & Offices
Glenway Ave. / Cincinnati, Ohio 45205

**For**
**Boys and Girls Clubs of Greater Cincinnati**
600 Dalton Ave.
Cincinnati, Ohio 45203

Issued for Bidding: February, 2023

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**TABLE OF CONTENTS**

**VOLUME 1**


| Division | Section Title | Pages |
|---|---|---|
| | **PROCUREMENT AND CONTRACTING DOCUMENTS GROUP** | |
| **EXHIBITS & ATTACHMENTS** | | |
| 000102 | Table of Contents | 5 |
| | Exhibit A – List of Drawings | 2 |
| **DIVISION 00 - PROCUREMENT AND CONTRACTING REQUIREMENTS** | | |
| 002113 | Instructions to Bidders | 1 |
| | AIA A701 Instructions to Bidders – Sample | 8 |
| 002213 | Supplementary Instructions to Bidders | 2 |
| 006000 | Project Forms | 1 |
| | **SPECIFICATIONS GROUP** | |
| | ***General Requirements*** | |
| **DIVISION 01 - GENERAL REQUIREMENTS** | | |
| 011000 | Summary | 9 |
| 012300 | Alternates | 2 |
| 012500 | Substitution Procedures | 4 |
| 012600 | Contract Modification Procedures | 2 |
| 012900 | Payment Procedures | 5 |
| 013100 | Project Management and Coordination | 10 |
| 013200 | Construction Progress Documentation | 9 |
| 013300 | Submittal Procedures | 10 |
| 014000 | Quality Requirements | 8 |
| 014200 | References | 7 |
| 015000 | Temporary Facilities and Controls | 9 |
| 016000 | Product Requirements | 5 |
| 017300 | Execution | 9 |
| 017700 | Closeout Procedures | 6 |
| 017823 | Operation And Maintenance Data | 7 |
| 017839 | Project Record Documents | 4 |
| 017900 | Demonstration And Training | 3 |

**VOLUME 2**

**DIVISION 03 - CONCRETE**

| | | |
|---|---|---|
| 033000 | Cast-In-Place Concrete | 21 |

**DIVISION 04 - MASONRY**

| | | |
|---|---|---|
| 042000 | Unit Masonry | 21 |
| 047200 | Cast Stone Masonry | 6 |

**DIVISION 05 - METALS**

| | | |
|---|---|---|
| 051200 | Structural Steel Framing | 10 |
| 052100 | Steel Joist Framing | 4 |
| 053100 | Steel Decking | 7 |
| 054000 | Cold-Formed Metal Framing | 8 |
| 055000 | Metal Fabrications | 8 |
| 055113 | Metal Pan Stairs | 4 |
| 055213 | Pipe and Tube Railings | 7 |
| 057300 | Decorative Metal Railings | 8 |

**DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES**

| | | |
|---|---|---|
| 061000 | Rough Carpentry | 6 |
| 061600 | Sheathing | 5 |
| 064116 | Plastic-Laminate-Faced Architectural Cabinets | 8 |
| 066400 | Plastic Paneling | 3 |

**DIVISION 07 - THERMAL AND MOISTURE PROTECTION**

| | | |
|---|---|---|
| 071326 | Self-Adhering Sheet Waterproofing | 5 |
| 071919 | Silicone Water and Graffiti-Resistant Treatments | 4 |
| 072100 | Thermal Insulation | 4 |
| 072119 | Foamed-In-Place Insulation | 2 |
| 072500 | Weather Barriers | 2 |
| 072726 | Fluid-Applied Membrane Air Barriers | 7 |
| 074113.16 | Standing-Seam Metal Roof Panels | 10 |
| 074213.13 | Formed Metal Wall Panels | 8 |
| 074293 | Soffit Panels | 7 |
| 075323 | Ethylene-Propylene-Diene-Monomer (EPDM) Roofing | 10 |
| 076200 | Sheet Metal Flashing and Trim | 9 |
| 077100 | Roof Specialties | 8 |
| 077200 | Roof Accessories | 5 |
| 077253 | Snow Guards | 3 |
| 078413 | Penetration Firestopping | 6 |
| 078443 | Joint Firestopping | 5 |
| 079200 | Joint Sealants | 9 |

**DIVISION 08 - OPENINGS**

| | | |
|---|---|---|
| 081113 | Hollow Metal Doors and Frames | 9 |
| 081416 | Flush Wood Doors | 5 |
| 083113 | Access Doors And Frames | 3 |
| 083613 | Sectional Doors | 8 |
| 084113 | Aluminum-Framed Entrances and Storefronts | 9 |

087100 Door Hardware 11
088000 Glazing 9

**DIVISION 09 - FINISHES**
092216 Non-Structural Metal Framing 7
092900 Gypsum Board 7
093013 Ceramic Tiling 8
095113 Acoustical Panel Ceilings 6
096513 Resilient Base and Accessories 6
096519 Resilient Tile Flooring 4
096723 Resinous Flooring 7
096813 Tile Carpeting 5
099113 Exterior Painting 6
099123 Interior Painting 8

**DIVISION 10 - SPECIALTIES**
101100 Visual Display Units 6
101419 Dimensional Letter Signage 5
101423 Panel Signage 6
102113 Toilet Compartments 4
102600 Wall And Door Protection 4
102800 Toilet, Bath, and Laundry Accessories 4
104413 Fire Protection Cabinets 4
104416 Fire Extinguishers 3
105300 Manufactured Hanger Rod Canopies 4

**DIVISION 12 - FURNISHINGS**
122413 Roller Window Shades 4
123661.16 Solid Surfacing Countertops 4

**DIVISION 14 - CONVEYING EQUIPMENT**
142123.16 Machine Room-Less Electric Traction Passenger Elevators 8

**DIVISION 31 - EARTHWORK**
311000 Site Clearing 4
312000 Earth Moving 12

**DIVISION 32 - EXTERIOR IMPROVEMENTS**
321216 Asphalt Paving 7
321313 Concrete Paving 13
321373 Concrete Paving Joint Sealants 4
321411 Modular Retaining Wall System 6
321723 Pavement Markings 2
321726 Tactile Warning Surfacing 4
321813 Synthetic Grass Surfacing 6
323113 Vinyl Fencing and Gates 3
329113 Soil Preparation 9
329200 Turf And Grasses 8

**DIVISION 33 - UTILITIES**
334600 Subdrainage 4

**VOLUME 3**

**DIVISION 22 – PLUMBING**


| | |
|---|---|
| 220516 | EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING |
| 220517 | SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING |
| 220518 | ESCUTCHEONS FOR PLUMBING PIPING |
| 220523.12 | BALL VALVES FOR PLUMBING PIPING |
| 220523.14 | CHECK VALVES FOR PLUMBING PIPING |
| 220529 | HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT |
| 220719 | PLUMBING PIPING INSULATION |
| 221116 | DOMESTIC WATER PIPING |
| 221119 | DOMESTIC WATER PIPING SPECIALTIES |
| 221316 | SANITARY WASTE AND VENT PIPING |
| 221319 | SANITARY WASTE PIPING SPECIALTIES |
| 221600 | FACILITY NATURAL-GAS PIPING |
| 224213.13 | COMMERCIAL WATER CLOSETS |
| 224213.16 | COMMERCIAL URINALS |
| 224216.13 | COMMERCIAL LAVATORIES |
| 224216.16 | COMMERCIAL SINKS |
| 224716 | PRESSURE WATER COOLERS |


**DIVISION 23 – HEATING VENTILATING AND AIR CONDITIONING**


| | |
|---|---|
| 230100 | GENERAL REQUIREMENTS FOR HVAC |
| 230513 | COMMON MOTOR REQUIREMENTS FOR HVAC |
| 230529 | HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT |
| 230553 | IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT |
| 230593 | TESTING, ADJUSTING, AND BALANCING FOR HVAC |
| 230713 | DUCT INSULATION |
| 230719 | HVAC PIPING INSULATION |
| 230800 | COMMISSIONING OF HVAC |
| 230923 | DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC |
| 230993.11 | SEQUENCE OF OPERATIONS FOR HVAC DDC |
| 232300 | REFRIGERANT PIPING |
| 233113 | METAL DUCTS |
| 233116 | NONMETAL DUCTS |
| 233119 | HVAC CASINGS |
| 233300 | AIR DUCT ACCESSORIES |
| 233423 | HVAC POWER VENTILATORS |
| 233600 | AIR TERMINAL UNITS |
| 233713 | DIFFUSERS, REGISTERS, AND GRILLES |
| 237433 | ROOFTOP UNITS |
| 238239.19 | ELECTRIC UNIT HEATERS |


**DIVISION 26 – ELECTRICAL**


| | |
|---|---|
| 260000 | GENERAL SPECIFICATIONS |
| 260519 | LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES |
| 260526 | GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS |
| 260529 | HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS |
| 260533 | RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS |
| 260544 | SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING |
| 260553 | IDENTIFICATION FOR ELECTRICAL SYSTEMS |
| 260923 | LIGHTING CONTROL DEVICES |

262416 PANELBOARDS
262726 WIRING DEVICES
262813 FUSES
262816 ENCLOSED SWITCHES AND CIRCUIT BREAKERS
265100 INTERIOR LIGHTING
265600 EXTERIOR LIGHTING

**DIVISION 27 – COMMUNICATIONS**

270500 BASIC COMMUNICATIONS REQUIREMENTS
270525 FIRESTOPPING
270526 GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS
270528 PATHWAYS FOR COMMUNICATIONS SYSTEMS
270802 DOCUMENTATION AND CLOSE OUT FOR TECH & SECURITY SYSTEMS
271100 COMMUNICATIONS EQUIPMENT ROOM FITTINGS
271513 COMMUNICATIONS COPPER HORIZONTAL CABLING
274000 MEDIA COMMUNICATIONS SYSTEMS
275116 PUBLIC ADDRESS SYSTEMS

**DIVISION 28 – ELECTRONIC SAFETY AND SECURITY**

280520 BASIC SECURITY MATERIALS AND METHODS
280526 GROUNDING AND BONDING FOR SECURITY SYSTEMS
280528 SECURITY SYSTEMS PATHWAYS AND SUPPORT EQUIPMENT
281300 ACCESS CONTROL SOFTWARE AND DATABASE MANAGEMENT
281500 ACCESS CONTROL HARDWARE DEVICES
281600 INTRUSION DETECTION SYSTEM
282100 VIDEO SURVEILLANCE CAMERAS

**END OF TABLE OF CONTENTS**

# SECTION 220516 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

## PART 1 - GENERAL

### 1.1 SUMMARY

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

### 1.2 ACTION SUBMITTALS

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

### 1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product certificates.

### 1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

## PART 2 - PRODUCTS

### 2.1 PACKLESS EXPANSION JOINTS

A. Packless Expansion Joints:
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. Flex-Hose Co., Inc.
b. Flexicraft Industries.
c. Flex Pression Ltd.
d. Metraflex, Inc.
e. Unisource Manufacturing, Inc.
2. Standards: ASTM F 1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

### 2.2 GROOVED-JOINT EXPANSION JOINTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Anvil International, Inc.
2. Shurjoint Piping Products.
3. Victaulic Company.

B. Description: Factory-assembled expansion joint made of several grooved-end pipe nipples, couplings, and grooved joints.

C. Standard: AWWA C606, for grooved joints.

D. Nipples: ASTM A 53/A 53M, Schedule 40, Type E or S, steel pipe with grooved ends.

## 2.3 ALIGNMENT GUIDES AND ANCHORS

A. Alignment Guides:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Adsco Manufacturing LLC.
b. American BOA, Inc.
c. Badger Industries, Inc.
d. Expansion Joint Systems, Inc.
e. Flex-Hose Co., Inc.
f. Flexicraft Industries.
g. Flex Pression Ltd.
h. Flex-Weld, Inc.
i. Flo Fab inc.
j. Hyspan Precision Products, Inc.
k. Metraflex, Inc.
l. Proco Products, Inc.
m. Senior Flexonics Pathway.
n. Tozen Corporation.
o. Unaflex.
p. Unisource Manufacturing, Inc.
q. Universal Metal Hose; a subsidiary of Hyspan Precision Products, Inc.
r. U.S. Bellows, Inc.
s. WahlcoMetroflex.

# PART 3 - EXECUTION

## 3.1 EXPANSION-JOINT INSTALLATION

A. Install expansion joints of sizes matching sizes of piping in which they are installed.

B. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

## 3.2 PIPE LOOP AND SWING CONNECTION INSTALLATION

A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Connect risers and branch connections to mains with at least five pipe fittings including tee in main.

C. Connect risers and branch connections to terminal units with at least four pipe fittings including tee in riser.

D. Connect mains and branch connections to terminal units with at least four pipe fittings including tee in main.

### 3.3 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install one guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.

C. Attach guides to pipe and secure guides to building structure.

D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

E. Anchor Attachments:
   1. Anchor Attachment to Black-Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   2. Anchor Attachment to Galvanized-Steel Pipe: Attach with pipe hangers. Use MSS SP-69, Type 42, riser clamp welded to anchor.
   3. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.

F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
   1. Anchor Attachment to Steel Structural Members: Attach by welding.
   2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.

G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

**END OF SECTION 220516**

# SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

## PART 1 - GENERAL

### 1.1 SUMMARY

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

### 1.2 ACTION SUBMITTALS

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

## PART 2 - PRODUCTS

### 2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

### 2.2 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Advance Products & Systems, Inc.
   2. CALPICO, Inc.
   3. Metraflex Company (The).
   4. Pipeline Seal and Insulator, Inc.
   5. Proco Products, Inc.
   6. Link-Seal Modular Seals

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
   1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Carbon steel.
   3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

### 2.3 GROUT

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

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

## PART 3 - EXECUTION

### 3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide **1-inch (25-mm)** annular clear space between piping and concrete slabs and walls.
   1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas **2 inches (50 mm)** above finished floor level.
   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 (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

### 3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

### 3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:
   1. Exterior Concrete Walls above Grade:
      a. Galvanized-steel-pipe sleeves.
   2. Exterior Concrete Walls below Grade:
      a. Cast-iron wall sleeves with sleeve-seal system] [Galvanized-steel wall sleeves with sleeve-seal system>.
         1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
   3. Concrete Slabs-on-Grade:
      a. Cast-iron wall sleeves with sleeve-seal system.
         1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
   4. Concrete Slabs and Interior Partitions above Grade:
      a. Steel-pipe sleeves.

**END OF SECTION 220517**

## SECTION 220518 - ESCUTCHEONS FOR PLUMBING PIPING

### PART 1 - GENERAL

### 1.1 SUMMARY

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

### 1.2 ACTION SUBMITTALS

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

### PART 2 - PRODUCTS

### 2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

### 2.2 FLOOR PLATES

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

### PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
   1. Escutcheons for New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
      c. Insulated Piping: One-piece, stamped-steel type.
      d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
      e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
      f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
      g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type.
      h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with 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 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.

**3.2 FIELD QUALITY CONTROL**

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

**END OF SECTION 220518**

# SECTION 220523.12 - BALL VALVES FOR PLUMBING PIPING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Brass ball valves.
   2. Bronze ball valves.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of valve.
   1. Certification that products comply with NSF 61 and NSF 372.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
   1. ASME B1.20.1 for threads for threaded end valves.
   2. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   3. ASME B16.18 for solder-joint connections.
   4. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.

D. Valves in Insulated Piping:
   1. Include 2-inch (50-mm) stem extensions.
   2. Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
   3. Memory stops that are fully adjustable after insulation is applied.

### 2.2 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. American Valve, Inc.
      b. Conbraco Industries, Inc.; Apollo Valves.
      c. Crane Co.; Crane Valve Group; Crane Valves.
      d. Hammond Valve.
      e. Lance Valves; a division of Advanced Thermal Systems, Inc.
      f. Legend Valve.
      g. Milwaukee Valve Company.
      h. NIBCO INC.
      i. Red-White Valve Corporation.
      j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   2. Description:

a. Standard: MSS SP-110.
b. CWP Rating: 600 psig.
c. Body Design: Two piece.
d. Body Material: Bronze.
e. Seats: PTFE or TFE.
f. Stem: Bronze.
g. Ball: Chrome-plated brass.
h. Port: Full.

## PART 3 - EXECUTION

### 3.1 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

**END OF SECTION 220523.12**

## SECTION 220523.14 - CHECK VALVES FOR PLUMBING PIPING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Bronze swing check valves.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of valve.
   1. Certification that products comply with NSF 6.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
   1. ASME B1.20.1 for threads for threaded end valves.
   2. ASME B16.1 for flanges on iron valves.
   3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   4. ASME B16.18 for solder joint.
   5. ASME B31.9 for building services piping valves.

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

D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

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

G. Valve Bypass and Drain Connections: MSS SP-45.

### 2.2 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Bronze Disc:
   1. Description:
      a. Standard: MSS SP-80, Type 3.
      b. CWP Rating: 200 psig.
      c. Body Design: Horizontal flow.
      d. Body Material: ASTM B 62, bronze.
      e. Ends: Threaded or soldered. See valve schedule articles.
      f. Disc: Bronze.

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

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

## PART 3 - EXECUTION

### 3.1 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

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

### 3.2 ADJUSTING

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

### 3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:
1. Pump-Discharge Check Valves:
a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or 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 CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

C. End Connections:
1. For Copper Tubing, NPS 2 and Smaller: Threaded or soldered.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged or threaded.
3. For Copper Tubing, NPS 5 and Larger: Flanged.
4. For Steel Piping, NPS 2 and Smaller: Threaded.
5. For Steel Piping, NPS 2-1/2 to NPS 4 : Flanged or threaded.
6. For Steel Piping, NPS 5 and Larger: Flanged.

### 3.4 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller: Bronze swing check valves, Class 125, bronze disc with soldered or threaded end connections.

**END OF SECTION 220523.14**

# SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

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

### 1.2 PERFORMANCE REQUIREMENTS

A. 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.
3. Design seismic-restraint hangers and supports for piping and equipment.

### 1.3 ACTION SUBMITTALS

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

## PART 2 - PRODUCTS

### 2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon 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.

## 2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

## 2.3 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) 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 (688-kPa), ASTM C 552, Type II cellular glass with 100-psig (688-kPa), or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) 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 (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

## 2.4 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated 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.

## 2.5 PIPE POSITIONING SYSTEMS

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

## 2.6 EQUIPMENT SUPPORTS

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

## 2.7 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
   1. Properties: Nonstaining, noncorrosive, and nongaseous.
   2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

## PART 3 - EXECUTION

### 3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. 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 (100 mm) thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
   2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

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, 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 (DN 100) and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
   a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
   b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
   c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
   d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
   e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.
5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

## 3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

## 3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

## 3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

## 3.5 HANGER AND SUPPORT SCHEDULE

A. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

B. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

C. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

D. Use thermal-hanger shield inserts for insulated piping and tubing.

E. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F (566 deg C), pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
6. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
7. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
8. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction might occur.
9. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 (DN 50 to DN 1050) if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

F. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
   2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.

G. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
   2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.

H. 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 (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.

I. 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.

J. 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 (32 mm).
   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.

K. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

L. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

M. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

**END OF SECTION 220529**

# SECTION 220719 - PLUMBING PIPING INSULATION

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes insulating the following plumbing piping services:

1. Domestic cold-water piping.
2. Domestic hot-water piping
3. Exposed sanitary drains, domestic water, domestic hot water, and stops for plumbing fixtures for people with disabilities.
4. Supplies and drains for handicap-accessible lavatories and sinks.

### 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.

B. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

## PART 2 - PRODUCTS

### 2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Pittsburgh Corning Corporation; Foamglas.
      b. Owens-Corning Fiberglass Corp.
      c. Knauf
      d. CertainTeed.
      e. Johns Manville.
   2. Block Insulation: ASTM C 552, Type I.
   3. Special-Shaped Insulation: ASTM C 552, Type III.
   4. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
   5. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
   6. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Aeroflex USA, Inc.; Aerocel.
      b. Armacell LLC; AP Armaflex.
      c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

## 2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F (minus 73 to plus 93 deg C).

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

C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

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

D. PVC Jacket Adhesive: Compatible with PVC jacket.

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

## 2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
4. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

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

## 2.4 SEALANTS

A. Joint Sealants:

1. Joint Sealants: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
   b. Eagle Bridges - Marathon Industries; 405.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
   d. Mon-Eco Industries, Inc.; 44-05.
   e. Pittsburgh Corning Corporation; Pittseal 444.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C).
5. Color: White or gray.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## 2.5 FACTORY-APPLIED JACKETS

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

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

## 2.6 FIELD-APPLIED JACKETS

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

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

C. Metal Jacket:
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
   b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
   c. RPR Products, Inc.; Insul-Mate.
2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
   a. Sheet and roll stock ready for shop or field sizing.

b. Finish and thickness are indicated in field-applied jacket schedules.
c. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
e. Factory-Fabricated Fitting Covers:
   1) Same material, finish, and thickness as jacket.
   2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
   3) Tee covers.
   4) Flange and union covers.
   5) End caps.
   6) Beveled collars.
   7) Valve covers.
   8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

D. Underground Direct-Buried Jacket: 125-mil-thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Pittsburgh Corning Corporation; Pittwrap.
      b. Polyguard Products, Inc.; Insulrap No Torch 125.
      c. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.

## 2.7 TAPES

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

   1. Width: 3 inches (75 mm).
   2. Thickness: 11.5 mils (0.29 mm).
   3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
   4. Elongation: 2 percent.
   5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
   6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

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

   1. Width: 3 inches (75 mm).
   2. Thickness: 6.5 mils (0.16 mm).
   3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
   4. Elongation: 2 percent.
   5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
   6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

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

   1. Width: 2 inches (50 mm).

2. Thickness: 6 mils (0.15 mm).
3. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Width: 2 inches (50 mm).
2. Thickness: 3.7 mils (0.093 mm).
3. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

### 2.8 SECUREMENTS

A. Aluminum Bands: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 1/2 inch (13 mm) wide with wing seal or closed seal.

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

C. Wire: 0.080-inch (2.0-mm) nickel-copper alloy.

## PART 3 - EXECUTION

### 3.1 PREPARATION

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

B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

### 3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) o.c.

    a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.

3. Nameplates and data plates.
4. Cleanouts.

## 3.3 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 (50 mm) below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

## 3.4 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe

insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

## 3.5 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 (150 mm) o.c.
4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

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

D. Insulation Installation on Valves and Pipe Specialties:

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

## 3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

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

B. Insulation Installation on Pipe Flanges:

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

C. Insulation Installation on Pipe Fittings and Elbows:

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

D. Insulation Installation on Valves and Pipe Specialties:

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

## 3.7 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 (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.

## 3.8 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

## 3.9 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

## 3.10 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold-Water:

1. Cellular Glass: 1 inch (25 mm) thick.
2. Flexible Elastomeric: 1/2 inch (13 mm) thick.
3. Insulation thicknesses shall be doubled for piping installed in non-conditioned spaces such as boiler rooms, attics, crawl spaces, tunnels, etc.

B. Domestic Hot-Water:

1. Cellular Glass: 1-1/2 inches (38 mm) thick.
2. Flexible Elastomeric: 1 inch (25 mm) thick.
3. Insulation thicknesses shall be doubled for piping installed in non-conditioned spaces such as boiler rooms, attics, crawl spaces, tunnels, etc.

C. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:

1. One-piece PVC, with 1/8” thickness, meeting the standards of ASTM E 84-07 with a flame spread/ 450 smoke index per the building code. Surfaces to be soft, smooth, non-absorbent, easy to clean U/V inhibited, antimicrobial, antifungal properties. Insulator shall have a dual fastening system which consists of fusion bonded Velcro fastener strips for full slit enclosure and tamper resistant, smooth, non-abrasive snap-locking fasteners. P-Trap Insulator: Shall have a one-piece design with a universal fit for 1 1/4"-1 1/2" brass or plastic traps, a longer neck area (for longer tailpieces) and a more forgiving girth area (for bulkier plastic DWV Schedule #40 plastic P-Traps w/swivel nut) and shall have drainage at lowest point to prevent condensation and/or leakage build up. Valve and Supply Insulator: Shall have a one-piece design with a universal fit over valve handles and brass, plastic or metal braided supplies and connectors and shall be able to flexcurl to a minimum of 360 degrees with a full slit closure for total compliance. Off-Set Insulator: Shall have a one-piece design with a universal fit and shall fit inside of P-trap insulator tailpiece area.

2. Soft, resilient molded vinyl, with 1/8” minimum constant nominal wall thickness with internal ribs, UV resistant, which meets the requirements of ASTM D-635 burning characteristics.

**END OF SECTION 220719**

# SECTION 221116 - DOMESTIC WATER PIPING

## PART 1 - GENERAL

### 1.1 SUMMARY

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

### 1.2 ACTION SUBMITTALS

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

### 1.3 INFORMATIONAL SUBMITTALS

A. System purging and disinfecting activities report.

B. Field quality-control reports.

## PART 2 - PRODUCTS

### 2.1 PIPING MATERIALS

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

B. Potable-water piping and components shall comply with NSF 14 and NSF 61. Plastic piping components shall be marked with "NSF-pw."

### 2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) water tube, drawn temper.

B. Soft Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) and ASTM B 88, Type L (ASTM B 88M, Type B) 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 (DN 50) and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

## 2.3 PIPING JOINING MATERIALS

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

B. Flux: ASTM B 813, water flushable.

## 2.4 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.

## 2.5 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. Standard: ASSE 1079.
   2. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
   3. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:
   1. Standard: ASSE 1079.
   2. Factory-fabricated, bolted, companion-flange assembly.
   3. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
   4. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:
   1. Nonconducting materials for field assembly of companion flanges.
   2. Pressure Rating: 150 psig (1035 kPa).
   3. Gasket: Neoprene or phenolic.
   4. Bolt Sleeves: Phenolic or polyethylene.
   5. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:
   1. Standard: IAPMO PS 66.
   2. Electroplated steel nipple complying with ASTM F 1545.
   3. Pressure Rating and Temperature: 300 psig (2070 kPa) at 225 deg F (107 deg C).
   4. End Connections: Male threaded or grooved.
   5. Lining: Inert and noncorrosive, propylene.

# PART 3 - EXECUTION

## 3.1 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 shutoff valve immediately upstream of each dielectric fitting.

D. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."

E. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

F. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

G. 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.

H. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

I. Install piping to permit valve servicing.

J. 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.

K. Install piping free of sags and bends.

L. Install fittings for changes in direction and branch connections.

M. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

N. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 220519 "Meters and Gages for Plumbing Piping."

O. 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."

P. 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."

Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

## 3.2 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. 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."

E. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

F. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

## 3.3 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Aboveground Domestic Water Piping NPS 2 (DN 50) and Smaller: Plastic-to-metal transition fittings or unions.

## 3.4 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 (DN 50).

C. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100).

D. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

## 3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
   1. Vertical Piping: MSS Type 8 or 42, clamps.
   2. Individual, Straight, Horizontal Piping Runs:
      a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
      c. Longer Than 100 Feet (30 m) if Indicated: MSS Type 49, spring cushion rolls.
   3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support vertical piping and tubing at base and at each floor.

C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch (10 mm).

D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 3/4 (DN 20) and Smaller: 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
   2. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
   3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
   4. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
   5. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
   6. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.
   7. NPS 8 (DN 200): 10 feet (3 m) with 3/4-inch (19-mm) rod.

E. Install supports for vertical copper tubing every 10 feet (3 m).

F. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4 (DN 32) and Smaller: 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
   2. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
   3. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
   4. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
   5. NPS 3 and NPS 3-1/2 (DN 80 and DN 90): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
   6. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.
   7. NPS 6 (DN 150): 12 feet (3.7 m) with 3/4-inch (19-mm) rod.
   8. NPS 8 to NPS 12 (DN 200 to DN 300): 12 feet (3.7 m) with 7/8-inch (22-mm) rod.

G. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

## 3.6 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. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
   2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
   3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 (DN 65) and larger.

## 3.7 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

B. Label pressure piping with system operating pressure.

## 3.8 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 (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
      e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
      f. Prepare reports for tests and for corrective action required.

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

C. Prepare test and inspection reports.

## 3.9 ADJUSTING

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

8. Check plumbing specialties and verify proper settings, adjustments, and operation.

## 3.10 CLEANING

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

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

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

## 3.11 PIPING SCHEDULE

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

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

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

D. Aboveground domestic water piping, NPS 2 (DN 50) and smaller, shall be the following:
   1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); wrought-copper, solder-joint fittings.
   2. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); copper pressure-seal-joint fittings; and pressure-sealed joints.

**END OF SECTION 221116**

# SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
1. Vacuum breakers.
2. Temperature-actuated, water mixing valves.
3. Hose bibbs.
4. Wall hydrants.
5. Drain valves.
6. Water-hammer arresters.
7. Trap-seal primer valves.

B. Related Requirements:
1. Section 221116 "Domestic Water Piping" for water meters.
2. Section 224716 "Pressure Water Coolers" for water filters for water coolers.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

### 1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

### 1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Potable-water piping and components shall comply with NSF 61.

### 2.2 PERFORMANCE REQUIREMENTS

A. King Pressure for Domestic Water Piping Specialties: 125 psig (860 kPa) unless otherwise indicated.

### 2.3 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
1. Standard: ASSE 1001.
2. Size: NPS 1/4 to NPS 3 (DN 8 to DN 80), as required to match connected piping.
3. Body: Bronze.
4. Inlet and Outlet Connections: Threaded.
5. Finish: [Rough bronze] [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] [Rough bronze].

## 2.4 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Water-Temperature Limiting Devices:
1. Standard: ASSE 1017.
2. Pressure Rating: 125 psig (860 kPa).
3. Type: Thermostatically controlled, water mixing valve.
4. Material: Bronze body with corrosion-resistant interior components.
5. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.

## 2.5 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 (DN 15 or DN 20) threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig (860 kPa).
7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.

## 2.6 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:
1. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
2. Pressure Rating: 125 psig (860 kPa).
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 (DN 20 or DN 25).
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. Operating Keys: One with each wall hydrant.

## 2.7 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 (2760-kPa) minimum CWP.
3. Size: NPS 3/4 (DN 20).
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

## 2.8 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:
   1. Standard: ASSE 1010 or PDI-WH 201.
   2. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

## 2.9 TRAP-SEAL PRIMER DEVICE

A. Manufacturers:
   1. Watts Regulator Co.: www.watts.com (Basis of Design).
   2. Jay R. Smith Manufacturing Company: www.jayrsmith.com.
   3. Sioux Chief: www.siouxchief.com.
   4. Wade Drains: www.wadedrains.com.
   5. Zurn Industries, Inc: www.zurn.com.
   6. Precision Plumbing Products (PPP): www.pppinc.net.

B. Trap Seal Protection Devices:
   1. Trap Primer Valves:
      a. Trap primer valves shall have brass finish, with 1/2 inch copper outlet. Trap primer valves shall be suitable for a working pressure of 30 psi-250 psi gauge pressure, and shall activate upon a 5 psi pressure drop in the supply line. Provide distributor(s) as required to service the proper number of traps (maximum 8 traps per trap primer valve).
      b. Trap primer valves shall conform to ASSE Standard No. 1018.
      c. Wade Model 4402 Trap Primer Valve or other compliant manufacturer's product
      d. Wade Model 4402-DU Distribution Unit or other compliant manufacturer's product
   2. Barrier-Type Trap Seal Protection Device:
      a. Internally inserted, made of plyable material that allows liquids to pass through but will also create a vapor seal to maximize reduction of evaporation of the water trap seal.
      b. Certified to ASSE 1072 standards and identified as such.
      c. Install per manufacturer's written instructions and requirements, especially sizing per specific condition.
      d. Wade #4405 Trap Seal Device (TSD), or other compliant manufacturer's product.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.

B. Install water-hammer arresters in water piping according to PDI-WH 201.

C. 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.

D. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

## 3.2 FIELD QUALITY CONTROL

A. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

B. Prepare test and inspection reports.

## 3.3 ADJUSTING

A. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

**END OF SECTION 221119**

## SECTION 221316 - SANITARY WASTE AND VENT PIPING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Pipe, tube, and fittings.
   2. Specialty pipe fittings.

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

B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-DWV" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

## PART 2 - PRODUCTS

### 2.1 PIPING MATERIALS

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

### 2.2 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

C. Adhesive Primer: ASTM F 656.
   1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Solvent Cement: ASTM D 2564.
   1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Solvent cement shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## 2.3 SPECIALTY PIPE FITTINGS

A. Transition Couplings:
   1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
   2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
   3. Unshielded, Nonpressure Transition Couplings:
      a. Standard: ASTM C 1173.
      b. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
      c. Sleeve Materials:
         1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
         2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
         3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
   4. Shielded, Nonpressure Transition Couplings:
      a. 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 3 - EXECUTION

## 3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

## 3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping at indicated slopes.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

I. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

J. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:
   1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 2 (DN 80) and smaller; 1 percent downward in direction of flow for piping NPS 3 (DN 100) and larger.
   2. Horizontal Sanitary Drainage Piping: 1 percent downward in direction of flow.
   3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

K. Install aboveground PVC piping according to ASTM D 2665.

L. Install underground PVC piping according to ASTM D 2321.

M. Plumbing Specialties:
   1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."
   2. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."

N. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

O. 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."

P. 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."

Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

### 3.3 JOINT CONSTRUCTION

A. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

## 3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:
   1. Install transition couplings at joints of piping with small differences in OD's.
   2. In Drainage Piping: Nonpressure transition couplings.

## 3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
   1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
   2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
   3. Vertical Piping: MSS Type 8 or Type 42, clamps.
   4. Install individual, straight, horizontal piping runs:
      a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
      c. Longer Than 100 Feet (30 m) if Indicated: MSS Type 49, spring cushion rolls.
   5. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   6. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches (300 mm) of each fitting and coupling.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
   2. NPS 3 (DN 80): 60 inches (1500 mm) with 1/2-inch (13-mm) rod.
   3. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1500 mm) with 5/8-inch (16-mm) rod.
   4. NPS 6 and NPS 8 (DN 150 and DN 200): 60 inches (1500 mm) with 3/4-inch (19-mm) rod.
   5. Spacing for 10-foot (3-m) lengths may be increased to 10 feet (3 m). Spacing for fittings is limited to 60 inches (1500 mm).

F. Install supports for vertical cast-iron soil piping every 15 feet (4.5 m).

G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4 (DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
   2. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
   3. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
   4. NPS 3 and NPS 5 (DN 80 and DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
   5. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.
   6. NPS 8 (DN 200): 10 feet (3 m) with 3/4-inch (19-mm) rod.

H. Install supports for vertical copper tubing every 10 feet (3 m).

I. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
   2. NPS 3 (DN 80): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
   3. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
   4. NPS 6 and NPS 8 (DN 150 and DN 200): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.

J. Install supports for vertical PVC piping every 48 inches (1200 mm).

K. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

## 3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:
   1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
   2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
   3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
   4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
   5. Comply with requirements for cleanouts and drains specified in Section 221319 "Sanitary Waste Piping Specialties."
   6. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 (DN 65) and larger.

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 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.

## 3.7 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg (250 Pa). Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

## 3.8 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

## 3.9 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping shall be:
1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
2. Dissimilar Pipe-Material Couplings: Nonpressure transition couplings.

C. Aboveground, vent piping shall be:
1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
2. Dissimilar Pipe-Material Couplings: Nonpressure transition couplings.

D. Underground, soil, waste, and vent piping shall be:

1. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
2. Dissimilar Pipe-Material Couplings: Nonpressure transition couplings.

**END OF SECTION 221316**

# SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
1. Cleanouts.
2. Floor drains.
3. Roof flashing assemblies.
4. Miscellaneous sanitary drainage piping specialties.
5. Flashing materials.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for grease interceptors.

### 1.3 QUALITY ASSURANCE

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

## PART 2 - PRODUCTS

### 2.1 CLEANOUTS

A. Cleanouts:
1. Size: Same as connected drainage piping
2. Body Material: PVC as required to match connected piping.

### 2.2 FLOOR DRAINS

A. Floor Drains:
1. Refer to floor drain specifications on the drawings.

### 2.3 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:
1. Description: Manufactured assembly made of 4.0-lb/sq. ft. (20-kg/sq. m), 0.0625-inch- (1.6-mm-), 0.0938-inch- (2.4-mm-) thick, lead flashing collar and skirt extending at least 6 inches (150 mm) from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.
a. Open-Top Vent Cap: Without cap.
b. Low-Silhouette Vent Cap: With vandal-proof vent cap.
c. Extended Vent Cap: With field-installed, vandal-proof vent cap.

### 2.4 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. (20-kg/sq. m), 0.0625-inch (1.6-mm) thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft. (15-kg/sq. m), 0.0469-inch (1.2-mm) thickness.

3. Burning: 6-lb/sq. ft. (30-kg/sq. m), 0.0938-inch (2.4-mm) thickness.

B. Fasteners: Metal compatible with material and substrate being fastened.

C. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

D. Solder: ASTM B 32, lead-free alloy.

E. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
1. Size same as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) 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 (15 m) for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) for larger piping.
4. Locate at base of each vertical soil and waste stack.

B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

D. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
   a. Radius, 30 Inches (750 mm) or Less: Equivalent to 1 percent slope, but not less than 1/4-inch (6.35-mm) total depression.
   b. Radius, 30 to 60 Inches (750 to 1500 mm): Equivalent to 1 percent slope.
   c. Radius, 60 Inches (1500 mm) or Larger: Equivalent to 1 percent slope, but not greater than 1-inch (25-mm) total depression.
3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

E. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

F. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

G. 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.

H. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

I. Install vent caps on each vent pipe passing through roof.

J. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

## 3.2 CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

## 3.3 FLASHING INSTALLATION

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

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Section 076200 "Sheet Metal Flashing and Trim."

F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

## 3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

**END OF SECTION 221319**

## SECTION 221600 - FACILITY NATURAL-GAS PIPING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.

### 1.2 ACTION SUBMITTALS

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

B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

C. Delegated-Design Submittal: For natural-gas piping and equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Detail fabrication and assembly of seismic restraints.
2. Design Calculations: Calculate requirements for selecting seismic restraints.

### 1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control reports.

### 1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

### 1.5 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

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

## PART 2 - PRODUCTS

### 2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
   1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
   2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
   3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
   4. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
      a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

### 2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:
   1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
   2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
   3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
   4. Corrugated stainless-steel tubing with polymer coating.
   5. Operating-Pressure Rating: 0.5 psig (3.45 kPa).
   6. End Fittings: Zinc-coated steel.
   7. Threaded Ends: Comply with ASME B1.20.1.
   8. Maximum Length: 72 inches (1830 mm.)

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.
   1. Copper-alloy convenience outlet and matching plug connector.
   2. Nitrile seals.
   3. Hand operated with automatic shutoff when disconnected.
   4. For indoor or outdoor applications.
   5. Adjustable, retractable restraining cable.

C. Y-Pattern Strainers:
   1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
   2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller.
   3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
   4. CWP Rating: 125 psig (862 kPa).

### 2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F (540 deg C) complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

## 2.4 MANUAL GAS SHUTOFF VALVES

A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.

B. General Requirements for Metallic Valves, NPS 2 (DN 50) and Smaller: Comply with ASME B16.33.
   1. CWP Rating: 125 psig (862 kPa).
   2. Threaded Ends: Comply with ASME B1.20.1.
   3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
   4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch (25 mm) and smaller.
   6. Service Mark: Valves 1-1/4 inches (32 mm) to NPS 2 (DN 50) shall have initials "WOG" permanently marked on valve body.

C. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.
   1. Body: Bronze, complying with ASTM B 584.
   2. Ball: Chrome-plated brass.
   3. Stem: Bronze; blowout proof.
   4. Seats: Reinforced TFE; blowout proof.
   5. Packing: Separate packnut with adjustable-stem packing threaded ends.
   6. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   7. CWP Rating: 600 psig (4140 kPa).
   8. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
   9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
   1. Body: Bronze, complying with ASTM B 584.
   2. Ball: Chrome-plated bronze.
   3. Stem: Bronze; blowout proof.
   4. Seats: Reinforced TFE; blowout proof.
   5. Packing: Threaded-body packnut design with adjustable-stem packing.
   6. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   7. CWP Rating: 600 psig (4140 kPa).
   8. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
   9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Two-Piece, Regular-Port Bronze Ball Valves with Bronze Trim: MSS SP-110.
   1. Body: Bronze, complying with ASTM B 584.
   2. Ball: Chrome-plated bronze.
   3. Stem: Bronze; blowout proof.
   4. Seats: Reinforced TFE.
   5. Packing: Threaded-body packnut design with adjustable-stem packing.
   6. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   7. CWP Rating: 600 psig (4140 kPa).

8. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

F. Bronze Plug Valves: MSS SP-78.
1. Body: Bronze, complying with ASTM B 584.
2. Plug: Bronze.
3. Ends: Threaded, socket, as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
4. Operator: Square head or lug type with tamperproof feature where indicated.
5. Pressure Class: 125 psig (862 kPa).
6. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
7. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

## 2.5 PRESSURE REGULATORS

A. General Requirements:
1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 (DN 50) and smaller.

B. Line Pressure Regulators: Comply with ANSI Z21.80.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Actaris.
b. American Meter Company.
c. Eclipse Combustion, Inc.
d. Fisher Control Valves and Regulators; Division of Emerson Process Management.
e. Invensys.
f. Maxitrol Company.
g. Richards Industries; Jordan Valve Div.
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.

C. Appliance Pressure Regulators: Comply with ANSI Z21.18.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Canadian Meter Company Inc.

b. Eaton Corporation; Controls Div.
c. Harper Wyman Co.
d. Maxitrol Company.
e. SCP, Inc.

2. Body and Diaphragm Case: Die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.

## 2.6 DIELECTRIC UNIONS

A. Dielectric Unions:
1. Description:
a. Standard: ASSE 1079.
b. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
c. End Connections: Solder-joint copper alloy and threaded ferrous.

# PART 3 - EXECUTION

## 3.1 INDOOR PIPING INSTALLATION

A. 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.

B. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

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. Locate valves for easy access.

G. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Verify final equipment locations for roughing-in.

K. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

L. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
   1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches (75 mm) long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

M. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

N. 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.

O. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

P. Connect branch piping from top or side of horizontal piping.

Q. Install unions in pipes NPS 2 (DN 50) and smaller, adjacent to each valve, at final connection to each piece of equipment.

R. Do not use natural-gas piping as grounding electrode.

S. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

T. 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."

U. 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."

V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

## 3.2 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing or copper connector.

B. Install underground valves with valve boxes.

C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

D. Install anode for metallic valves in underground PE piping.

## 3.3 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:
1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:
1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

## 3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
1. NPS 1 (DN 25) and Smaller: Maximum span, 96 inches (2438 mm); minimum rod size, 3/8 inch (10 mm).
2. NPS 1-1/4 (DN 32): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).
3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).

C. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:
1. NPS 3/8 (DN 10): Maximum span, 48 inches (1220 mm); minimum rod size, 3/8 inch (10 mm).
2. NPS 1/2 (DN 15): Maximum span, 72 inches (1830 mm); minimum rod size, 3/8 inch (10 mm).
3. NPS 3/4 (DN 20) and Larger: Maximum span, 96 inches (2440 mm); minimum rod size, 3/8 inch (10 mm).

## 3.5 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches (1800 mm) of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

## 3.6 FIELD QUALITY CONTROL

A. Natural-gas piping will be considered defective if it does not pass tests and inspections.

B. Prepare test and inspection reports.

## 3.7 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter shall be one of the following:
1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be one of the following:
1. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.
3. Cast-iron, nonlubricated plug valve.

C. Distribution piping valves for pipe sizes NPS 2 and smaller shall be one of the following:
1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

D. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be one of the following:
1. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.
3. Cast-iron, plug valve.

E. Valves in branch piping for single appliance shall be one of the following:
1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

**END OF SECTION 231123**

## SECTION 224213.13 - COMMERCIAL WATER CLOSETS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Water closets.
   2. Flushometer valves.
   3. Toilet seats.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include diagrams for power, signal, and control wiring.

### 1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flushometer valves to include in operation and maintenance manuals.

## PART 2 - PRODUCTS

### 2.1 FLOOR-MOUNTED, BOTTOM-OUTLET WATER CLOSETS

A. Water Closets:
   1. Bowl:
      a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
      b. Material: Vitreous china.
      c. Style: Flushometer valve.
      d. Rim Contour: Elongated.
      e. Color: White.

### 2.2 FLUSHOMETER VALVES

A. Lever-Handle, Diaphragm Flushometer Valves:
   1. Standard: ASSE 1037.
   2. Minimum Pressure Rating: 125 psig (860 kPa).
   3. Features: Include integral check stop and backflow-prevention device.
   4. Material: Brass body with corrosion-resistant components.

### 2.3 TOILET SEATS

A. Toilet Seats:
   1. Standard: IAPMO/ANSI Z124.5.
   2. Material: Plastic.
   3. Type: Commercial (Standard).
   4. Shape: Elongated rim, open front.
   5. Hinge Material: Noncorroding metal.
   6. Color: White.

## PART 3 - EXECUTION

### 3.1 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. Use carrier supports with waste-fitting assembly and seal.
   3. 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 220518 "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 079200 "Joint Sealants."

### 3.2 CONNECTIONS

A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

D. Where installing piping adjacent to water closets, allow space for service and maintenance.

## 3.3 ADJUSTING

A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.

B. Adjust water pressure at flushometer valves to produce proper flow.

## 3.4 CLEANING AND PROTECTION

A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed water closets and fittings.

C. Do not allow use of water closets for temporary facilities unless approved in writing by Owner.

**END OF SECTION 224213.13**

## SECTION 224213.16 - COMMERCIAL URINALS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Urinals.
   2. Flushometer valves.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include diagrams for power, signal, and control wiring.

### 1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flushometer valves to include in operation and maintenance manuals.

## PART 2 - PRODUCTS

### 2.1 WALL-HUNG URINALS

A. Urinals:.
   1. Fixture:
      a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
      b. Material: Vitreous china.
      c. Color: White.
   2. Flushometer Valve: Battery-operated sensor.
   3. Waste Fitting:
      a. Standard: ASME A112.18.2/CSA B125.2 for coupling.
      b. Size: NPS 2 (DN 50).
   4. 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.

### 2.2 URINAL FLUSHOMETER VALVES

A. Battery-Powered, Solenoid-Actuator, Piston Flushometer Valves:
   1. Standard: ASSE 1037.
   2. Minimum Pressure Rating: 125 psig (860 kPa).
   3. Features: Include integral check stop and backflow-prevention device.
   4. Material: Brass body with corrosion-resistant components.
   5. 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.
   6. 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.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before 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.

### 3.2 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. 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 220518 "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 079200 "Joint Sealants."

### 3.3 CONNECTIONS

A. 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 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

D. Where installing piping adjacent to urinals, allow space for service and maintenance.

## 3.4 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.

## 3.5 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 224213.16**

## SECTION 224216.13 - COMMERCIAL LAVATORIES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Lavatories.
   2. Faucets.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include diagrams for power, signal, and control wiring of automatic faucets.

### 1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lavatories and faucets to include in operation and maintenance manuals.

## PART 2 - PRODUCTS

### 2.1 VITREOUS-CHINA, WALL-MOUNTED LAVATORIES

A. Lavatory: Vitreous china, wall mounted
   1. Fixture:
      a. Standard: ASME A112.19.2/CSA B45.1.
      b. Type: For wall hanging.
      c. Color: White.
      d. Mounting Material: Chair carrier.
   2. Faucet: Manually operated faucet.
   3. Support: ASME A112.6.1M, Type I, exposed-arm lavatory carrier.

### 2.2 MANUALLY OPERATED FAUCETS

A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for faucet materials that will be in contact with potable water.

B. Lavatory Faucets: Manual-type, single-control mixing valve.
   1. Standard: ASME A112.18.1/CSA B125.1.
   2. Finish: Polished chrome plate.

### 2.3 SUPPLY FITTINGS

A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.

B. Standard: ASME A112.18.1/CSA B125.1.

C. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless-steel wall flange.

D. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.

### 2.4 WASTE FITTINGS

A. Standard: ASME A112.18.2/CSA B125.2.

B. Drain: Grid type with NPS 1-1/4 (DN 32) offset and straight tailpiece.

C. Trap:
1. Material: Chrome-plated.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before lavatory installation.

B. Examine counters and walls for suitable conditions where lavatories will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

A. Install lavatories level and plumb according to roughing-in drawings.

B. Install supports, affixed to building substrate, for wall-mounted lavatories.

C. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1.

D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

E. Seal joints between lavatories and counters and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

### 3.3 CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

## 3.4 ADJUSTING

A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.

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

## 3.5 CLEANING AND PROTECTION

A. After completing installation of lavatories, inspect and repair damaged finishes.

B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed lavatories and fittings.

D. Do not allow use of lavatories for temporary facilities unless approved in writing by Owner.

**END OF SECTION 224216.13**

## SECTION 224216.16 - COMMERCIAL SINKS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Service basins.
   2. Sinks.
   3. Sink faucets.
   4. Supply fittings.
   5. Waste fittings.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

### 1.3 CLOSEOUT SUBMITTALS

A. Maintenance data.

## PART 2 - PRODUCTS

### 2.1 SERVICE BASINS

A. Service Basins: Plastic, floor mounted.
   1. Fixture:
      a. Standard: IAPMO/ANSI Z124.6.
      b. Material: Cast polymer.
      c. Drain: Grid with NPS 3 (DN 80) outlet.
   2. Mounting: On floor and flush to wall.

### 2.2 SINKS

A. Sinks: Stainless steel
   1. Fixture: Self-rimming for mounting in counter

### 2.3 SINK FAUCETS

A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for faucet-spout materials that will be in contact with potable water.

B. Sink Faucets: Manual type mixing valve.

### 2.4 SUPPLY FITTINGS

A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.

B. Standard: ASME A112.18.1/CSA B125.1.

C. Supply Piping: Chrome-plated brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass or stainless-steel wall flange.

D. Supply Stops: Chrome-plated brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.

### 2.5 WASTE FITTINGS

A. Standard: ASME A112.18.2/CSA B125.2.

B. Trap:
1. Material: Chrome-plated.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before sink installation.

B. Examine walls, floors, and counters for suitable conditions where sinks will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

A. Install sinks level and plumb according to roughing-in drawings.

B. Install supports, affixed to building substrate, for wall-hung sinks.

C. Install accessible wall-mounted sinks at handicapped/elderly mounting height according to ICC/ANSI A117.1.

D. Set floor-mounted sinks in leveling bed of cement grout.

E. Install water-supply piping with stop on each supply to each sink faucet.

F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

G. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

H. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

### 3.3 CONNECTIONS

A. Connect sinks with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

## 3.4 ADJUSTING

A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.

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

## 3.5 CLEANING AND PROTECTION

A. After completing installation of sinks, inspect and repair damaged finishes.

B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed sinks and fittings.

D. Do not allow use of sinks for temporary facilities unless approved in writing by Owner.

**END OF SECTION 224216.16**

## SECTION 224716 - PRESSURE WATER COOLERS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes pressure water coolers and related components.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of pressure water cooler.

B. Shop Drawings: Include diagrams for power, signal, and control wiring.

### 1.3 CLOSEOUT SUBMITTALS

A. Maintenance Data: For pressure water coolers to include in maintenance manuals.

## PART 2 - PRODUCTS

### 2.1 PRESSURE WATER COOLERS

A. Pressure Water Coolers: Flush to wall.
   1. Standards:
      a. Comply with NSF 61.
      b. Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant unless otherwise indicated.
   2. 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.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.

B. Examine walls and floors for suitable conditions where fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.

B. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.

C. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball or gate valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."

D. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

E. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

F. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

**3.3 CONNECTIONS**

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

**3.4 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 224716**

# SECTION 230100 - GENERAL REQUIREMENTS FOR HVAC

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes general requirements for HVAC work. Refer to architectural drawings, general notes, instructions to bidders, general conditions, supplementary general conditions, base building specifications and drawings, shop drawing manuals and as-built plans, except as noted herein, which apply in all respects to this section. The contractor shall visit the site and familiarize himself with all existing conditions prior to bidding the work.

### 1.2 USE OF DRAWINGS AND SPECIFICATIONS

A. EBS drawings and specifications are intended to convey design intent only. All means and methods sequences, techniques, and procedures of construction as well as any associated safety precautions and programs, and all incidental and temporary devices required to construct the project, and to provide a complete and fully operational mechanical system are the responsibility of the mechanical contractor.

### 1.3 STANDARDS

A. Equipment and materials shall conform with appropriate provisions of AGA, ARI, ASME, ASTM, CISPI, UL, NEMA, ANSI, SMACNA, ASHRAE, NFPA, NEC, as applicable to each individual unit or assembly. All equipment must bear UL label.

### 1.4 LICENSE/EXPERIENCE

A. Contractor must be licensed by the state to install HVAC systems/equipment. Contractor must also have a minimum of 5 years experience (unless stated otherwise in other sections) and have at least (5) successful project installations of similar size and scope. References must be provided upon request.

### 1.5 CODES

A. All work shall be performed in strict accordance with all applicable state and local codes and ordinances. The mechanical contractor shall satisfy code requirements at a minimum without any extra cost to the owner. In case of conflict between the drawings/specifications and the codes and ordinances, the highest standard shall apply.

### 1.6 PERMITS AND FEES

A. The mechanical contractor shall procure and pay for all permits, fees, taxes and inspections necessary to complete the mechanical work. Furnish certificate of approval for work from inspection authority to owner before final acceptance for work. Certificate of final inspection and approval shall be submitted with the contractor’s request for payment. No final payment will be approved without this certificate.

### 1.7 SITE EXAMINATION

A. The mechanical contractor shall thoroughly examine all areas of work where equipment, ductwork, and piping will be installed and shall report any condition that, in his opinion, prevents the proper installation of the mechanical work prior to bid, purchasing equipment, purchasing materials, and construction. Contractor shall also examine the drawings and specifications of other branches of work, making reference to them for details of new or existing building conditions. No extras will be allowed for failure to include all required work in bid.

B. All work shall be done at times convenient to the owner and only during normal working hours, unless specified otherwise.

C. Mechanical contractor shall take their own measurements and be responsible for them.

D. Access panels are not shown on drawings. During site examination, contractor shall identify all areas where access panels are required, and report to general contractor. Designation of who furnishes and who installs access panels must be coordinated with general contractor prior to starting work.

**1.8 CONTRACTOR COORDINATION**

A. Coordination drawings showing system and component installation layout, routing, details, etc. Shall be produced by the mechanical contractor and under the supervision of the general contractor/construction manager, or appropriate party as applicable.

B. All systems installed by each sub-contractor shall be coordinated with one another and approved by general contractor/construction manager, etc. prior to installation and/or fabrication.

C. If questions concerning design intent arise during coordination, EBS can assist where appropriate.

D. The architectural drawings shall take precedence over all other drawings. Do not scale distances off the mechanical drawings; use actual building dimensions.

**PART 2 - PRODUCTS**

**2.1 SHOP DRAWINGS**

A. Submit to the architect electronic copies of complete and certified shop drawings, descriptive data, performance data and ratings, diagrams and specifications on all specified equipment, including accessories, and materials for review. The make, model number, type, finish and accessories of all equipment and materials shall be reviewed and approved by the mechanical contractor and general contractor prior to submitting to the architect for their review and approval. Approval of shop drawings does not relieve the mechanical contractor/ vendor from compliance with the requirements of the contract drawings, specifications, and applicable codes.

B. Shop drawings shall be required on the following:
1. HVAC equipment
2. Fans
3. Diffusers, registers, grilles, dampers, and all sheet metal accessories
4. Temperature controls
5. HVAC coordination drawings including but not limited to ductwork, piping, etc.
6. Duct/pipe/insulation
7. Air control accessories (dampers, vanes, doors, connectors, etc.)
8. Air balance report

C. Products installed by the mechanical contractor and provided by others must be submitted for review prior to purchasing. Products shall not be selected based on permit drawings without express permission - products shall be selected based on construction drawings.

**2.2 RECORD DRAWINGS**

A. The mechanical contractor shall be responsible for creating coordination and record drawings. Drawings shall be produced in AUTOCAD 2004 format or later. Coordinate exact format with architect of record.

## 2.3 STARTUP AND TESTING

A. All mechanical systems and associated components shall go through start-up and be tested for proper operation per the manufacturer recommendations and industry standards. Startup to include factory trained personnel. Provide a copy of all start-up and testing paperwork to owner.

## 2.4 FIRE STOPPING

A. Provide fire stopping at all penetrations through rated separations per local codes & regulations & per UL recommendations for assemblies encountered in project.

B. The fire stopping material shall meet the integrity of the fire rated wall, floor, ceiling & roof being penetrated. Refer to architect's drawings for wall, floor, ceiling & roof fire ratings prior to bidding work.

C. Refer to architect's drawings for wall, floor, ceiling, and roof fire ratings prior to bidding work.

## 2.5 ACCESS PANELS

A. Provide ceiling and wall access panel quantities & locations to the general contractor prior to bidding. Access panels are required for all concealed appliances, controls devices, heat exchangers and HVAC system components that utilize energy. Where access panels are used, the access panel should be sized to allow accessibility for inspection, service, repair and replacement without disabling the function of a fire-resistance-rated assembly or removing permanent construction, other appliances, venting systems or any other piping or ducts not connected to the appliance being inspected, serviced, repaired or replaced. There shall be no extras for having to add access panels after bids are awarded.

## 2.6 CUTTING AND PATCHING

A. Neatly do all cutting as required and patch all cut surfaces to match building construction. The contractor shall employ and pay a trade trained and qualified contractor to perform the required patching work. All surfaces disturbed shall be restored with like materials to the satisfaction of the owner. All penetrations through roof shall be made by bonded roofer. Mechanical contractor shall pay all fees required.

## 2.7 FLASHING AND COUNTERFLASHING

A. Roof flashing shall be furnished and installed by the roofing contractor. Roof counterflashing shall be furnished and installed by the mechanical contractor. Coordinate work with roofing contractor and pay all fees.

B. Obtain approval from general contractor, construction manager, owner and/or roofing contractor prior to making any penetrations so that warranties are not compromised or voided.

## 2.8 WARRANTY

A. The mechanical contractor shall unconditionally warrant all work to be free of defects in equipment, material and workmanship. The mechanical contractor will repair or replace any defective work promptly and without charge to the owner.

B. Restore any other existing work damaged while repairing defective equipment, materials and workmanship.

## PART 3 - EXECUTION

### 3.1 MECHANICAL WORK

A. The mechanical contractor shall provide new HVAC equipment, fans, ductwork, piping, air devices, controls as indicated on drawings and as specified. Equipment and appliances shall be installed as required by the terms of their approval, in accordance with the conditions of the listing, the manufacturer's installation instructions, and applicable code.

### 3.2 OWNER'S INSTRUCTIONS

A. Provide two sets of complete operating and maintenance instructions with drawings, typewritten instructions, and operating sequences and descriptive data sheets. Assemble each set in a hard bound cover. Provide PDF files of all documentation.

### 3.3 FINALE

A. Put all equipment in service and demonstrate that all conditions of the contract have been fulfilled. Remove all tools, debris, etc. occasioned by work under this contract. Submit all warranties, test reports, operating and maintenance manuals for HVAC systems, log sheets and charts, and guarantees as previously specified. Provide all reports, forms, etc. required by inspectors to the satisfaction of the owner. Provide as-built record drawings (in AUTOCAD 2004 or later) showing an accurate account of the final installed systems. Systems including but not limited to all equipment and associated controls, ductwork/piping, air devices, etc.

**END OF SECTION 230100**

# SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC PIPING AND 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 104 deg F 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, 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: Greased, 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: 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 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. Furnish and install hot-dipped galvanized steel fastener systems, hangers/supports, anchors, rods, straps, trim, and angles for support of equipment.

### 1.2 PERFORMANCE REQUIREMENTS

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

B. Structural Performance: Hangers and supports for HVAC equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design equipment hangers and supports capable of supporting combined operating weight of supported equipment and connected systems and components.

### 1.3 SUBMITTALS

A. Refer to specification 230100 – General Requirements for HVAC.

### 1.4 QUALITY ASSURANCE

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

## PART 2 - EXECUTION

### 2.1 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.

C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

D. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

F. 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 hangers and supports to prevent swaying.

H. Load Distribution: Install hangers and supports so that live and dead loads and stresses from movement will not be transmitted.

I. Insulated Piping:

1. Attach clamps and spacers to 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.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

4. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

**END OF SECTION 230529**

## SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

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

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

## PART 2 - PRODUCTS

### 2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:
   1. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:
   1. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

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

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

### 2.2 WARNING SIGNS AND LABELS

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

B. Label Content: Include caution and warning information plus emergency notification instructions where applicable.

### 2.3 PIPE LABELS

A. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

B. 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.

## 2.4 DUCT LABELS

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

B. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings; also include duct size and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.

# PART 3 - EXECUTION

## 3.1 PREPARATION

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

## 3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

## 3.3 PIPE LABEL INSTALLATION

A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

B. Pipe Label Color Schedule:
   1. Chilled-Water Piping: White letters on a safety-green background.
   2. Condenser-Water Piping: White letters on a safety-green background.
   3. Heating Water Piping: White letters on a safety-green background.
   4. Refrigerant Piping: Black letters on a safety-orange background.
   5. Low-Pressure Steam Piping: White letters on a safety-purple background.
   6. High-Pressure Steam Piping: White letters on a safety-purple background.
   7. Steam Condensate Piping: White letters on a safety-purple background.

## 3.4 DUCT LABEL INSTALLATION

A. Install **self-adhesive** duct labels with permanent adhesive on air ducts in the following color codes:
   1. **Blue**: For cold-air supply ducts.
   2. **Yellow**: For hot-air supply ducts.
   3. **Green**: For exhaust-, outside-, relief-, return-, and mixed-air ducts.

B. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

**END OF SECTION 230553**

## SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

## PART 1 - GENERAL

**1.1** SUMMARY

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

**1.2** DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An entity engaged to perform TAB Work.

**1.3** SUBMITTALS

A. Refer to specification 230100 – General Requirements for HVAC.

**1.4** QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC or NEBB.

B. Certify TAB field data reports and perform the following:
   1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
   2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

C. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

## PART 2 - PRODUCTS (Not Applicable)

## PART 3 - EXECUTION

**3.1** EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data including fan and pump curves.
   1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
   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.

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 operating safety interlocks and controls on HVAC equipment.

H. 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** 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," NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," and SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.

**3.3** REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. 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 if applicable.

**3.4** FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
   1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
   2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Fan curves.
2. Manufacturer's test data.
3. Field test reports prepared by system and equipment installers.
4. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
2. Name and address of the TAB contractor.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:
    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.
12. Nomenclature sheets for each item of equipment.
13. Notes to explain why certain final data in the body of reports vary from indicated values.

**3.5** 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, concealed exhaust between isolation damper and penetration of building exterior.

1.2 SUBMITTALS

A. Refer to specification 230100 – General Requirements for HVAC.

1.3 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.

B. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

C. Duct and plenum insulation shall comply with R-value requirements of the applicable energy code.

## PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. 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 III with factory applied FSK jacket.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. CertainTeed Corporation.
2. Johns Manville; a Berkshire Hathaway company.
3. Knauf Insulation.
4. Manson Insulation Inc.
5. Owens Corning.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

2.3 MASTICS/SEALANTS

A. Materials shall be compatible with insulation materials, jackets, and substrates. Seal all longitudinal and transverse joints with a UL 181A or 181B non-hardening mastic or liquid elastic sealant of a type recommended by the manufacturer for sealing joints and seams in sheet metal ductwork.

2.4 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.5 TAPES

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

B. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

2.6 REQUIREMENTS

A. Minimum duct insulation R-values shall comply with climate zone 4a and meet the requirements of Table 6.8.2B of the 2010 ASHRAE 90.1 Energy Code.

2.7 PREPARATION

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

2.8 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 with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

C. Install insulation with least number of joints practical.

D. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

E. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

F. 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.

2.9 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.
   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.
   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.

## 2.10 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 as required per code.
   2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
   3. 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.
   4. 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.
   5. 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.
   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.

## 2.11 DUCT INSULATION SCHEDULE, GENERAL

A. Refer to Duct Insulation Schedule on sheet M200 for additional details.

**END OF SECTION 230713**

# SECTION 230719 - HVAC PIPING INSULATION

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes insulating the following HVAC piping systems:
   1. Refrigerant suction and hot-gas piping, indoors and outdoors.

B. Related Sections:
   1. Section 230100 “General Requirements for HVAC.”
   2. Section 230713 "Duct Insulation."

### 1.2 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 and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

## PART 2 - PRODUCTS

### 2.1 INSULATION MATERIALS

A. Products shall not contain asbestos, lead, mercury, or mercury compounds.

B. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

### 2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

## 2.3 SEALANTS

A. Joint Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 100 to plus 300 deg F.
4. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## 2.4 PREPARATION

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

## 2.5 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 and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Manufacturer approved UV protective coating to be applied to all outdoor Elastomeric insulation. Apply per manufacturers requirements.
1. Install insulation continuously through hangers and around anchor attachments.
2. 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.
3. 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, UV protective coatings, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

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.

## 2.6 PENETRATIONS

A. Insulation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
   1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

C. Insulation Installation at Floor Penetrations:
   1. Pipe: Install insulation continuously through floor penetrations.
   2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

## 2.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

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

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

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install mitered sections of pipe insulation.
   2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

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

## 2.8 FINISHES

A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating. Provide manufacturer provided and recommended UV coating on all flexible elastomeric thermal insulation installed outdoors.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

## 2.9 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing insulation in layers in reverse order of its installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of soldered joints, three locations of isolation valves, three locations of thermal expansion devices.

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

## 2.10 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range.

## 2.11 PIPING INSULATION SCHEDULE

A. Refrigerant Suction and Hot-Gas Piping: Flexible elastomeric preformed pipe insulation.

B. Piping shall be thermally insulated in accordance with the table below. If values listed below are different from manufacturer’s requirements, install per manufacturer’s requirements.

**TABLE 6.8.3B Minimum Pipe Insulation Thickness**
**Cooling Systems (Chilled Water, Brine, and Refrigerant)[a,b,c]**

| Fluid Operating Temperature Range (°F) and Usage | Insulation Conductivity | | Nominal Pipe or Tube Size (in) | | | | |
|---|---|---|---|---|---|---|---|
| | Conductivity Btu·in./(h·ft²·°F) | Mean Rating Temperature, °F | <1 | 1 to <1-1/2 | 1-1/2 to <4 | 4 to <8 | ≥8 |
| | | | Insulation Thickness (in) | | | | |
| 40°F–60°F | 0.21–0.27 | 75 | 0.5 | 0.5 | 1.0 | 1.0 | 1.0 |
| <40°F | 0.20–0.26 | 50 | 0.5 | 1.0 | 1.0 | 1.0 | 1.5 |

a For insulation outside the stated conductivity range, the minimum thickness (*T*) shall be determined as follows: $T = r\{(1 + t/r)^{K/k} - 1\}$ where T = minimum insulation thickness (in.), r = actual outside radius of pipe (in.), t = insulation thickness listed in this table for applicable fluid temperature and pipe size, K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu·in./h·ft2·°F); and k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.

b These thicknesses are based on *energy efficiency* considerations only. Issues such as water vapor permeability or surface condensation sometimes require vapor retarders or additional insulation.

c For direct-buried cooling *system* piping, insulation is not required.

d The table is based on steel pipe. Non-metallic pipes schedule 80 thickness or less shall use the table values. For other non-metallic pipes having *thermal resistance* greater than that of steel pipe, reduced insulation thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per foot than a steel pipe of the same size with the insulation thickness shown in the table.

**END OF SECTION 230719**

## SECTION 230800 - COMMISSIONING OF HVAC

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment.

B. Related Sections:
1. Section 019113 "General Commissioning Requirements" for general commissioning process requirements.

### 1.2 DEFINITIONS

A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

B. CxA: Commissioning Authority.

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.

### 1.3 INFORMATIONAL SUBMITTALS

A. Certificates of readiness.

B. Certificates of completion of installation, prestart, and startup activities.

C. Direct commissioning testing.

D. Verify testing, adjusting, and balancing of Work are complete.

E. Provide test data, inspection reports, and certificates in Systems Manual.

### 1.4 COMMISSIONING DOCUMENTATION

A. Provide the following information to the CxA for inclusion in the commissioning plan:
1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment, and components to be verified and tested.
4. Certificate of readiness, signed by the Contractor, certifying that HVAC&R systems, assemblies, equipment, components, and associated controls are ready for testing.
5. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
6. Certificate of readiness certifying that HVAC&R systems, subsystems, equipment, and associated controls are ready for testing.

7. Test and inspection reports and certificates.
8. Corrective action documents.
9. Verification of testing, adjusting, and balancing reports.

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION**

**3.1 TESTING PREPARATION**

A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Inspect and verify the position of each device and interlock identified on checklists.

F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

**3.2 Testing AND BALANCING VERIFICATION**

A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.

B. Notify the CxA at least [**10**] <**Insert number**> days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.

C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.
   1. The CxA will notify testing and balancing [**Contractor**] [**Subcontractor**] [**10**] <**Insert number**> days in advance of the date of field verification. Notice will not include data points to be verified.
   2. The testing and balancing [**Contractor**] [**Subcontractor**] shall use the same instruments (by model and serial number) that were used when original data were collected.
   3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
   4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

## 3.3 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

B. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.

C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

D. The CxA along with the HVAC&R [**Contractor**] [**Subcontractor**], testing and balancing [**Contractor**] [**Subcontractor**], and HVAC&R Instrumentation and Control [**Contractor**] [**Subcontractor**] shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.

E. Tests will be performed using design conditions whenever possible.

F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

G. The CxA may direct that set points be altered when simulating conditions is not practical.

H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

## 3.4 HVAC&R systems, subsystems, and equipment Testing Procedures

A. Boiler Testing and Acceptance Procedures: Testing requirements are specified in HVAC boiler Sections. Provide submittals, test data, inspector record, and boiler certification to the CxA.

B. HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC." Assist the CxA with preparation of testing plans.

C. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in HVAC piping Sections. HVAC&R [**Contractor**] [**Subcontractor**] shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:

1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
2. Description of equipment for flushing operations.
3. Minimum flushing water velocity.
4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.

D. Energy Supply System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of [**oil**] [**gas**] [**coal**] [**steam**] [**hot-water**] [**and**] [**solar**] systems and equipment at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

E. Refrigeration System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of chillers, cooling towers, refrigerant compressors and condensers, heat pumps, and other refrigeration systems. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

F. HVAC&R Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air, steam, and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC&R terminal equipment and unitary equipment.

G. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation and seismic controls.

**END OF SECTION 230800**

## SECTION 230800 - COMMISSIONING OF HVAC

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment.

B. Related Sections:
1. Section 019113 "General Commissioning Requirements" for general commissioning process requirements.

### 1.2 DEFINITIONS

A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

B. CxA: Commissioning Authority.

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.

### 1.3 INFORMATIONAL SUBMITTALS

A. Certificates of readiness.

B. Certificates of completion of installation, prestart, and startup activities.

### 1.4 CONTRACTOR'S RESPONSIBILITIES

A. Perform commissioning tests at the direction of the CxA.

B. Attend construction phase controls coordination meeting.

C. Attend testing, adjusting, and balancing review and coordination meeting.

D. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

E. Provide information requested by the CxA for final commissioning documentation.

F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

### 1.5 CxA'S RESPONSIBILITIES

A. Provide Project-specific construction checklists and commissioning process test procedures for actual HVAC&R systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.

B. Direct commissioning testing.

C. Verify testing, adjusting, and balancing of Work are complete.

D. Provide test data, inspection reports, and certificates in Systems Manual.

### 1.6 COMMISSIONING DOCUMENTATION

A. Provide the following information to the CxA for inclusion in the commissioning plan:
1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment, and components to be verified and tested.
4. Certificate of readiness, signed by the Contractor, certifying that HVAC&R systems, assemblies, equipment, components, and associated controls are ready for testing.
5. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
6. Certificate of readiness certifying that HVAC&R systems, subsystems, equipment, and associated controls are ready for testing.
7. Test and inspection reports and certificates.
8. Corrective action documents.
9. Verification of testing, adjusting, and balancing reports.

## PART 2 - PRODUCTS (Not Used)

## PART 3 - EXECUTION

### 3.1 TESTING PREPARATION

A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Inspect and verify the position of each device and interlock identified on checklists.

F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

## 3.2 Testing AND BALANCING VERIFICATION

A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.

B. Notify the CxA at least [**10**] <**Insert number**> days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.

C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.
   1. The CxA will notify testing and balancing [**Contractor**] [**Subcontractor**] [**10**] <**Insert number**> days in advance of the date of field verification. Notice will not include data points to be verified.
   2. The testing and balancing [**Contractor**] [**Subcontractor**] shall use the same instruments (by model and serial number) that were used when original data were collected.
   3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
   4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

## 3.3 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

B. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.

C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

D. The CxA along with the HVAC&R [**Contractor**] [**Subcontractor**], testing and balancing [**Contractor**] [**Subcontractor**], and HVAC&R Instrumentation and Control [**Contractor**] [**Subcontractor**] shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.

E. Tests will be performed using design conditions whenever possible.

F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

G. The CxA may direct that set points be altered when simulating conditions is not practical.

H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

**3.4 HVAC&R systems, subsystems, and equipment Testing Procedures**

A. Boiler Testing and Acceptance Procedures: Testing requirements are specified in HVAC boiler Sections. Provide submittals, test data, inspector record, and boiler certification to the CxA.

B. HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC." Assist the CxA with preparation of testing plans.

C. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in HVAC piping Sections. HVAC&R [**Contractor**] [**Subcontractor**] shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:
   1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
   2. Description of equipment for flushing operations.
   3. Minimum flushing water velocity.
   4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.

D. Energy Supply System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of [**oil**] [**gas**] [**coal**] [**steam**] [**hot-water**] [**and**] [**solar**] systems and equipment at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

E. Refrigeration System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of chillers, cooling towers, refrigerant compressors and condensers, heat pumps, and other refrigeration systems. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

F. HVAC&R Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air, steam, and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC&R terminal equipment and unitary equipment.

G. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation and seismic controls.

**END OF SECTION 230800**

# SECTION 230923- DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes controls components for a Variable Volume and Temperature (VVT) system. Refer to additional specifications, drawings, schedules, etc. for more information.

### 1.2 DEFINITIONS

A. Algorithm: A logical procedure for solving a recurrent mathematical problem. A prescribed set of well-defined rules or processes for solving a problem in a finite number of steps.

B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.

C. BACnet Specific Definitions:
   1. BACnet: Building Automation Control Network Protocol, ASHRAE 135. A communications protocol allowing devices to communicate data over and services over a network.
   2. BACnet Interoperability Building Blocks (BIBBs): BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBs are combined to build the BACnet functional requirements for a device.
   3. BACnet/IP: Defines and allows using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number.
   4. BACnet Testing Laboratories (BTL): Organization responsible for testing products for compliance with ASHRAE 135, operated under direction of BACnet International.
   5. PICS (Protocol Implementation Conformance Statement): Written document that identifies the particular options specified by BACnet that are implemented in a device.

D. Binary: Two-state signal where a high signal level represents ON" or "OPEN" condition and a low signal level represents "OFF" or "CLOSED" condition. "Digital" is sometimes used interchangeably with "Binary" to indicate a two-state signal.

E. Controller: Generic term for any standalone, microprocessor-based, digital controller residing on a network, used for local or global control. Three types of controllers are indicated: Network Controller, Programmable Application Controller, and Application-Specific Controller.

F. Control System Integrator: An entity that assists in expansion of existing enterprise system and support of additional operator interfaces to I/O being added to existing enterprise system.

G. COV: Changes of value.

H. DDC System Provider: Authorized representative of, and trained by, DDC system manufacturer and responsible for execution of DDC system Work indicated.

I. Distributed Control: Processing of system data is decentralized and control decisions are made at subsystem level. System operational programs and information are provided to remote subsystems and status is reported back. On loss of communication, subsystems shall be capable of operating in a standalone mode using the last best available data.

J. DOCSIS: Data-OverCable Service Interface Specifications.

K. Gateway: Bidirectional protocol translator that connects control systems that use different communication protocols.

L. HLC: Heavy load conditions.

M. I/O: System through which information is received and transmitted. I/O refers to analog input (AI), binary input (BI), analog output (AO) and binary output (BO). Analog signals are continuous and represent control influences such as flow, level, moisture, pressure, and temperature. Binary signals convert electronic signals to digital pulses (values) and generally represent two-position operating and alarm status. "Digital," (DI and (DO), is sometimes used interchangeably with "Binary," (BI) and (BO), respectively.

N. LAN: Local area network.

O. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

P. Modbus TCP/IP: An open protocol for exchange of process data.

Q. MS/TP: Master-slave/token-passing, IEE 8802-3. Datalink protocol LAN option that uses twisted-pair wire for low-speed communication.

R. Network Controller: Digital controller, which supports a family of programmable application controllers and application-specific controllers, that communicates on peer-to-peer network for transmission of global data.

S. Network Repeater: Device that receives data packet from one network and rebroadcasts it to another network. No routing information is added to protocol.

T. PDA: Personal digital assistant.

U. Peer to Peer: Networking architecture that treats all network stations as equal partners.

V. POT: Portable operator's terminal.

W. RAM: Random access memory.

X. RF: Radio frequency.

Y. Router: Device connecting two or more networks at network layer.

Z. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

AA. UPS: Uninterruptible power supply.

BB. USB: Universal Serial Bus.

CC. User Datagram Protocol (UDP): This protocol assumes that the IP is used as the underlying protocol.

DD. VAV: Variable air volume.

EE. WLED: White light emitting diode.

## 1.3 ACTION SUBMITTALS

A. Product Submittal Requirements: Provide shop drawings and other submittals on hardware, software, and equipment to be installed or furnished. Begin no work until submittals have been approved for conformity with design intent. When manufacturer's cutsheets apply to a product series rather than a specific product, clearly indicate applicable data by highlighting or by other means. Clearly reference covered specification and drawing on each submittal. General catalogs shall not be accepted as cutsheets to fulfill submittal requirements. Select and show submittal quantities appropriate to scope of work. Submittal approval does not relieve Contractor of responsibility to supply sufficient quantities to complete work.

B. Shop Drawings:
   1. Direct Digital Control System Hardware
      a. Complete bill of materials indicating quantity, manufacturer, model number, and relevant technical data of equipment to be used.
      b. Manufacturer's description and technical data such as performance curves, product specifications, and installation and maintenance instructions for items listed below and for relevant items not listed below:
         1) Direct digital controllers (controller panels)
         2) Transducers and transmitters
         3) Sensors (include accuracy data)
         4) Actuators
         5) Valves
         6) Relays and switches
         7) Control panels
         8) Power supplies
         9) Batteries
         10) Operator interface equipment
         11) Wiring
      c. Wiring diagrams and layouts for each control panel. Show termination numbers.
      d. Floor plan schematic diagrams indicating field sensor and controller locations.
      e. Riser diagrams showing control network layout, communication protocol, and wire types.
   2. Central System Hardware and Software
      a. Complete bill of material indicating quantity, manufacturer, model number, and relevant technical data of equipment used.
      b. Manufacturer's description and technical data such as product specifications and installation and maintenance instructions for items listed below and for relevant items furnished under this contract not listed below:
         1) Central Processing Unit (CPU) or web server
         2) Power supplies
         3) Battery backups
         4) Interface equipment between CPU or server and control panels
         5) Operating System software
         6) Operator Interface software
         7) Color graphic software
         8) Third-party software
   3. Schematic diagrams of control, communication, and power wiring for central system installation. Provide written descriptions and points list. Show interface wiring to control system.
   4. Network riser diagrams of wiring between central control unit and control panels.
   5. Details of control panel faces.

6. Damper schedule.
7. Valve schedule.
8. Include technical data for operating system software, operator interface, color graphics, and other third-party applications.

C. Controlled Systems
1. Riser diagrams showing control network layout, communication protocol, and wire types.
2. Schematic diagram of each controlled system. Label control points with point names. Graphically show locations of control elements.
3. Schematic wiring diagram of each controlled system. Label control elements and terminals. Where a control element is also shown on control system schematic, use the same name.
4. Instrumentation list (Bill of Materials) for each controlled system. List each control system element in a table. Show element name, type of device, manufacturer, model number, and product data sheet number.
5. Complete description of control system operation including sequences of operation. Include and reference schematic diagram of controlled system. List I/O points and software points specified in Section 23 09 93. Indicate alarmed and trended points.

D. Description of process, report formats, and checklists to be used in Section 23 09 23 Article 3.16 (Control System Demonstration and Acceptance).

## 1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials and parts that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Include product manufacturers' recommended parts lists for proper product operation over four-year period following warranty period. Parts list shall be indicated for each year.

C. Project Record Documents
1. Submit three copies of record (as-built) documents upon completion of installation for approval prior to final completion. Submittal shall consist of:
a. Project Record Drawings. As-built versions of submittal shop drawings provided as 3 prints of each drawing on 11" x 17" paper.
b. Testing and Commissioning Reports and Checklists. Completed versions of reports, checklists, and trend logs used to meet requirements of Section 23 09 23 Article 3.16 (Control System Demonstration and Acceptance).
c. Operation and Maintenance (O&M) Manual. Printed, electronic, or online help documentation of the following:
1) As-built versions of submittal product data.
2) Names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.
3) Operator's manual with procedures for operating control systems: logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing setpoints and variables.
4) Programming manual or set of manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
5) Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware;

how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.

6) Documentation of programs created using custom programming language including setpoints, tuning parameters, and object database. Electronic copies of programs shall meet this requirement if control logic, setpoints, tuning parameters, and objects can be viewed using furnished programming tools.
7) Graphic files, programs, and database on magnetic or optical media.
8) List of recommended spare parts with part numbers and suppliers.
9) Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
10) Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation or web server software, and graphics software.
11) Licenses, guarantees, and warranty documents for equipment and systems.
12) Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.

D. Training and Materials
1. Provide course outline and materials for each class at least six weeks before first class. Commissioning Agent will modify course outlines and materials if necessary to meet Owner's needs. Commissioning Agent will review and approve course outlines and materials at least three weeks before first class.
a. Training shall be furnished via on-site, instructor-led classroom sessions at the Owner approved location.
b. Training shall consist of five (5), eight-hour training sessions for a total of 40 training hours. Total classroom training shall be 40 hours minimum. Owner shall include his/her selected personnel for training, not to exceed 10 people per training session.

## 1.5 INTEGRATED WITH THE WORK OF THIS SECTION

A. General: The Installer furnishing the DDC network shall meet with the Installer(s) furnishing each of the following products to coordinate details of the interface between these products and the DDC network. The Owner or his/her designated representative, the engineer and the commissioning agent shall be present at this meeting. Each Installer shall provide the Owner and all other Installers with details of the proposed interface including PICS for BACnet equipment, hardware and software identifiers for the interface points, network identifiers, wiring requirements, communication speeds, system graphics, point naming conventions, and required network accessories. The purpose of this meeting shall be to insure there are no unresolved issues regarding the integration of these products into the DDC network. Submittals for these products shall not be approved prior to the completion of this meeting.

## 1.6 QUALITY ASSURANCE

A. DDC System Manufacturer Qualifications:
1. Nationally recognized manufacturer of DDC systems and products.
2. DDC systems with similar requirements to those indicated for a continuous period of five years within time of bid.
3. DDC systems and products that have been successfully tested and in use on at least five past projects.

4. Having complete published catalog literature, installation, operation and maintenance manuals for all products intended for use.
5. Having full-time in-house employees for the following:
6. Technical support for DDC system installation training, commissioning and troubleshooting of installations.
7. Owner operator training.

B. DDC System Provider Qualifications:
1. Authorized representative of, and trained by, DDC system manufacturer.
2. In-place facility located within 40 miles of Project.
3. Demonstrated past experience with installation of DDC system products being installed for period within five consecutive years before time of bid.
4. Demonstrated past experience on five projects of similar complexity, scope and value.
5. Each person assigned to Project shall have demonstrated past experience.
6. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
7. Service and maintenance staff assigned to support Project during warranty period.
8. Product parts inventory to support on-going DDC system operation for a period of not less than 5 years after Substantial Completion.
9. DDC system manufacturer's backing to take over execution of Work if necessary to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's corporate officer, if requested.

## 1.7 SYSTEM PERFORMANCE

A. Performance Standards. System shall conform to the following minimum standards over network connections. Systems shall be tested using manufacturer's recommended hardware and software for operator workstation (server and browser for web-based systems).
1. Graphic Display. A graphic with 20 dynamic points shall display with current data within 10 sec.
2. Graphic Refresh. A graphic with 20 dynamic points shall update with current data within 8 sec. and shall automatically refresh every 15 sec.
3. Configuration and Tuning Screens. Screens used for configuring, calibrating, or tuning points, PID loops, and similar control logic shall automatically refresh within 6 sec.
4. Object Command. Devices shall react to command of a binary object within 2 sec. Devices shall begin reacting to command of an analog object within 2 sec.
5. Alarm Response Time. An object that goes into alarm shall be annunciated at each end user device (PDA, smartphone, etc.) within 15 sec.
6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 sec. Select execution times consistent with the mechanical process under control.
7. Performance. Programmable controllers shall be able to completely execute DDC PID control loops at a frequency adjustable down to once per sec. Select execution times consistent with the mechanical process under control.
8. Multiple Alarm Annunciation. Each workstation on the network shall receive alarms within 5 sec of other workstations.

## 1.8 WARRANTY

A. Warrant labor and materials for specified control system free from defects for a period of 12 months after final acceptance. Control system failures during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner. Respond during normal business hours within 24 hours of Owner's warranty service request.

B. Work shall have a single warranty date, even if Owner receives beneficial use due to early system start-up. If specified work is split into multiple contracts or a multi-phase contract, each contract or phase shall have a separate warranty start date and period.

C. If Engineer determines that equipment and systems operate satisfactorily at the end of final start-up, testing, and commissioning phase, Engineer will certify in writing that control system operation has been tested and accepted in accordance with the terms of this specification. Date of acceptance shall begin warranty period.

D. Provide updates to operator workstation or web server software, project-specific software, graphic software, database software, and firmware that resolve Contractor-identified software deficiencies at no charge during warranty period. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above-mentioned items. Do not install updates or upgrades without Owner's written authorization.

E. Exception: Contractor shall not be required to warrant reused devices except those that have been rebuilt or repaired. Installation labor and materials shall be warranted. Demonstrate operable condition of reused devices at time of Engineer's acceptance.

F. The ATCC shall provide support for operation of the system and improvements to energy usage to the Owner throughout the first year of operation, for no more than 80 hours.

## PART 2 - PRODUCTS (ROOF TOP UNIT VVT CONTROLS)

### 2.1 Materials

A. Use new products the manufacturer is currently manufacturing and selling for use in new installations. Do not use this installation as a product test site unless explicitly approved in writing by Owner. Spare parts shall be available for at least five years after completion of this contract.

### 2.2 Communication

A. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135-2004, BACnet.

B. Install new wiring and network devices as required to provide a complete and workable control network.

C. Use existing Ethernet backbone for network segments marked "existing" on project drawings.

D. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.

E. Internetwork operator interface and value passing shall be transparent to internetwork architecture.
   1. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, and status shall be viewable and editable from each internetwork controller.
   2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. An authorized

operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.

F. Controllers with real-time clocks shall use the BACnet Time Synchronization service. System shall automatically synchronize system clocks daily from an operator-designated controller via the internetwork. If applicable, system shall automatically adjust for daylight saving and standard time.

## 2.3 Operator Interface

A. Operator Interface. Furnish (3) Wall-Mtd. System Touch interface as shown on the system drawings. System Touch shall be able to access all necessary operational information in the DDC system. Operator interface shall allow each operator to execute the following functions as a minimum:
1. Log In and Log Out. System shall require user name and password to log in to operator interface.
2. View and Adjust Equipment Properties. Operators shall be able to view controlled equipment status and to adjust operating parameters such as set points, PID gains, on and off controls, and sensor calibration.
3. View and Adjust Operating Schedules. Operators shall be able to view scheduled operating hours of each schedulable piece of equipment on a weekly or monthly calendar-based graphical schedule display, to select and adjust each schedule and time period, and to simultaneously schedule related equipment. System shall clearly show exception schedules and holidays on the schedule display.
4. View and Respond to Alarms. Operators shall be able to view a list of currently active system alarms, to acknowledge each alarm, and to clear (delete) unneeded alarms. Remote users shall be able to receive alarms via emails or cell phone text messages.
5. View and Configure Trends. Operators shall be able to view a trend graph of each trended point and to edit graph configuration to display a specific time period or data range. Operator shall be able to create custom trend graphs to display on the same page data from multiple trended points.
6. Manage Control System Hardware. Operators shall be able to view controller status, to restart (reboot) each controller, and to download new control software to each controller.
7. Manage Operator Access. Typically, only a few operators are authorized to manage operator access. Authorized operators shall be able to view a list of operators with system access and of functions they can perform while logged in. Operators shall be able to add operators, to delete operators, and to edit operator function authorization. Operator shall be able to authorize each operator function separately.

## 2.4 Controller Software

A. Building and energy management application software shall reside and operate in system controllers. Applications shall be configurable through the operator workstation, web browser interface, or engineering workstation.

B. Memory and System Time. All controllers shall have a Non-Volatile Memory providing indefinite storage of application and configuration data. The system must have an ability to maintain time, and automatically correct for daylight savings time and leap year adjustments. In the event of power failure or user generated power cycle, all system components must automatically updated with current time and date from a network Time Sync device. The controller shall also have the capability of changing occupancy mode by reading a set of discrete, dry contacts controlled by an external time clock.

C. Stand alone capability. All controllers shall be capable of providing all control functions of the HVAC system without the use of a computer. The controllers shall include the inherent capability to access the system control selections as well as to monitor system performance by means of a communicating network with a PC and EMS software program.

D. System Security.
1. Wall mounted local interface device shall be password protected with minimum of two levels of security. Level one shall provide limited access to controller operational parameters and level two shall provide full access to controller operational and configuration parameters.

E. Scheduling.
1. System shall provide the following schedule options as a minimum:
2. Weekly. Provide separate schedules for each day of the week. Each schedule shall be able to include up to 5 occupied periods (5 start-stop pairs or 10 events).
3. Exception. Operator shall be able to designate an exception schedule for each of the next 365 days. After an exception schedule has executed, system shall discard and replace exception schedule with standard schedule for that day of the week.
4. Holiday. Operator shall be able to define 24 special or holiday schedules of varying length on a scheduling calendar that repeats each year.

F. Binary and Analog Alarms. See Paragraph 2.3.G.7 (Alarm Processing).

G. Sequencing. Application software shall sequence Air-Handling Units, Zone & Bypass Dampers as specified in Sequence of Operations for HVAC Controls.

H. PID Control. System shall provide direct- and reverse-acting PID (proportional-integral-derivative) algorithms. Each algorithm shall have anti-windup and selectable controlled variable, setpoint, and PID gains. Each algorithm shall calculate a time-varying analog value that can be used to position an output or to stage a series of outputs.

I. Staggered Start. System shall stagger controlled equipment restart after power outage. Operator shall be able to adjust equipment restart order and time delay between equipment restarts.

J. Anti-Short Cycling. Binary output objects shall be protected from short cycling by means of preconfigured minimum on-time and off-time settings, customized for the specific requirements of the application.

K. On and Off Control with Differential. System shall provide direct- and reverse-acting on and off algorithms with adjustable differential to cycle a binary output based on a controlled variable and setpoint.

L. Zoning system compatible with constant volume air source (Variable Volume/Variable Temperature) (VVT). The zoning system shall be compatible with constant volume air source and consist of programmable, multiple communicating Zone Controllers and a Bypass Controller. The system shall also include a complete array of input and output devices. The system shall provide full control of HVAC heating and cooling equipment in a multiple zone application. The zoning system shall be capable of operating as a stand-alone system or networked with multiple systems to communicating air source controllers.
1. Zone control. Each zone shall be capable of monitoring space conditions and providing the correct amount of conditioned air to satisfy the space load. Each zone shall be capable of the following:
a. Space temperatures control. To maintain individual heating and cooling set points.

b. Relative Humidity/Air Quality (DCV). Each zone shall be capable of maintaining space relative humidity set point or air quality set point (zone level demand control ventilation) as defined in ASHRAE 62-1989 (including Addendum 62a-1990).
c. Demand coordination. Each zone shall be capable of zone demand data coordination with other zones in the system.

2. Static pressure control. The zoning system shall be capable of maintaining a user adjustable supply air duct static pressure set point.
   a. The Bypass controller shall additionally provide the capability to increase system airflow during conditions when the temperature of the supply air from the equipment is approaching the limits of operation. In these cases, the Bypass controller shall raise the static pressure setpoint to a user configurable maximum limit in order to increase the system airflow during these conditions.
   b. The Bypass control shall contain the ability to monitor the bypass damper movement (or VFD speed) and automatically adjust the setpoint control band and/or hysteresis in order to provide stability and prevent premature actuator failure.
3. Air source control. Shall control all associated HVAC rooftop equipment functions, and be capable of stand-alone or networked operation. The resident algorithms shall use error reduction logic as designated in ASHRAE standard 90.1 to provide temperature control and lower energy usage. The Air source shall be capable of zone demand data coordination with the associated zones.
4. System Terminal Modes. Each air terminal mode shall be based on the current air source mode, terminal type, space temperature, and the current temperature set points.
   a. Off:
      1) All terminal dampers will maintain a 65% open position. Fans shall be disabled.
      2) If the zone requirement is heating, all single duct terminals shall maintain their damper position at 65%. Any zone controller servicing a parallel box shall fully close their dampers while the fan is operating. If local heat is available, the parallel fans shall start and local heat shall be enabled to maintain its unoccupied heating set point. The damper shall be modulated open to 65% after heating is no longer required.
   b. Cooling and Night Time Free Cooling (NTFC):
      1) If the zone requirement is none, then the zone controllers shall modulate their dampers to maintain their minimum cooling damper position or damper ventilation position if the supply air temp is between 65 and 75 F. During the NTFC mode the zone controller shall control between its occupied heating and cooling set points. During the cooling mode, the zone controller shall modulate its damper to its appropriate (occupied or unoccupied) cooling set point.
      2) If the zone requirement is cooling, then the zone controllers shall modulate their air dampers between their minimum and maximum cooling damper position to maintain their cooling set point. Parallel fans shall be disabled unless the damper has closed below the user adjustable fan-on minimum position (optional). In that case, the fan shall be energized to mix return air with the cold primary air in order to prevent “cold air dumping” from the diffusers.
      3) If the zone requirement is heating, then the zone controllers shall modulate their dampers to maintain their minimum cooling damper position. Any zone controllers servicing single duct units with reheat capability shall maintain the greater of either the minimum cooling damper position or the specified reheat damper position. Zone controllers servicing parallel units shall enable their fans while the damper shall maintain its minimum cooling damper position.
   c. Vent:

1) If the air source equipment is operating in a fan only mode to provide ventilation without mechanical heating or cooling, then the zone controllers shall maintain the user configured ventilation damper position.

d. Heat:
1) If the zone requirement is none, then the zone controller shall maintain its minimum heating damper position. Parallel fans shall be disabled and their air damper shall be modulated to maintain their minimum heating damper position.
2) If the zone requirement is cooling, then the zone controller shall modulate its damper to maintain its minimum heating damper position. Parallel fans shall be disabled.
3) If the zone requirement is heating, then the zone controllers shall modulate their air dampers between their minimum and maximum heating damper position to maintain their heating set point.

e. Pressurization:
1) If the zone requirement is none or cooling, then the zone controller shall maintain its maximum cooling damper position. Parallel fans shall be disabled.
2) If the zone requirement is heating, and the zone controller has been enabled to provide local heating, then the zone controller shall modulate its damper to its maximum cooling damper position and enable its auxiliary heat. If local heat is not available, the damper shall still be modulated to maintain its maximum cooling damper position.

f. Evacuation:
1) During the Evacuation mode all terminal fans shall be disabled and all dampers shall close.

5. Air source interface. The zoning system shall be capable of zone demand data coordination with a communicating rooftop. Setpoint and zone temperature information from the zones shall be shared with the rooftop controller so that the rooftop controller's error reduction calculations can determine the proper number of heating or cooling stages to operate in order to satisfy the system load.
a. The zoning system shall have the capability of linking up to 32 zones to a single air source and determining system heating and cooling requirements.
b. The zoning system shall be capable of providing a communication check of all associated controls and display device type as well as error conditions.
c. The zoning system shall coordinate and exchange the flowing data as minimum:
1) Average zone temperature
2) Average occupied zone temperature
3) Average occupied and unoccupied heat/cool set points
4) Occupancy status
d. Space temperature and space temperature set points for use by the air source controller shall include a weighted factor, proportional to the size of the zone.
e. Only those zones with valid temperature readings shall be included.
f. The zoning system shall provide periodic updates to the air source.
g. The zoning system shall obtain and support the following air source modes as a minimum:
1) Off
2) Cooling
3) Heating
4) Night Time Free Cooling
5) Ventilation
6) Pressurization
7) Evacuation
h. The air source controller shall, through the Air Distribution System, bias its occupancy time schedules to provide optimization routines and occupant override.

i. For those zoning systems that do not include inherent air source interface capacity, each zone shall independently determine the operational mode of the equipment through its associated duct temperature sensor mounted in the supply ductwork. If there is air source controller, then the system will assumed to be always On.

6. HVAC Equipment Protection. The air sources controller shall be capable of monitoring the leaving air temperature to control stages in both the heating and cooling modes. It shall have the capability to shut down stages based on a rise or fall in leaving air temperature above or below adjustable or calculated values. Calculated supply air temperature requirements shall be based on error reduction calculations from reference zone data to determine the optimum supply air temperature to satisfy space requirements. The system shall provide protection from short cycling of heating and cooling by utilizing time guards and minimum run time configurations.
7. Energy Conservation.
   a. Load balancing from error reduction calculations that optimize staging.
   b. The locking out of mechanical heating or cooling modes based on configurable outside air temperature limits.
   c. Staggered start. The system shall intelligently start all equipment in a stagger start manner after a transition from unoccupied to occupied modes as well as power failure to reduce high peak power consumption on start-up.
   d. Peak Demand Limiting. Controllers in the system shall have the capability of being overridden by separate heating and cooling Peak Demand Limiting signals. Option/General purpose controller existing on the communications bus shall be able to send a demand limiting broadcast to reduce overall energy consumption and control on and off peak time kW usage
   e. Temperature compensated start. The zone controller shall be capable of supporting temperature compensated start with the air source. Prior to occupancy the zone controllers and Air Source shall work together to provide zone-by-zone temperature compensated conditioning. The air source will track the time required for recovery report the optimal start bias time to the zones prior to each occupied period so that the zone can start conditioning the space prior to occupancy.
8. Demand Control Ventilation (DCV). The zone shall be capable of reading an analog signal from a CO2 sensor or other sensor measuring volatile contaminants, or relative humidity and provide DCV at the zone by calculating a DCV damper position and participate in system DCV operation with the air source
   a. System DCV (System Level).The zoning system shall have the ability to collect the DCV value from any or all of the zone controllers in the system. These values may be the average or the highest sensor value which will be transmitted to an air source controller's analog DCV sensor input. The air sources configured DCV routine may perform the appropriate actions to reduce CO2 concentration at the reporting zones. The system shall be capable of maintaining a ventilation setpoint through a DCV algorithm in conjunction with zone to fulfill the requirements of ASHRAE standard, 62-1989 "Ventilation For Acceptable Indoor Air Quality" (including Addendum 62a-1990)..
   b. Local DCV (Zone Level). Each zone shall be capable of reading an analog signal from a CO2 sensor or other sensors measuring volatile contaminants and maintaining a ventilation setpoint through a DCV algorithm in conjunction with system controller to fulfill the requirements of ASHRAE standard, 62-1989 "Ventilation For Acceptable Indoor Air Quality" (including Addendum 62a-1990). The zone shall calculate a DCV damper position for the zone based on an error reduction calculation. When the DCV damper position value is greater than temperature control damper position the DCV damper position shall be used to position the damper. System heating and cooling and zone supplemental heat shall be allowed to operate.

9. Abnormal Conditions. The proposed system shall include the ability to detect abnormal conditions, and to react to them automatically. A return to normal conditions shall also generate a return to normal notification and the system shall revert back to its original control scheme before the abnormal condition existed. The following abnormal terminal conditions shall automatically generate an alarm and the system shall take the following actions:
    a. If a space temperature sensor is determined by the zone controller to be invalid, the zone controller shall generate an alarm. During this condition, the zone damper will be positioned to either the minimum heating, minimum cooling or the configured ventilation damper position, based on the air source equipment operating mode.
    b. If a relative humidity sensor is determined by the zone controller to be invalid, the zone controller shall generate an alarm.
    c. If an indoor air quality sensor is determined by the zone controller to be invalid, the zone controller shall generate an alarm, and disable its IAQ algorithm.
    d. System level demand coordination. If an air source controller is participating in demand coordination with other zones and loses communication with the associated zones, it shall generate an alarm. Likewise, any zone detecting a communication failure, will generate an alarm.
    e. Zone level demand coordination. If the system looses communication with one of the zones associated with that system the zoning system shall remove that zone temperature from its weighted averages. The zone controller shall continue to operate in a stand-alone mode.
    f. If the zoning system if configured to interface with the air source for zone demand data coordination and that communication is broken, each zone controller shall determine the equipment operating mode based on the temperature of the primary air. The air source will be assumed to be always on.

**2.5 Controllers**

A. General. The control system shall be available as a complete package with the required input sensors and devices readily available. Provide Building Controllers (BC), Advanced Application Controllers (AAC), Application Specific Controllers (ASC), and Sensors (SEN) as required to achieve performance specified in Paragraph 2.4.

B. Every device in the system which executes control logic and directly controls HVAC equipment must conform to a standard BACnet Device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L. Unless otherwise specified.

C. BACnet Communication
    1. Each BC shall reside on or be connected to a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing.
    2. BACnet routing shall be performed by BCs or other BACnet device routers as necessary to connect BCs to networks of AACs and ASCs.
    3. Each AAC shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using the MS/TP Data Link/Physical layer protocol.
    4. Each ASC shall reside on a BACnet network using the MS/TP Data Link/Physical layer protocol.

D. Communication.
    1. Service Port. Each controller shall provide a service communication port for connection to a Portable Operator's Terminal. Connection shall be extended to space temperature sensor ports where shown on drawings.

2. Signal Management. BC and ASC operating systems shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and to allow for central monitoring and alarms.
3. Data Sharing. Each BC and AAC shall share data as required with each networked BC and AAC.
4. Stand-Alone Operation. Each piece of equipment shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network.

E. Environment. Controller hardware shall be suitable for anticipated ambient conditions.
1. Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).
2. Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).

F. Keypad. Where specified provide a local keypad and display for each BC and ASC. Operator shall be able to use keypad to view and edit data. Keypad and display shall require password to prevent unauthorized use. If the manufacturer does not normally provide a keypad and display for each BC and ASC, provide the software and any interface cabling needed to use a laptop computer as a Portable Operator's Terminal for the system.

G. Serviceability.
1. Controllers shall have diagnostic LEDs for power, communication, and processor.
2. Wires shall be connected to a field-removable modular terminal strip or to a termination card connected by a ribbon cable.
3. All controllers in the system shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.

H. Memory.
1. Controller memory shall support operating system, database, and programming requirements.
2. Each controller in the system shall use nonvolatile memory providing indefinite storage of BIOS, application programming, and all configuration data in the event of power loss.

I. Immunity to Power and Noise. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).

J. Zone Controller (ZC). Defined as Application Specific Controllers (ASC) shall be capable of independent zone control or function as part of the zoning system to achieve performance as specified for zone control in Paragraph 2.4.
1. Input and output devices shall be wired to “quick-connect plug type” terminals to facilitate removal of the module without disconnecting wiring from the plug type terminal.
2. ZC shall have an integrated brushless actuator and be capable of operating zone dampers as well as parallel fan powered terminal boxes.
3. ZC shall be capable of controlling supplemental heat or auxiliary heat sources, including fan control, when required at the zone level.
4. The zone controller shall have the capability to support adjustable minimum and maximum damper positions.

5. ZC shall be capable of reading an analog signal from a CO2 sensor or other sensor measuring volatile contaminants, or relative humidity and provide DCV at the zone by calculating a DCV damper position and participate in system DCV operation with the air source.

K. Bypass Controller. Defined as Application Specific Controllers (ASC) shall be capable of reading supply static pressure and controlling the bypass damper (or a VFD speed control output) to maintain the supply static set point. This operation shall be provided when operating within a zoning system application, as specified for bypass control in Paragraph 2.4 or in a stand-alone mode.
1. Input and output devices shall be wired to “quick-connect plug type” terminals to facilitate removal of the module without disconnecting wiring from the plug type terminal.
2. The controller shall contain an onboard pressure sensor to measure duct static pressure. The sensor measuring range shall be from 0.0 to 2.0 inches H2O.
3. Bypass Controller shall have an integrated brushless actuator providing a minimum of 35 in/lbs of torque and be capable of operating a bypass damper. The direction of rotation shall be reversible in the field to accommodate field supplied bypass damper assemblies.
4. Bypass Controller shall provide an analog output signal for an external actuator or to control the speed of a variable frequency drive (VFD).

L. Rooftop Unit Controller (RTC). Defined as Application Specific Controllers (ASC), shall control all associated HVAC Constant Volume rooftop equipment functions, this operation shall be provided when operating within a zoning system application, as specified for an air source control, in Paragraph 2.4 or in a stand-alone mode. The resident algorithms shall use error reduction logic as designated in ASHRAE standard 90.1 to provide temperature control and energy usage.
1. Capacity control shall be based on the use of a conventional thermostat, or programmable thermostat, or alternatively, a constant volume unit may utilize its own internal time clock and setpoints (cooling and heating) coupled with a room (wired or network communicating) sensor for capacity control. The controls shall provide separate occupied and unoccupied cooling and heating setpoints – except if a conventional thermostat is used.
2. RTC shall feature and maintain a 365-day Real-Time Clock/Calendar with holiday functions.
3. RTC shall be capable of stand-alone or networked operation.
4. In the stand alone mode, each RTC shall establish occupancy scheduling based on its own local occupancy schedule, the closure of a contact connected to an external time clock or EMS system, or by a timed override request (1 to 24 hours) through its space temperature sensor override button.
5. When networked, RTC occupancy may be established by user interface or occupancy signal from other controller located in network.
6. RTC shall utilize fan control, 2 stages of cooling, and up to 3 stages of heating to maintain zone temperature at setpoint.
7. RTC shall provide analog output signal for economizer control.
8. Field supplied and installed devices. The installer shall provide one or more of the following sensors as shown on the plans:
    a. Compatible Space Temperature Sensor. The space temperature sensor shall be field-supplied for field installation as shown on the plans. The sensor shall contain:
        1) If required remote occupant override button
        2) Remote communication port
        3) If required a setpoint adjustment.
        4) If required LCD display.
    b. Indoor Air Quality (IAQ) Sensor: The filed-supplied and field-mounted and wired sensor utilize an infrared diffusion sampling tube with a range of 0 to 2000 PPM

and shall include indicating LED's.

M. General Purpose Controller. Defined as Advanced Application Controllers (AAC) the General Purpose Controller shall be a solid state micro-controller with pre-tested and factory configured software designed for controlling building equipment using DDC algorithms and facility management routines. The controller shall be capable of operating in either a stand-alone mode or as part of a network.
   1. Input and output devices shall be wired to "quick-connect plug type" terminals to facilitate removal of the module without disconnecting wiring from the plug type terminal.
   2. Inputs. Shall support the following input types as a minimum
      a. Dry or pulsed dry contacts
      b. 0-5 VDC
      c. 0–10 VDC
      d. 4–20 mA
      e. 10K thermistors
      f. 1000-ohm Nickel RTD
   3. Outputs. Shall support the following input types as a minimum
      a. Discrete types
      b. 0–10 VDC analog type
      c. 4–20 mA analog type
   4. Real-Time Clock. Shall feature and maintain a 365-day hardware clock/calendar with holiday functions.
   5. Direct digital control routines. The following types of direct digital control routines shall be provided as a minimum:
      a. Indoor/Outdoor Lighting Control
      b. Time Schedule with/without override
      c. Enthalpy/Analog Comparison
      d. Analog Comparison
      e. Interlock / Permissive Interlock
      f. Fan Control
      g. Time Schedule with/without override
      h. Unit Heater
      i. Constant Volume Air Source control
      j. WSHP Loop Monitor and Pump Control
      k. Electric Meter with Demand Limit

**2.6 Input and Output Interface**

A. General. Hard-wire input and output points to BCs, AACs, or ASCs.

B. Protection. Shorting an input or output point to itself, to another point, or to ground shall cause no controller damage. Input or output point contact with up to 24 V for any duration shall cause no controller damage.

C. Binary Inputs. Binary inputs shall monitor the on and off signal from a remote device. Binary inputs shall provide a wetting current of at least 12 mA and shall be protected against contact bounce and noise. Binary inputs shall sense dry contact closure without application of power external to the controller.

D. Pulse Accumulation Inputs. Pulse accumulation inputs shall conform to binary input requirements and shall accumulate up to 10 pulses per second.

E. Analog Inputs. Analog inputs shall monitor low-voltage (0-10 Vdc), current (4-20 mA), or resistance (thermistor or RTD) signals. Analog inputs shall be compatible with and field configurable to commonly available sensing devices.

F. Binary Outputs. Binary outputs shall send an on-or-off signal for on and off control. Building Controller binary outputs shall have three-position (on-off-auto) override switches and status lights. Outputs shall be selectable for normally open or normally closed operation.

G. Analog Outputs. Analog outputs shall send a modulating 0-10 Vdc or 4-20 mA signal as required to properly control output devices. Each Building Controller analog output shall have a two-position (auto-manual) switch, a manually adjustable potentiometer, and status lights. Analog outputs shall not drift more than 0.4% of range annually.

H. Universal Inputs and Outputs. Inputs and outputs that can be designated as either binary or analog in software shall conform to the provisions of this section that are appropriate for their designated use.

## 2.7 Auxiliary Control Devices

A. Zone Dampers. Each Zone Damper shall include:
1. A motorized damper assembly constructed of 24 gage galvanized iron with blade of 20 gage.
2. Blade operation providing full modulation from open to closed position.
3. The ability to operate in a controlling/link arrangement, where the controlling damper is operated by the zone controller. The zone controller shall provide a separate 0-10 vdc output proportional to the controlling damper position (available only if no modulating heat is used) to be used to link additional zone dampers. These additional dampers will track the position of the controlling damper and modulate to the same position as the controlling damper. The number of additional dampers are dependent upon the load of each field supplied damper actuator and the external output drive capability.
4. Round dampers shall have elliptical blades with a seal around the entire damper blade edge. Rectangular dampers shall have fully sealed edges.
5. A duct temperature sensor shall be an integral part of the damper assembly.

B. Ventilation Sensors Duct-Mounted Carbon Dioxide Sensor.
1. Carbon Dioxide (CO2) sensors for duct-mounted applications shall be identical to the wall-mounted sensors specified above except as described below.
2. The CO2 sensor shall be mounted in an enclosed aspirator box that mounts directly to the duct. The aspirator box shall be equipped with an induction tube to direct a side-stream of air from the duct through the CO2 sensor. A hinged, clear access door shall be installed on the front of the aspirator box to permit access to the sensor and to permit viewing the sensor without opening the door.
3. CO2 sensors for duct-mounted applications shall be designed for flow-through sampling.

C. Temperature Sensors.
1. Type. Temperature sensors shall be nominal 10K ohm thermistor type.
2. Duct Sensors. Duct sensors shall be single point or averaging as shown. Averaging sensors shall be a minimum of 1.5 m (5 ft) in length per 1 $m^2$(10 $ft^2$) of duct cross-section.
3. Space Sensors. Space sensors shall have setpoint adjustment, override switch, display, and communication port as shown.

D. Voltage Transformers.

1. AC voltage transformers shall be UL/CSA recognized, 600 Vac rated, and shall have built-in fuse protection.
2. Transformers shall be suitable for ambient temperatures of 4°C-55°C (40°F-130°F) and shall provide ±0.5% accuracy at 24 Vac and 5 VA load.
3. Windings (except for terminals) shall be completely enclosed with metal or plastic.

**END OF SECTION 230923**

# SECTION 230993.11 - SEQUENCE OF OPERATIONS FOR HVAC DDC

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes control sequences for HVAC systems, subsystems, and equipment.

### 1.2 SPLIT SYSTEM AIR CONDITIONING ONLY UNIT (AHU-1/ODU-1)

A. General

1. Cooling mode

a. When the thermostat calls for cooling the condensing unit shall engage, the wall mount air handler fan shall run, and the DX cooling coil shall cool the air to maintain temperature setpoint. When the setpoint is reached the condensing unit shall shut off (unoccupied mode only).

2. Ventilation

a. The energy recovery ventilator shall run during occupied mode to provide fresh air and exhaust per 2015 OMC section 403 building ventilation air. The energy recovery ventilator shall be controlled by the timeclock. The timeclock will operate the energy recovery ventilator to run during business hours on a scheduled time frame.

3. Temperature Setpoint

a. Occupied Mode

1) Cooling: 68° F (adjustable)

b. Unoccupied Mode

1) Cooling: 74° F (adjustable)

### 1.3 ROOFTOP UNITS (RTU-1, RTU-5)

A. General

1. Heating mode

a. Roof top unit shall be controlled from a remote sensor/ thermostat in the space. When the thermostat calls for heating the fan shall run and the gas fired heat exchanger shall fire to maintain temperature setpoint. When the setpoint is reached the heat exchanger shall shut off.

2. Cooling mode

    a. When the thermostat calls for cooling the roof top unit shall engage, the Roof Top Unit fan shall run, and the DX cooling coil shall cool the air to maintain temperature setpoint. When the setpoint is reached the compressors shall shut off. The thermostat shall be on a night set back (occupied and unoccupied schedule).

3. Economizer

    a. Economizer shall be set to meet required the code minimum fresh air. When in occupied mode the economizer shall open to minimum position. If the outside air enthalpy is below the enthalpy setpoint of 28 Btu/lb of dry air (adjustable) and the thermostat calls for cooling, the economizer damper shall be enabled and shall modulate to provide additional outside air for space cooling.

4. Temperature setpoint

    a. Occupied mode

        1) Heating: 72° F (adjustable)

        2) Cooling: 74° F (adjustable)

    b. Unoccupied mode

        1) Heating: 60° F (adjustable)

        2) Cooling: 80° F (adjustable)

## 1.4 ROOF TOP UNIT (RTU-2, RTU-3, RTU-4)

A. General

1. Rooftop units shall include BACnet-compatible system for control of packaged Rooftop Units, VVT Zone Controllers & Bypass Dampers. Rooftop units include system controllers w/integral Operator Interface that serve the unit's DX cooling, gas heating, fan, etc. All devices communicate with one another via a 22Ga., 2-wire (shielded) communication bus Variable Volume and Temperature (VVT). New wall-mtd. System Touch Interface (SYST1-4-CAR) shall be provided for monitoring and setpoint & time schedule adjustments. All setpoints shown in this sequence of operation may be adjusted though the System Touch Interface
2. OCCUPIED & UNOCCUPIED OPERATION:
    a. Unit shall be scheduled for occupied/unoccupied 7-day and holiday operation. An unoccupied override pushbutton (on wall-mounted temperature sensor) will force that individual zone to occupied mode for 2 hours (adjustable).
    b. Occupied setpoints are preset at 74 ºF for cooling and 70 ºF for heating, adjustable for up to + / - 3 ºF from a space temperature sensor slidebar setpoint adjustment. Unoccupied setpoints are preset at 80 ºF for cooling and 60 ºF for heating.
    c. During the occupied mode, the fan is operational. During the unoccupied mode the unit fan shall cycle based on a call for unoccupied cooling or heating.
    d. During unoccupied mode, the RTU fan will cycle on based on a call for unoccupied cooling or heating and remain off when satisfied. RTU will operate off of the unoccupied cooling & heating setpoints of 80 °F and 60 °F for all zones (adjustable). System will to run until space temperature lowers (cooling mode) or raises (heating mode) by 4 ºF.
3. SYSTEM MODE DETERMINATION:
    a. This system mode (heat or cool) is chosen by calculating the average heat and cool demands between all zones (difference between setpoint & actual space temperature).

NOTE: Each zone may be designated a priority level, which will allow for a "weighted" average demand for larger or more critical zones.

b. When the average cooling demand rises to 0.7 ºF above setpoint, the unit shall enter cooling mode. When the average heating demand falls to 0.7 ºF below setpoint, the unit shall enter heating mode. If both average heating and cooling demands are above 0.7 ºF, the highest demand will determine the mode. Once a mode is selected, it will remain in that mode until either the average zone demand reaches setpoint or the opposite mode demand is higher (after a minimum 30 minute run time).

4. HVAC UNIT CONTROL:
   a. Once a system mode is determined, the VVT System will communicate with the Carrier OPEN RTU Controller to enable heating or cooling. The RTU Controller will utilize PID logic to stage heating or cooling based on average demand.
   b. The unit will always maintain a minimum supply temperature of 50 ºF during cooling mode and a maximum supply temperature of 140 ºF during heating mode. Economizer control will be utilized for free cooling during cooling mode when outdoor temperatures are suitable. Heating and/or cooling may be locked out based on outdoor temperature lockout setpoints if desired.
   c. When outdoor temp is not suitable, economizer damper shall be at minimum ventilation position and mechanical cooling will be staged to maintain occupied space temperature cooling setpoint. When outdoor temp is suitable, return air shall be exhausted and unit shall bring in additional outdoor air. If outdoor damper reaches 100% and space temperature setpoint cannot be met, damper will remain open and mechanical cooling will be enabled.
5. ZONE DAMPER CONTROL:
   a. Each zone will have a minimum damper position for ventilation purposes. When a zone's temperature rises above its cooling setpoint and the overall system mode is cooling, the zone damper shall modulate to maintain cooling setpoint. If the zone's temperature is below its heating setpoint and the overall system mode is heating, the zone damper shall modulate to maintain heating setpoint.
   b. When no system mode is present and the supply air temperature is acceptable (65-75 ºF), the zone damper will open beyond the minimum position to the ventilation position to provide additional ventilation to the space.
6. BYPASS DAMPER CONTROL:
   a. The Bypass Controller shall work in conjunction with all Zone Controllers to maximize the amount of supply air in the duct system and to prevent inadequate air flow through the HVAC unit.
   b. The Bypass Controller shall preposition its damper(s) to the maximum open position prior to system startup. The static pressure will be regulated from minimum system pressure during startup to maximum system pressure during normal operating conditions. During changeover mode, the Bypass Controller shall open the bypass dampers to pre-condition the supply air temperature if it is counterproductive for use by any zone.
   c.
7. Economizer
   a. Economizer shall be set to meet required the code minimum fresh air. When in occupied mode the economizer shall open to minimum position. If the outside air enthalpy is below the enthalpy setpoint of 28 Btu/lb of dry air (adjustable) and the thermostat calls for cooling, the economizer damper shall be enabled and shall modulate to provide additional outside air for space cooling.
8. CO2 MONITORING
   a. Install carbon dioxide (CO2) sensor in the main return duct. CO2 sensor will communicate to control panel then Economizer damper shall open to minimum position of 10% airflow

when CO2 concentration are below 1,000 PPM (adjustable). If levels exceed 1,000 PPM damper shall open to design ventilation air quantity.

9. Temperature setpoint
    a. Occupied mode
        1) Heating: 72° F (adjustable)
        2) Cooling: 74° F (adjustable)
    b. Unoccupied mode
        1) Heating: 60° F (adjustable)
        2) Cooling: 80° F (adjustable)

## 1.5 EXHAUST FANS

A. E-1: Exhaust fan shall operate through a timeclock. Coordinate runtime schedule with the Owner. During occupied hours exhaust fan shall run. During unoccupied hours exhaust fan shall be off.

B. E-2: Exhaust fan shall operate through a timeclock. Coordinate runtime schedule with the Owner. During occupied hours exhaust fan shall run. During unoccupied hours exhaust fan shall be off.

C. E-3: Exhaust fan shall operate through wall mounted line voltage thermostat. Thermostat shall be set in accordance with the server equipment requirements.

PART 2 - **PRODUCTS** (Not Applicable)

PART 3 - **EXECUTION** (Not Applicable)

**END OF SECTION 230993.11**

# SECTION 232300 - REFRIGERANT PIPING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Refrigerant pipes and fittings.
2. Refrigerant piping valves and specialties.
3. Refrigerants.

### 1.2 SUBMITTALS

A. Refer to specification 230100 – General Requirements for HVAC.

### 1.3 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-410A:

1. Refer to manufacturer requirements for suction and liquid line pressures.

### 2.2 COPPER TUBE AND FITTINGS

A. Copper Tube: 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. Working Pressure Rating: Factory test at minimum 500 psig.
4. Maximum Operating Temperature: 250 deg F.

## 2.3 VALVES AND SPECIALTIES

A. General:

1. Verify operating and max temperature and pressures with equipment manufacturers. Refer to manufacturer's installation manual for connection dimensions and types.

B. Check Valves:

1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.

C. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.

D. Solenoid valves in "Solenoid Valves" Paragraph below are made normally closed or normally open. Normally closed are direct acting and pilot operated. Holding coils are available in several voltages.

E. Solenoid Valves: Comply with AHRI 760 and UL 429; listed and labeled by a National Recognized Testing Laboratory (NRTL).

1. Body and Bonnet: Plated steel.
2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location.

F. Safety Relief Valves: Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
2. Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.

G. Thermostatic Expansion Valves: Comply with AHRI 750.

1. Body, Bonnet, and Seal Cap: Forged brass or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.

4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
5. Superheat: Adjustable.
6. Reverse-flow option (for heat-pump applications).
7. End Connections: Socket, flare, or threaded union.

H. Straight-Type Strainers:

1. Body: Welded steel with corrosion-resistant coating.
2. Screen: 100-mesh stainless steel.
3. End Connections: Socket or flare.

I. Angle-Type Strainers:

1. Body: Forged brass or cast bronze.
2. Drain Plug: Brass hex plug.
3. Screen: 100-mesh monel.
4. End Connections: Socket or flare.

J. Moisture/Liquid Indicators:

1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in parts per million (ppm).
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.

K. Replaceable-Core Filter Dryers: Comply with AHRI 730.

1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Refer to manufacturer recommendations
4. Designed for reverse flow (for heat-pump applications).
5. Access Ports: Connections at entering and leaving sides for pressure differential measurement.
6. End Connections: Socket.

L. Permanent Filter Dryers: Comply with AHRI 730.

1. Body and Cover: Painted-steel shell.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Refer to manufacturer recommendations.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: Connections at entering and leaving sides for pressure differential measurement.

## 2.4 REFRIGERANTS

A. ASHRAE R-410A

## PART 3 - EXECUTION

### 3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Suction Lines: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with soldered joints.

B. Hot-Gas, Liquid Lines, and Suction Lines: Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with soldered joints.

C. Safety-Relief-Valve Discharge Piping: Copper, Type ACR drawn-temper tubing and wrought-copper fittings with soldered joints.

### 3.2 PIPING INSTALLATION

A. Install refrigerant piping according to ASHRAE 15.

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 adjacent to machines to allow service and maintenance.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Select system components with pressure rating equal to or greater than system operating pressure.

I. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

J. 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.

K. Install refrigerant piping in protective conduit where installed belowground.

L. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

M. 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.

N. 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.

O. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

P. Identify refrigerant piping and valves according to Section 230553 "Identification for HVAC Piping and Equipment."

Q. Install sleeves for piping penetrations of walls, ceilings, and floors.

R. Install sleeve seals for piping penetrations of concrete walls and slabs.

S. Install escutcheons for piping penetrations of walls, ceilings, and floors.

## 3.3 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 BAg (cadmium-free silver) alloy for joining copper with bronze or steel.

## 3.4 HANGERS AND SUPPORTS

A. Coordinate hanger type in field. Install at intervals that satisfy pipe and equipment manufacturer recommendations.

B. Support multi-floor vertical runs at least at each floor.

## 3.5 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.

## 3.6 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. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up.
4. Charge system with a new filter-dryer core in charging line.

## 3.7 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**

# SECTION 233113 - METAL DUCTS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
1. Rectangular ducts and fittings.
2. Round ducts and fittings.
3. Flat Oval double wall duct and fittings.
4. Sheet metal materials.
5. Sealants and gaskets.
6. Hangers and supports.

### 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."

B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

### 1.3 SUBMITTALS

A. Refer to specification 230100 – General Requirements for HVAC.

## 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."

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."

C. 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."

D. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

E. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

F. 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."

## 2.3 . FLAT OVAL DOUBLE WALL DUCT AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct."

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."

C. 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."

D. Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

E. Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

F. Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees."

## 2.5 SHEET METAL MATERIALS

G. 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.

H. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

## 2.6 . SEALANT AND GASKETS

I. General Sealant and Gasket Requirements: Ductwork to be sealed through the use of tapes, mastics, liquid sealants, gasketing, or other approved means to help limit air loss. Seal all ductwork, including supplies and return grilles, during construction to prevent dust and debris from entering the distribution system. Seal connections between ductwork/ equipment and ductwork/ air device/ drywall to maintain minimal duct leakage.

## 2.7. HANGERS AND SUPPORTS

J. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

K. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

L. 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."

M. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

N. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

O. 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.

P. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

Q. 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. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

B. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

C. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.

### 3.2 DUCT SEALING

A. Seal ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

### 3.3 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

### 3.4 CONNECTIONS

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

### 3.5 START UP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

**END OF SECTION 233113**

## SECTION 233116 - NONMETAL DUCTS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
1. Fibrous-glass ducts and fittings.
2. Phenolic-foam ducts and fittings.

B. Related Sections:
1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for nonmetal ducts.
2. Section 233113 "Metal Ducts" for single- and double-wall, rectangular and round ducts.
3. Section 233119 "HVAC Casings" for factory- and field-fabricated casings for mechanical equipment.
4. Section 233300 "Air Duct Accessories" for dampers, duct-mounting access doors and panels, turning vanes, and flexible ducts.

### 1.2 PERFORMANCE REQUIREMENTS

A. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

### 1.3 ACTION SUBMITTALS

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

B. LEED Submittals:
1. Product Data for Prerequisite IEQ 1: Documentation indicating that duct systems comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
2. Product Data for Prerequisite EA 2: Documentation indicating that duct systems comply with ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
3. Duct-Cleaning Test Report for Prerequisite IEQ 1: Documentation of work performed for compliance with ASHRAE 62.1, Section 7.2.4 - "Ventilation System Start-up."
4. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
5. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings:
1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Duct layout indicating sizes and pressure classes.
3. Elevation of top of ducts.
4. Dimensions of main duct runs from building grid lines.
5. Fittings.
6. Reinforcement and spacing.
7. Seam and joint construction.
8. Penetrations through fire-rated and other partitions.
9. Equipment installation based on equipment being used on Project.

10. Hangers and supports, including methods for duct and building attachment and vibration isolation.

## 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."

C. NFPA Compliance:
   1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
   2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

# PART 2 - PRODUCTS

## 2.1 FIBROUS-GLASS DUCTS AND FITTINGS

A. Fibrous-Glass Duct Materials: Resin-bonded fiberglass, faced on the outside surface with fire-resistive FSK vapor retarder and with a smooth fiberglass mat finish on the air-side surface.
   1. Duct Board: Factory molded into rectangular boards.
   2. Round Duct: Factory molded into straight round duct and smooth fittings.
   3. Temperature Limits: 40 to 250 deg F (5 to 121 deg C) inside ducts; 150 deg F (66 deg C) ambient temperature surrounding ducts.
   4. Maximum Thermal Conductivity: [**0.24 Btu x in./h x sq. ft. x deg F (0.035 W/m x K)**] <**Insert conductivity**> at 75 deg F (24 deg C) mean temperature.
   5. Moisture Absorption: Not exceeding 5 percent by weight at 120 deg F (49 deg C) and 95 percent relative humidity for 96 hours when tested according to ASTM C 1104/C 1104M.
   6. Permeability: 0.02 perms (1.15 ng/Pa x s x sq. m) maximum when tested according to ASTM E 96/E 96M, Procedure A.
   7. Antimicrobial Agent: Compound shall be tested for efficacy by an NRTL, and registered by the EPA for use in HVAC systems.
   8. Noise-Reduction Coefficient: 0.65 minimum when tested according to ASTM C 423, Mounting A.

9. Required Markings: EI rating, UL label, and other markings required by UL 181 on each full sheet of duct board.

B. Closure Materials:
1. Pressure-Sensitive Tape: Comply with UL 181A; imprinted by the manufacturer with the coding "181A-P," the manufacturer's name, and a date code.
   a. Tape: Aluminum foil-scrim tape imprinted with listing information.
   b. Minimum Tape Width: 2-1/2 inches (64 mm); 3 inches (76 mm) for duct board thicker than 1 inch (25 mm).
   c. Staples: 1/2-inch (13-mm) outward clinching, 2 inches (51 mm) o.c. in tabs, one tab per joint.
   d. Water resistant.
   e. Mold and mildew resistant.
2. Heat-Activated Tape: Comply with UL 181A; imprinted by the manufacturer with the coding "181A-H," the manufacturer's name, and a date code.
   a. Tape: Aluminum foil-scrim tape imprinted with listing information.
   b. Minimum Tape Width: 3 inches (76 mm).
   c. Heat-Sensitive Imprint: Printed indicator on tape to show proper heating during application has been achieved.
   d. Water resistant.
   e. Mold and mildew resistant.
3. Two-Part Tape Sealing System: Comply with UL 181A; imprinted by the manufacturer with the coding "181A-M," the manufacturer's name, and a date code.
   a. Tape: Woven glass fiber impregnated with mineral gypsum.
   b. Minimum Tape Width: 3 inches (76 mm).
   c. Sealant: Modified styrene acrylic.
   d. Water resistant.
   e. Mold and mildew resistant.
   f. 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).
   g. 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. Fabrication:
1. Select joints, seams, transitions, elbows, and branch connections and fabricate according to [SMACNA's "Fibrous Glass Duct Construction Standards," Chapter 2, "Specifications and Closure," and Chapter 4, "Fittings and Connections."] [NAIMA AH116, "Fibrous Glass Duct Construction Standards," Section II, "Fabrication of Straight Duct Modules," Section III, "Fabrication of Fittings from Modules or Flat Board," and Section IV, "Closure."]
2. Fabricate 90-degree mitered elbows to include turning vanes.
3. Reinforcements: Comply with requirements in [SMACNA's "Fibrous Glass Duct Construction Standards," Chapter 5, "Reinforcement"] [NAIMA AH116, "Fibrous Glass Duct Construction Standards," Section V, "Reinforcement"] for channel- and tie-rod reinforcement materials, spacing, and fabrication.
4. Preformed Round Duct: Comply with NAIMA AH116, "Fibrous Glass Duct Construction Standards," Section VII, "Preformed Round Duct."

## 2.2 PHENOLIC-FOAM DUCTS AND FITTINGS

A. Duct Panel: CFC-free phenolic-foam bonded on both sides with factory-applied 0.001-inch-(0.025-mm-) thick, aluminum foil reinforced with fiberglass scrim.

1. Maximum Temperature: 158 deg F (70 deg C) inside ducts or ambient temperature surrounding ducts.
2. Maximum Thermal Conductivity: [**0.13 Btu x in./h x sq. ft. x deg F (0.019 W/m x K)**] <**Insert conductivity**> at 75 deg F (24 deg C) mean temperature.
3. Permeability: 0.0002 perms (0.0115 ng/Pa x s x sq. m) maximum when tested according to ASTM E 96/E 96M, Procedure A.
4. Antimicrobial Agent: Compound shall be tested for efficacy by an NRTL, and registered by the EPA for use in HVAC systems.
5. Noise-Reduction Coefficient: 0.65 minimum when tested according to ASTM C 423, Mounting A.
6. Required Markings: UL label and other markings required by UL 181 on each full sheet of duct panel; UL ratings for closure materials.

B. Closure Materials:
1. V-Groove Adhesive: Silicone.
   a. 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).
   b. 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."
2. Pressure-Sensitive Tape: Comply with UL 181A; imprinted by the manufacturer with the coding "181A-P," the manufacturer's name, and a date code.
   a. Tape: Aluminum foil tape imprinted with listing information.
   b. Minimum Tape Width: 3 inches (76 mm).
   c. Water resistant.
   d. Mold and mildew resistant.
3. Polymeric Sealing System:
   a. Structural Membrane: Woven glass fiber.
   b. Minimum Tape Width: 3 inches (76 mm).
   c. Sealant: Water based.
   d. Color: White.
   e. Water resistant.
   f. Mold and mildew resistant.
   g. 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).
   h. 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. Fabrication:
1. Fabricate joints, seams, transitions, reinforcement, elbows, branch connections, access doors and panels, and damage repairs according to Knauf Insulation's "Knauf KoolDuct System Design Guide," Section 4, "Duct Construction," and Section 5, "Ductwork System General."
2. Fabricate 90-degree mitered elbows to include turning vanes.

## 2.3 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables: [**ASTM A 603, galvanized**] [**ASTM A 492, stainless**] steel with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

E. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

F. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.

## PART 3 - EXECUTION

### 3.1 DUCT INSTALLATION

A. Install ducts with fewest possible joints.

B. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

C. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

D. Install ducts with a clearance of 1 inch (25 mm), plus allowance for insulation thickness.

E. 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. Overlap openings on four sides by at least 1-1/2 inches (38 mm).

F. 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.

G. Protect duct interiors from the 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."**]

H. Install fibrous-glass ducts and fittings to comply with [**NAIMA AH116, "Fibrous Glass Duct Construction Standards**] [**SMACNA's "Fibrous Glass Duct Construction Standards**]."

I. Install foam ducts and fittings to comply with Knauf Insulation's "Knauf KoolDuct System Design Guide."

### 3.2 HANGER AND SUPPORT INSTALLATION

A. Install hangers and supports for fibrous-glass ducts and fittings to comply with [SMACNA's "Fibrous Glass Duct Construction Standards," Chapter 6, "Hangers and Supports."] [NAIMA AH116, "Fibrous Glass Duct Construction Standards," Section VI, "Hangers and Supports."]

B. Install hangers and supports for phenolic-foam ducts and fittings to comply with Knauf Insulation's "Knauf KoolDuct System Design Guide," Section 5, "Ductwork System General."

C. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Install concrete inserts before placing concrete.
   2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches (100 mm) thick.
   4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.

D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

## 3.3 DUCT CLEANING

A. Clean [**new**] [**and**] [**existing**] 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 duct as recommended by duct 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. Particulate Collection and Odor Control:
   1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
   2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:
   1. Air outlets and inlets (registers, grilles, and diffusers).
   2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
   3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
   4. Coils and related components.
   5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
   6. Supply-air ducts, dampers, actuators, and turning vanes.
   7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:
   1. 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.
   2. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of ducts or duct accessories.

3. Clean fibrous-glass duct with HEPA vacuuming equipment; do not permit duct to get wet. Replace fibrous-glass duct that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
4. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
5. Provide drainage and cleanup for wash-down procedures.
6. 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.

## 3.4 START UP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

## 3.5 DUCT SCHEDULE

A. Indoor Ducts and Fittings:
   1. Fibrous-Glass Rectangular Ducts and Fittings:
      a. Minimum Flexural Rigidity: EI-[**475**] [**800**] [**1400**].
      b. Minimum Board Thickness: [**1 inch (25 mm)**] [**1-1/2 inches (38 mm)**] [**2 inches (51 mm)**].
   2. Fibrous-Glass Round Ducts and Fittings:
      a. Minimum Thickness: [1 inch (25 mm)] <Insert thickness>.
   3. Phenolic-Foam Rectangular Ducts and Fittings:
      a. Minimum Panel Thickness: [7/8 inch (22 mm)] [1-3/32 inches (28 mm)].
      b. Aluminum Cladding: Minimum 0.025 inch (0.635 mm) thick.

B. Outdoor Duct and Fittings:
   1. Phenolic-Foam Rectangular Ducts and Fittings:
      a. Minimum Panel Thickness: [7/8 inch (22 mm)] [1-3/32 inches (28 mm)].
      b. Aluminum Cladding: Minimum 0.032 inch (0.813 mm) thick.
      c. Polymeric Sealing System: Coat ducts, including gang-nail couplings, grip flanges, and couplings.

**END OF SECTION 233116**

# SECTION 233119 - HVAC CASINGS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
1. Factory-fabricated, field-assembled, [**single**] [**double**] [**single- and double**]-wall casings for HVAC equipment.

### 1.2 PERFORMANCE REQUIREMENTS

A. Structural Performance:
1. Casings shall be fabricated to withstand 133 percent of the indicated static pressure without structural failure. Wall and roof deflection at the indicated static pressure shall not exceed 1/8 inch per foot (0.97 mm per meter) of width.
   a. Fabricate outdoor casings to withstand wind load of 15 lbf/sq. ft. (720 N/sq. m) and snow load of 30 lbf/sq. ft. (1440 N/sq. m).

B. Seismic Performance: HVAC casings shall withstand the effects of earthquake motions determined according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" [**and**] [**ASCE/SEI 7**] <**Insert requirement**>.
1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[ **and the unit will be fully operational after the seismic event**]."

### 1.3 ACTION SUBMITTALS

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

B. LEED Submittals:
1. Product Data for Prerequisite IEQ 1: Documentation indicating that HVAC casings comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
2. Product Data for Prerequisite EA 2: Documentation indicating that HVAC casings comply with ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
3. Leakage Test Report for Prerequisite EA 2: Documentation of work performed for compliance with ASHRAE/IESNA 90.1, Section 6.4.4.2.2 - "Duct Leakage Tests."
4. Duct-Cleaning Test Report for Prerequisite IEQ 1: Documentation of work performed for compliance with ASHRAE 62.1, Section 7.2.4 - "Ventilation System Start-up."
5. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including a printed statement of VOC content.
6. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings: For HVAC casings. Include plans, elevations, sections, components, and attachments to other work.

### 1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

## 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 GENERAL CASING FABRICATION REQUIREMENTS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 9, "Equipment and Casings," for acceptable materials, material thicknesses, and casing construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
   1. Fabricate casings with more than 3-inch wg (750-Pa) negative static pressure according to SMACNA's "Rectangular Industrial Duct Construction Standards."
   2. Casings with more than 2-inch wg (500-Pa) positive static pressure may be fabricated according to SMACNA's "Rectangular Industrial Duct Construction Standards."

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Exterior Surface Galvanized Coating Designation: [**G60 (Z180)**] [**G90 (Z275)**].
   2. Interior Surface Galvanized Coating Designation:
      a. Sections Not Exposed to Moisture: [**G60 (Z180)**] [**G90 (Z275)**].
      b. Sections Housing and Downstream from Cooling Coil and Humidifiers: [**G90 (Z275)**].

C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

D. Sealing Requirement: SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Seal Class A. Seal all seams, joints, connections, and abutments to building.

E. Penetrations: Seal all penetrations airtight. Cover with escutcheons and gaskets, or fill with suitable compound so there is no exposed insulation. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping." Provide shaft seals where fan shafts penetrate casing.

F. Access Doors: Fabricate access doors according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 9-15, "Casing Access Doors - 2-inch wg (500 Pa)," and Figure 9-16, "Casing Access Doors - 3-10-inch wg (750-2500 Pa)"; and according to pressure class of the plenum or casing section in which access doors are to be installed.
   1. Size: [20 by 54 inches (500 by 1370 mm)] <Insert size>.
   2. Vision Panel: Double-glazed, wire-reinforced safety glass with an airspace between panes and sealed with interior and exterior rubber seals.
   3. Hinges: Piano or butt hinges and latches, number and size according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   4. Latches: Minimum of two wedge-lever-type latches, operable from inside and outside.
   5. Neoprene gaskets around entire perimeters of door frames.
   6. Doors shall open against air pressure.

G. Condensate Drain Pans: Formed sections of G90 (Z275) coated, galvanized sheet steel complying with requirements in ASHRAE 62.1. Pans shall extend a minimum of 12 inches (300 mm) past coil.
1. Double-wall construction shall have space between walls filled with foam insulation and sealed moisture tight.
2. Intermediate drain pan or drain trough shall collect condensate from top coil for units with stacked coils or stacked eliminators.
3. Insulation: Polystyrene or polyurethane.
4. Slopes shall be in a minimum of two planes to collect condensate from cooling coils (including coil piping connections and return bends), eliminators, and humidifiers when units are operating at maximum catalogued face velocity across cooling coil.
5. Each drain pan connection shall have a trap.[ **Drain traps with depth and height differential between inlet and outlet equal or greater to the design static pressure plus 2-inch wg (500 Pa.)**] Include slab height in trap calculation.

## 2.2 MANUFACTURED CASINGS

A. Description: Double-wall, insulated, pressurized equipment casing.

B. Double-Wall Panel Fabrication: Solid, galvanized sheet steel exterior wall and [**solid**] [**perforated**], galvanized sheet steel interior wall; with space between wall filled with insulation.
1. Wall Thickness: [2 inches (50 mm)] [4 inches (100 mm)].
2. Fabricate with a minimum number of joints.
3. Weld exterior and interior walls to perimeter; to interior, longitudinal, galvanized-steel channels; and to box-end internal closures. Paint welds.
4. Sheet metal thickness shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for static-pressure class indicated for casing.
5. Sheet Metal Thicknesses:
   a. Exterior Wall Thickness: [**0.040 inch (1.0 mm)**] <**Insert dimension**> minimum.
   b. Interior Wall Thickness: [**0.034 inch (0.85 mm)**] <**Insert dimension**> minimum.
6. Double-Wall Casing Inner Panel: Perforated, galvanized sheet steel having 3/32-inch-(2.4-mm-) diameter perforations, with overall open area of [**23**] <**Insert number**> percent.
7. Double-Wall Casing Inner Panel: Solid sheet steel.
8. Fill each panel assembly with insulating material that is noncombustible, inert, mildew resistant, and vermin proof and that complies with NFPA 90A.
9. Fabricate panels with continuous [**tongue-and-groove**] [**self-locking**] [**tongue-and-groove or self-locking**] joints effective inside and outside each panel.

C. Trim Items: Fabricate from a minimum of 0.052-inch (1.3-mm) galvanized sheet steel, furnished in standard lengths for field cutting.

## 2.3 CASING LINER

A. Fibrous-Glass Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
1. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
   a. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   b. 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."

B. Flexible-Elastomeric Casing Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1, and with NFPA 90A or NFPA 90B.
   1. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
   2. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
      a. indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
      b. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Natural-Fiber Casing Liner: 85 percent cotton, 10 percent borate, and 5 percent polybinding fibers, treated with a microbial growth inhibitor, and complying with NFPA 90A or NFPA 90B.
   1. Maximum Thermal Conductivity: [**0.24 Btu x in./h x sq. ft. x deg F (0.034 W/m x K)**] <**Insert conductivity**> at 75 deg F (24 deg C) mean temperature when tested according to ASTM C 518.
   2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
   3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
      a. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
      b. 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. Insulation Pins and Washers:
   1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, [**0.106-inch- (2.6-mm-)**] [**0.135-inch- (3.5-mm-)**] diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.
   2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick, galvanized steel, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

E. Shop or Factory Application of Casing Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."
   1. Adhere a single layer of indicated thickness of casing liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of casing liner is prohibited.
   2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
   3. Butt transverse joints without gaps, and coat joint with adhesive.
   4. Fold and compress liner in corners of casings or cut and fit to ensure butted-edge overlapping.
   5. Apply adhesive coating on longitudinal seams in casings with air velocity of 2500 fpm (12.7 m/s).
   6. Secure liner with mechanical fasteners 4 inches (100 mm) from corners and at intervals not exceeding 12 inches (300 mm) transversely; at 3 inches (75 mm) from transverse joints and at intervals not exceeding 18 inches (450 mm) longitudinally.

7. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from casing wall. Fabricate edge facings at the following locations:
   a. Fan discharges.
   b. Intervals of lined casing preceding unlined duct.
   c. Upstream edges of transverse joints in casings where air velocities are higher than 2500 fpm (12.7 m/s) or where indicated.
8. Secure insulation between perforated sheet metal inner wall of same thickness as specified for outer wall. Use mechanical fasteners that maintain inner wall at uniform distance from outer wall without compressing insulation.

## 2.4 SEALANT MATERIALS

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. 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. 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).
8. 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."
9. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive or negative.
10. Service: Indoor or outdoor.
11. Substrate: Compatible with galvanized sheet steel.

C. 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."

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

## 2.5 EXECUTION

## 2.6 INSTALLATION

A. Install casings according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Equipment Mounting:
   1. Install HVAC casings on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in [**Section 033000 "Cast-in-Place Concrete."**] [**Section 033053 "Miscellaneous Cast-in-Place Concrete."**]
   2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
   3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

C. Apply sealant to joints, connections, and mountings.

D. Field-cut openings for pipe and conduit penetrations; insulate and seal according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Support casings on floor or foundation system. Secure and seal to base.

F. Support components rigidly with ties, braces, brackets, [**seismic restraints,** ]and anchors of types that will maintain housing shape and prevent buckling.

G. Align casings accurately at connections, with 1/8-inch (3-mm) misalignment tolerance and with smooth interior surfaces.

## 2.7 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Perform field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual."
   2. Test the following systems:
      a. Systems required by ASHRAE/IESNA 90.1.
      b. Supply Air: [**100**] [**50**] <**Insert value**> percent of total installed duct area with a pressure class of [**3-inch wg (750 Pa)**] [**4-inch wg (1000 Pa)**] <**Insert value**> or higher.
   3. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
   4. Determine leakage from entire system or section of system by relating leakage to surface area of test section. Comply with requirements for leakage classification of ducts connected to casings.
   5. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.

B. HVAC casings will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

## 2.8 CLEANING

A. Comply with requirements for cleaning in Section 233113 "Metal Ducts."

**END OF SECTION 233119**

# SECTION 233300 - AIR DUCT ACCESSORIES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
1. Manual volume dampers.
2. Flexible connectors.
3. Flexible ducts.
4. Duct accessory hardware.

### 1.2 SUBMITTALS

A. Refer to specification 230100 – General Requirements for HVAC.

## 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 MANUAL VOLUME DAMPERS

A. Furnish and install opposed-blade, multi-leaf, leak-proof volume control dampers where indicated on drawings and locations in supply, return, and exhaust ducts where branches are taken from larger ducts and as required to achieve system air balance quantities. Balancing devices must be provided in accordance with OMC 603.17. All manual volume dampers must be shown on coordination drawings when submitted for review.

### 2.3 FLEXIBLE CONNECTORS

A. Materials: Flame-retardant or noncombustible fabrics.

B. Coatings and Adhesives: Comply with UL 181, Class 1.

C. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

D. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

## 2.4 FLEXIBLE DUCTS

A. Non-insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire.

B. 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; vapor-barrier film.
   1. Insulation R-value: Comply with ASHRAE/IESNA 90.1.

C. Flexible Duct Connectors:

   1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action or Nylon strap in sizes 3 through 18 inches, to suit duct size.
   2. Non-Clamp Connectors: Adhesive, Liquid adhesive plus tape, or Adhesive plus sheet metal screws.

## 2.5 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.

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 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.

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 flexible connectors to connect ducts to equipment.

H. Connect diffusers to supply ducts with maximum 8’ lengths of flexible duct clamped or strapped in place.

I. 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.

**END OF SECTION 233300**

# SECTION 233423- HVAC POWER VENTILATORS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Ceiling-mounted ventilators.
   2. Centrifugal roof ventilators.

### 1.2 SUBMITTALS

A. Refer to specification 230100 – General Requirements for HVAC.

### 1.3 QUALITY ASSURANCE

A. Air and sound ratings shall be certified by HVI.

## PART 2 - PRODUCTS

### 2.1 CEILING-MOUNTED VENTILATORS

A. Manufacturer: Exhaust fan manufacturers shall be equal to the following:
   1. Broan
   2. Greenheck
   3. Loren Cook Company
   4. Panasonic

B. Housing: 26-gage galvanized steel construction with adjustable mounting brackets.

C. Fan Wheel: Centrifugal blower wheel. Motor shall be permanently lubricated.

D. Grille: Painted steel, louvered grille with flange on intake and thumbscrew attachment to fan housing.

E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

F. Controls: Fan to run intermittently with a fan switch in the bathroom and a reverse acting thermostat in the Server room.

G. Accessories:
   1. Backdraft damper in duct connection of fan.

H. Capacities and Characteristics: Refer to schedule on drawing.

## 2.2 CENTRIFUGAL ROOF VENTILATORS

A. Manufacturer: Exhaust fan manufacturers shall be equal to the following:
   1. Carnes
   2. Greenheck
   3. Loren Cook Company

B. Housing: Removable, galvanized steel, mushroom-domed top; square, one-piece, aluminum base with venturi inlet cone.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

D. Accessories:

   1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
   2. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

E. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

F. Capacities and Characteristics: Refer to schedule on drawing.

## 2.3 MOTORS

A. Enclosure Type: Totally enclosed motor with long life bearings designed for continuous operation.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Install units with clearances for service and maintenance. Install per manufacturer’s requirements.

**END OF SECTION 233423**

## SECTION 233600 - AIR TERMINAL UNITS

## PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Shutoff, single-duct air terminal units.

1.2 ACTION SUBMITTALS

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

B. Shop Drawings: For air terminal units. Include plans, elevations, sections, details, and attachments to other work.

C. Delegated-Design Submittal:
1. Materials, fabrication, assembly, and spacing of hangers and supports.
2. Design Calculations: Calculations[**, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation**] for selecting hangers and supports.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

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: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

1.6 SHUTOFF, SINGLE-DUCT AIR TERMINAL UNITS

A. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.
1. Damper Actuator: 24 V.
2. Thermostat: Wall-mounted electronic type with clock display, temperature display in Fahrenheit and Celsius, and space temperature set point.

B. Direct Digital Controls: Single-package unitary controller and actuator specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
1. Room Sensor: Wall mounted, with temperature set-point adjustment and access for connection of portable operator terminal.

1.7 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. Steel Cables: [**Galvanized steel complying with ASTM A 603**] [**Stainless steel complying with ASTM A 492**].

D. 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.

E. Air Terminal Unit Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

F. Trapeze and Riser Supports: Steel shapes and plates for units with steel casings; aluminum for units with aluminum casings.

1.8 SOURCE QUALITY CONTROL

A. Factory Tests: Test assembled air terminal units according to ARI 880.
1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, [**coil type,**] and ARI certification seal.

**PART 2 - EXECUTION**

2.1 INSTALLATION

A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

C. Install wall-mounted thermostats.

2.2 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 and for slabs more than 4 inches (100 mm) thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches (100 mm) thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hangers Exposed to View: Threaded rod and angle or channel supports.

D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

## 2.3 CONNECTIONS

A. Connect ducts to air terminal units according to [Section 233113 "Metal Ducts."] [Section 233116 "Nonmetal Ducts."]

B. Make connections to air terminal units with flexible connectors complying with requirements in Section 233300 "Air Duct Accessories."

## 2.4 IDENTIFICATION

A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

## 2.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
   1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
   2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Air terminal unit will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

## 2.6 STARTUP SERVICE

A. [Engage a factory-authorized service representative to perform] [Perform] startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
   3. Verify that controls and control enclosure are accessible.
   4. Verify that control connections are complete.
   5. Verify that nameplate and identification tag are visible.
   6. Verify that controls respond to inputs as specified.

2.7 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**] [**Train**] Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

**END OF SECTION 233600**

# SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

## PART 1 - GENERAL

### 1.1 SUMMARY

### 1.2 SUBMITTALS

A. Refer to specification 230100 – General Conditions of HVAC.

## PART 2 - PRODUCTS

### 2.1 CEILING DIFFUSERS, REGISTERS, AND GRILLES

A. Manufacturer: Air devices shall be equal to the following:
   1. Price
   2. Titus
   3. Krueger
   4. Greenheck

B. Manufacturer: Louvers shall be equal to the following:
   1. Ruskin
   2. Greenheck
   3. Nailor

C. Refer to air device schedule on drawings for details.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install diffusers, registers, grilles, and louvers level and plumb. Install per manufacturer's requirements.

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.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

D. Provide all miscellaneous items necessary for a complete and proper installation in the type of ceiling and walls used in this project.

### 3.2 ADJUSTING

A. After installation, adjust registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

**END OF SECTION 233713**

## SECTION 237433 - ROOFTOP UNITS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes factory-packaged rooftop units providing gas-fired heating and electric cooling.

B. Factory assembled, single-piece heating and cooling rooftop unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, and special features required prior to field start-up.

C. Unit shall use R-410A refrigerant.

D. Unit shall be installed in accordance with the manufacturer's instructions.

E. Unit must be selected and installed in compliance with local, state, and federal codes.

F. Unit shall be stored and handled per manufacturer's recommendations.

### 1.2 SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include plans, elevations, sections, and attachment details.

### 1.3 WARRANTY

A. Special Warranty: Manufacturer agrees to replace components of units that fail in materials or workmanship within specified warranty period.
   1. Complete unit: One year from date of Substantial Completion (parts only).
   2. Warranty Period for Heat Exchangers: Stainless steel (15 year), Aluminum (10 year) non-prorated, parts only.
   3. Compressor: 5 year
   4. Parts: 1 year

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Carrier

B. Tempstar (ICP)

C. Trane

### 2.2 PERFORMANCE REQUIREMENTS

A. Refer to Rooftop Unit Schedule for applicable technical data and associated accessories.

## 2.3 UNIT CABINET

A. Unit cabinet shall be constructed of galvanized steel, and shall be bonderized and coated with a pre-painted baked enamel finish on all externally exposed surfaces.

B. Unit cabinet exterior paint shall be: film thickness, (dry) 0.003 inches minimum, gloss (per ASTM D523, 60°F/16°C): 60, Hardness: H-2H Pencil hardness.

C. Evaporator fan compartment interior cabinet insulation shall conform to AHRI Standards 210/240 and or 340/360 minimum exterior sweat criteria. Interior surfaces shall be insulated with a minimum 1/2 in. thick, 1 lb density, flexible fiberglass insulation, neoprene coated on the air side. Aluminum foil-faced fiberglass insulation shall be used in the gas heat compartment.

D. Base of unit shall have a minimum of 4 locations for thru-the-base gas and electrical connections (factory-installed or field-installed), standard.

E. Base Rail:
   1. Unit shall have base rails on a minimum of 2 sides.
   2. Holes shall be provided in the base rails for rigging shackles to facilitate maneuvering and overhead rigging.
   3. Holes shall be provided in the base rail for moving the rooftop by fork truck.
   4. Base rail shall be a minimum of 16 gauge thickness.

F. Condensate pan and connections:
   1. Shall be a sloped condensate drain pan made of a corrosion resistant material.
   2. Shall use a ¾" 14 NPT drain connection, possible either through the bottom or side of the drain pan. Connection shall be made per manufacturer's recommendations.

G. Top panel:
   1. Shall be a single piece top panel on all sizes.

H. Gas Connections:
   1. All gas piping connecting to unit gas valve shall enter the unit cabinet at a single location on side of unit (horizontal plane).
   2. Thru-the-base capability
      a. Standard unit shall have a thru-the-base gas-line location using a raised, embossed portion of the unit basepan.
      b. Optional, factory approved, water-tight connection method must be used for thru-the-base gas connections.
      c. No basepan penetration, other than those authorized by the manufacturer, is permitted.

## 2.4 SUPPLY FAN

A. Direct Drive Evaporator fan motor:
   1. Shall be an ECM motor design.
   2. Shall have permanently lubricated bearings.
   3. Shall have inherent automatic-reset thermal overload protection.
   4. Shall have slow ramp up to speed capabilities.
   5. Shall require no fan/motor belts for operation, adjustments and or initial fan speed set up.
   6. Shall be internally protected from electrical phase reveral and loss.

B. Evaporator Fan shall be easily set with dedicated selection switch and adjustment pot on unit control.

C. Provide staged cooling capacity control, the indoor fan speed is automatically controlled to meet the code-compliant <66% low fan speed and 100% full fan speed operation.

D. Vane Axial fan design.

E. Cast Aluminum stator and high impact composite material on stator, rotor and air inlet casing.

F. Motors:
1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

## 2.5 CONDENSER FAN

A. Condenser fan motors:
1. Shall be a totally enclosed motor.
2. Shall use permanently lubricated bearings.
3. Shall have inherent thermal overload protection with an automatic reset feature.
4. Shall use a shaft-down design.

B. Condenser Fans:
1. Shall be a direct-driven propeller type fan constructed of high impact composite material.
2. Shall have high impact composite blades completely formed into one piece without blade fasteners or connectors and shall be dynamically balanced.

## 2.6 COOLING COILS

A. Standard Aluminum Fin-Copper Tube Coils:
1. Standard evaporator and condenser coils shall have aluminum lanced plate fins mechanically bonded to seamless internally grooved copper tubes with all joints brazed.
2. Evaporator coils shall be leak tested to 150 psig, pressure tested to 450 psig, and qualified to UL 1995 burst test at 1775 psig.
3. Condenser coils shall be leak tested to 150 psig, pressure tested to 650 psig, and qualified to UL 1995 burst test at 1980 psig.

## 2.7 REFRIGERATION SYSTEM

A. Comply with requirements in ASHRAE 15, "Safety Standard for Refrigeration Systems."

B. Refrigerant Charge: Factory charged with refrigerant and filled with oil.

C. Refrigerant circuit shall include the following control, safety, and maintenance features:
1. TXV shall include a multiple feed distribution system that optimizes coil performance.
2. Refrigerant filter drier – Solid core design.
3. Service gauge connections on suction and discharge lines.
4. Pressure gauge access through a specially designed access port in the panel of the unit.

D. There shall be a gauge line access port in the skin of the rooftop, covered by a removable plug.
1. The plug shall be easy to remove and replace.
2. When the plug is removed, the gauge access port shall enable maintenance personnel to route their pressure gauge lines.
3. This gauge access port shall facilitate correct and accurate condenser pressure readings by enabling the reading with the compressor access panel on.
4. The plub shall be made of a leak proof, UV-resistant, composite material.

E. Compressors:
1. Unit shall use fully hermetic, scroll compressor for each independent refrigeration circuit.
2. Compressor motors shall be cooled by refrigerant gas passing through motor windings.
3. Compressors shall be internally protected from high discharge temperature conditions.
4. Compressors shall be protected from an over-temperature and over-amperage conditions by an internal, motor overload device.
5. Compressor shall be factory mounted on rubber grommets.
6. Compressor motors shall have internal line break thermal, current overload and high pressure differential protection.
7. Crankcase heaters shall not be required for normal operating range, unless required by compressor manufacturer due to refrigerant charge limits.
8. Compressor shall be a 2 stage cooling capacity design minimum.

F. Safety Controls:
1. Compressor over-temperature, over-current, high internal pressure differential.
2. Low pressure switch. Low pressure switch shall use different color wire than the high pressure switch. The purpose is to assist the installer and service technician to correctly wire and or troubleshoot the rooftop unit.
3. High pressure switch. High pressure switch shall use different color wire than the low pressure switch. The purpose is to assist the installer and service technician to correctly wire and or troubleshoot the rooftop unit.
4. Automatic reset, motor thermal overload protector.
5. Heating section shall be provided with the following minimum protections:
   a. High temperature limit switches.
   b. Induced draft motor speed sensor.
   c. Flame rollout switch.
   d. Flame proving controls.

## 2.8 INDIRECT-FIRED GAS FURNACE HEATING

A. General:
1. Heat exchanger shall be an induced draft design. Positive pressure heat exchanger designs shall not be allowed.
2. Shall incorporate a direct-spark ignition system and redundant main gas valve.
3. Gas supply pressure at the inlet to the rooftop unit gas valve must match that required by the manufacturer.

B. The heat exchanger shall be controlled by an integrated gas controller (IGC) microprocessor.
1. IGC board shall notify users of fault using an LED (light-emitting diode).
2. The LED shall be visible without removing the control box access panel.
3. IGC board shall contain algorithms that modify evaporator fan operation to prevent future cycling on high temperature limit switch.
4. Unit shall be equipped with anti-cycle protection with one short cycle on unit flame rollout switch or 4 continuous short cycles on the high temperature limit switch. Fault indication shall be made using an LED.

C. Stainless Steel Heat Exchanger construction:
1. Direct-spark ignition system.
2. Redundant main gas valve.
3. Burners shall be of the in-shot type con-structed of aluminum-coated steel.
4. All gas piping shall enter the unit cabinet at a single location on side of unit (horizontal plane).
5. The stainless steel heat exchanger shall be of the tubular-section type, constructed of a minimum of 20-gauge type 409 stainless steel.

6. Type 409 stainless steel shall be used in heat exchanger tubes and vestibule plate.

D. Induced draft combustion motor and blower
1. Shall be a direct-drive, single inlet, forward-curved centrifugal type.
2. Shall be made from steel with a corrosion resistant finish.
3. Shall have permanently lubricated sealed bearings.
4. Shall have inherent thermal overload protection.
5. Shall have an automatic reset feature.

## 2.9 ACCESSORIES

A. FILTERS
1. Filters shall be held in place by a pivoting filter tray, facilitating easy removal and installation.
2. Shall consist of factory installed, low velocity, throw-away 2 in. thick fiberglass filters.
3. Filters shall be standard, commercially available sizes.
4. Only one size filter per unit is allowed.
5. Filters shall be accessible through an access panel with “no-tool” removal.

B. Integrated Economizer.
1. Integrated, gear driven opposing modulating blade design type capable of simultaneous economizer and compressor operation.
2. Damper blades shall be galvanized steel with composite gears. Plastic or composite blades on intake or return shall not be acceptable.
3. Shall include all hardware and controls to provide free cooling with outdoor air when temperature and/or humidity are below setpoints.
4. Shall be equipped with gear driven dampers for both the outdoor ventilation air and the return air for positive air stream control.
5. Standard leak rate shall be equipped with dampers not to exceed 2% leakage at 1 in. wg pressure differential.
6. Economizer controller equal to Honeywell W7220 that provides:
   a. 2-line LCD interface screen for setup, configuration and troubleshooting.
   b. On-board Fault Detection and Diagnostics (FDD) that senses and alerts when the economizer is not operating properly, per California Title 24, ASHRAE 90.1 and IECC.
   c. Sensor failure loss of communication identification.
   d. Automatic sensor detection.
   e. Capabilities for use with multiple-speed indoor fan systems.
   f. Utilize digital sensors: dry bulb and enthalpy.
7. Shall be capable of introducing up to 100% outdoor air.
8. Shall be equipped with a barometric relief damper capable of relieving up to 100% return air and contain seals that meet ASHRAE 90.1 requirements.
9. Shall be designed to close damper(s) during loss-of-power situations with spring return built into motor.
10. Provide single enthalpy sensor for economizer control. Set sensor to activate economizer mode when outdoor air enthalpy is 28 Btu/lb of dry air or less (adjustable).
11. The economizer shall maintain minimum airflow into the building during occupied period and provide design ventilation rate for full occupancy.
12. Dampers shall be completely closed when the unit is in the unoccupied mode.
13. Economizer controller shall accept a 2 to 10 Vdc CO2 sensor input for IAQ/DCV control. In this mode, dampers shall modulate the outdoor air damper to provide ventilation based on the sensor input.
14. Compressor lockout temperature on W7220 control is adjustable from –45°F to 80°F, set at a factory default of 32°F.

15. Actuator shall be direct coupled to economizer gear. No linkage arms or control rods shall be acceptable.
16. Economizer controller shall provide indications when in free cooling mode, in the DCV mode, or the exhaust fan contact is closed.

C. Hot Gas Re-Heat Dehumidification System
1. The Hot Gas Re-Heat Dehumidification System shall be factory installed and shall provide greater dehumidification of the occupied space by 2 modes of dehumidification operations in addition to its normal design cooling mode:
    a. Subcooling mode further sub cools the hot liquid refrigerant leaving the condenser coil when both temperature and humidity in the space are not satisfied.
    b. Hot gas reheat mode shall mix a portion of the hot gas from the discharge of the compressor with the hot liquid refrigerant leaving the condenser coil to create a 2-phase heat transfer in the system, resulting in a neutral leaving air temperature when only humidity in the space is not satisfied.
    c. Includes low ambient controller.

D. Convenience Outlet
1. Outlet shall be powered from main line power to the rooftop unit.
2. Outlet shall be powered from line side or load side of disconnect by installing contractor, as required by code. If outlet is powered from load side of disconnect, unit electrical ratings shall be UL certified and rated for additional outlet amperage.
3. Outlet shall be factory-installed and internally mounted with easily accessible 115v female receptacle.
4. Outlet shall include 15 amp GFI receptacles with independent fuse protection.
5. Voltage required to operate convenience outlet shall be provided by a factory installed step-down transformer.
6. Outlet shall be accessible from outside the unit.
7. Outlet shall include a field installed “Wet in Use” cover.

E. Roof Curbs (Vertical)
1. Full perimeter roof curb with exhaust capability providing separate air streams for energy recovery from the exhaust air without supply air contamination.
2. Formed galvanized steel with wood nailer strip and shall be capable of supporting entire unit weight.
3. Permits installation and securing of ductwork to curb prior to mounting unit on the curb.

F. Smoke detectors
1. Shall be a 4-Wire Controller and Detector.
2. Shall be environmental compensated with differential sensing for reliable, stable, and drift-free sensitivity.
3. Shall use magnet-activated test/reset sensor switches.
4. Shall have tool-less connection terminal access.
5. Shall have a recessed momentary switch for testing and resetting the detector.
6. Controller shall include:
    a. One set of normally open alarm initiation contacts for connection to an initiating device circuit on a fire alarm control panel.
    b. Two Form-C auxiliary alarm relays for interface with rooftop unit or other equipment.
    c. One Form-C supervision (trouble) relay to control the operation of the Trouble LED on a remote test/reset station.
    d. Capable of direct connection to 2 individual detector modules.
    e. Can be wired to up to 14 other duct smoke detectors for multiple fan shut-down applications.

## 2.10 ELECTRICAL POWER CONNECTIONS

A. General Electrical Power Connection Requirements: Factory-installed and -wired switches, motor controllers, transformers, and other necessary electrical devices shall provide a single-point field power connection to unit.

B. Enclosure: NEMA Type rated for outdoor use.

C. Wiring: Numbered and color-coded to match wiring diagram.

D. Wiring Location: Install factory wiring outside an enclosure in a raceway.

E. Factory-Mounted, Overcurrent-Protection Service: For each motor.

F. Transformer: Factory mounted with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.

G. Controls: Factory wire unit-mounted controls where indicated.

## 2.11 CONTROLS

A. Shall be complete with self-contained low-voltage control circuit protected by a resettable circuit breaker on the 24-v transformer side. Transformer shall have 75VA capability.

B. Shall utilize color-coded wiring.

C. Shall include a Unit Control Board to conveniently and safely provide connection points for vital control functions such as: smoke detectors, phase monitor, gas controller, economizer, thermostat, and low and high pressure switches. Controller shall also provide an intuitive means to adjust the indoor fan speed through a simple switch and pot adjustment design.

D. Unit shall include a minimum of one 8-pin screw terminal connection board for connection of control wiring.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Comply with manufacturer's rigging and installation instructions for unloading units and moving to final locations.

B. Curb Support: Install roof curb on roof structure according to "The NRCA Roofing Manual."
   1. Install and secure units on curbs and coordinate roof penetrations and flashing with roof construction.
   2. Coordinate size, installation, and structural capacity of roof curbs, equipment supports, and roof penetrations.
   3. Coordinate size, location, and installation of unit manufacturer's roof curbs and equipment supports with roof Installer.

C. Equipment Mounting:
   1. Comply with requirements for vibration isolation per ASHRAE chapter 47 *Sound and Vibration Control*.

D. Comply with requirements for gas-fired furnace installation in NFPA 54, "National Fuel Gas Code."

E. Install separate devices furnished by manufacturer and not factory installed.

F. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

G. Install drain pipes from unit drain pans to sanitary drain.
1. Drain Piping: Schedule 40 PVC pipe complying with ASTM D 1785, with solvent-welded fittings.
2. Pipe Size: Same size as condensate drain pan connection.

## 3.2 CONNECTIONS

A. Where installing piping adjacent to units, allow space for service and maintenance.

B. Duct Connections:
1. Comply with requirements in Section 233113 "Metal Ducts."
2. Drawings indicate the general arrangement of ducts.
3. Connect ducts to units with flexible duct connectors. Comply with requirements for flexible duct connectors in Section 233300 "Air Duct Accessories."

C. Electrical Connections: Comply with requirements for power wiring, switches, and motor controls in electrical Sections.
1. Install electrical devices furnished by unit manufacturer but not factory mounted.

## 3.3 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.
2. Inspect units for visible damage to furnace combustion chamber.
3. Perform the following operations for both minimum and maximum firing and adjust burner for peak efficiency:
   a. Measure gas pressure at manifold.
   b. Measure combustion-air temperature at inlet to combustion chamber.
   c. Measure flue-gas temperature at furnace discharge.
   d. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
   e. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
4. Inspect units for visible damage to refrigerant compressor, condenser and evaporator coils, and fans.
5. Start refrigeration system when outdoor-air temperature is within normal operating limits and measure and record the following:
   a. Cooling coil leaving-air, dry- and wet-bulb temperatures.
   b. Cooling coil entering-air, dry- and wet-bulb temperatures.
   c. Condenser coil entering-air dry-bulb temperature.
   d. Condenser coil leaving-air dry-bulb temperature.
6. Simulate maximum cooling demand and inspect the following:
   a. Compressor refrigerant suction and hot-gas pressures.
   b. Short-circuiting of air through outside coil or from outside coil to outdoor-air intake.
7. Inspect casing insulation for integrity, moisture content, and adhesion.
8. Verify that clearances have been provided for servicing.
9. Verify that controls are connected and operable.
10. Verify that filters are installed.
11. Clean coils and inspect for construction debris.
12. Clean furnace flue and inspect for construction debris.

13. Inspect operation of power vents.
14. Purge gas line.
15. Verify bearing lubrication.
16. Clean fans and inspect fan-wheel rotation for movement in correct direction without vibration and binding.
17. Start unit.
18. Inspect and record performance of interlocks and protective devices including response to smoke detectors by fan controls and fire alarm.
19. Operate unit for run-in period.
20. Calibrate controls.
21. Adjust and inspect high-temperature limits.
22. Verify operational sequence of controls.
23. Measure and record the following airflows. Plot fan volumes on fan curve.
    a. Supply-air volume.
    b. Return-air flow.
    c. Outdoor-air flow.
24. After startup, change filters, verify bearing lubrication, etc.
25. Remove and replace components that do not properly operate and repeat startup procedures as specified above.
26. Prepare written report of the results of startup services.

## 3.4 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.

**END OF SECTION 237433**

## SECTION 238239.19 - ELECTRIC UNIT HEATERS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Wall heaters.

### 1.2 SUBMITTALS

A. Refer to specification 230100 – General Conditions of HVAC.

## PART 2 - PRODUCTS

### 2.1 WALL HEATERS

A. Manufacturer: Heaters shall be equal to the following:
   1. Berko
   2. Markel
   3. Marley

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

C. Casing
   1. Frame: Heavy gauge steel.
   2. Finish: Phosphatized and painted with a powder coating enamel.

D. Coil
   1. 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.

E. Fan and Motor
   1. Fan: Aluminum propeller directly connected to motor.
   2. Motor: Permanently lubricated.

F. Controls
   1. Built-in thermostat.
   2. Built-in fan relay.
   3. Built-in thermal cutout.
   4. Electrical Connection: Factory wire motors and controls for a single field connection.

G. Accessories (refer to schedule on drawing for any additional accessories)
   1. Double-pole, single throw disconnect switch.
   2. Front cover.

H. Capacities and Characteristics: Refer to schedule on drawing.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install wall and ceiling unit heaters to comply with NFPA 90A.

B. Install 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.

**END OF SECTION 238239.19**

# SECTION 260000 – GENERAL SPECIFICATIONS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Refer to architectural drawings, general notes, instructions to bidders, general conditions, supplementary general conditions, base building specifications and drawings, shop drawing manuals and as-built plans, except as noted herein, which apply in all respects to this section. The contractor shall visit the site and familiarize himself with all existing conditions prior to bidding the work

### 1.2 USE OF DRAWINGS AND SPECIFICATIONS

A. EBS drawings and specifications are intended to convey design intent only. All means and methods sequences, techniques, and procedures of construction as well as any associated safety precautions and programs, and all incidental and temporary devices required to construct the project, and to provide a complete and fully operational electrical system are the responsibility of the electrical contractor.

### 1.3 STANDARDS

A. Materials equipment and materials shall conform with appropriate provisions of NEC, ASTM, UL, ETL, NEMA, ANSI, as applicable to each individual unit or assembly.

### 1.4 CODES

A. All work shall be performed in strict accordance with all applicable state and local codes and ordinances. In case of conflict between the drawings/specifications and the codes and ordinances, the highest standard shall apply. The electrical contractor shall satisfy code requirements as a minimum standard without any extra cost to owner.

### 1.5 PERMITS AND FEES

### 1.6 **The electrical contractor shall procure and pay for all permits, fees and inspections necessary to complete the electrical work.**

### 1.7 WARRANTY

A. The electrical contractor shall unconditionally warrant all work to be free of defects in material and workmanship for a period of one (1) year from the date of final acceptance, and will repair or replace any defective work promptly and without charge and restore any other existing work damaged in the course of repairing defective materials and workmanship.

### 1.8 SITE EXAMINATION

A. The electrical contractor shall thoroughly examine all areas of work where equipment will be installed and shall report any condition that, in his opinion, prevents the proper installation of the electrical work prior to bid. He shall also examine the drawings and specifications of other branches of work making reference to them for details of new or existing building conditions.

B. All work shall be done at times convenient to the owner.

C. Electrical contractor shall take his own measurements and be responsible for them.

D. Access panels are not shown on drawings. During site examination, contractor shall identify all areas where access panels are required, and report to general contractor. Designation of who furnishes and who installs access panels must be coordinated with general contractor prior to starting work.

## 1.9 CONTRACTOR COORDINATION

A. Coordination drawings showing system and component installation layout, routing, details, etc. Shall be produced by the electrical contractor and under the supervision of the general contractor/construction manager, or appropriate party as applicable.

B. All systems installed by each sub-contractor shall be coordinated with one another and approved by general contractor/construction manager, etc. prior to installation and/or fabrication. Where the electrical contractor is making a connection to equipment/components that are furnished by others, electrical contractor to verify all connection requirements with actual equipment being connected, including but not limited to OCP size, means of disconnect, special connection requirements, or other items indicated on shop drawings, or manufacturer's installation instructions and/or installation diagrams, and furnish all labor and materials required for the installation and operation of the equipment. No allowances will be made for failure to coordinate, after electrical connections have been installed.

C. If questions concerning design intent arise during coordination, EBS can assist where appropriate.

D. The architectural drawings shall take precedence over all other drawings. Do not scale distances off the electrical drawings; use actual building dimensions.

E. Coordination drawings showing system and component installation layout, routing, details, etc. shall be produced by the electrical contractor and under the supervision of the general contractor/construction manager, or appropriate party as applicable. All systems installed by each sub-contractor shall be coordinated with one another and approved by general contractor/construction manager, etc. prior to installation and/or fabrication. If questions concerning design intent arise during coordination, EBS can assist where appropriate.

## 1.10 UTILITY COORDINATION

A. Electrical contractor to verify installation of metering and utility demarcation equipment with utility provider prior to start of work and furnish and install required items per utility company's installation requirements and/or manuals.

## 1.11 SUBMITTALS

A. Products installed by the electrical contractor and provided by others must be submitted for review prior to purchasing. Products shall not be selected based on permit drawings without express permission - products shall be selected based on construction drawings.

## 1.12 RECORD DRAWING

A. The electrical contractor shall be responsible for creating record drawings. Drawings shall be produced in Autocad 2004 format or later.

## 1.13 SHOP DRAWINGS

A. Submit to the architect pdf file copies of complete & certified shop drawings, descriptive data, performance data & ratings, diagrams and specifications on all specified equipment, including accessories, and materials for review.

B. The make, model number, type, finish & accessories of all equipment and materials shall be reviewed & approved by the electrical contractor & general contractor prior to submitting to the architect for their review & approval.

C. Review of shop drawings does not relieve the electrical contractor/vendor from compliance with the requirements of the contract drawings, specifications & applicable codes.

**1.14 TESTING**

A. All electrical systems shall be tested for proper operation. Balance all branch circuit loads between the phases of the system to within 10% of the highest phase load in each panelboard.

**1.15 TEMPORARY POWER**

A. The electrical contractor shall provide temporary electrical wiring for construction. The temporary service shall be a minimum of 60 amps, single phase, three wire, 120/208 volts fused at main disconnect. All receptacles on this temporary service shall be protected by a GFI breaker.

**1.16 MECHANICAL EQUIPMENT**

A. All final connections to mechanical equipment shall be done by the electrical contractor.

**1.17 DEMOLITION**

A. The electrical contractor shall be responsible for deenergizing circuits in demolition areas to insure a safe condition. Electrical devices and associated wiring located within the demolition area that will no longer be used shall be removed and properly disposed of at contractor's expense unless otherwise noted.

**1.18 POWER OUTAGES**

A. The electrical contractor shall schedule all electrical system(s) outages with the general contractor and owner at least 24 hours in advance. Unless approved otherwise all outages shall occur between 11:00pm and 5:00am.

**1.19 MATERIALS**

A. Provide all new material and equipment unless noted otherwise. All equipment shall be UL approved and labeled, or other approved testing organization which has acceptance by the local jurisdiction, for the purpose for which they are used, in addition to meeting all requirements of the current applicable codes and regulations. No substitution to materials specified will be allowed unless approved by the owner.

B. Electrical contractor shall not order or purchase any materials or equipment until permit drawings have been approved. No allowances will be made for any changes that occur if permit drawings have not been approved prior to ordering.

**1.20 CUTTING AND FITTING**

A. Perform cutting, coring, fitting, repairing and finishing of the work necessary for the installation of the equipment of this section. However, no cutting of the work of other trades or of any structural member shall be done without the consent of the owner. Properly fill, seal, fireproof, and waterproof all openings, sleeves, and holes in slabs, walls, and casework.

## 1.21 WIRING METHODS

A. Provide code approved wiring methods for branch circuiting indoors, such as NM cable (only where permitted by NEC 334), EMT conduit, or MC cable for mechanical equipment, lighting, and power.

B. Conduit runs on exterior of building shall be rigid steel conduit with weather tight, corrosion-resistant fittings. Schedule 40 PVC is acceptable where permitted by code and or underground runs or concrete encasement where not exposed to physical damage.

C. The minimum size of conduit shall be 3/4" unless otherwise noted. Conduit connectors shall be double locknut type, UL listed and labeled, with compression or set screw fittings.

D. Rigid conduit shall be hot dipped galvanized.

E. Where raceways are installed for others to use, or for future use, provide nylon pull string.

F. Penetrations through fire rated construction shall be sealed using 3M fire barrier caulk, Nelson Electric Flameseal or T&B Flamesafe or other approved method.

## 1.22 CONDUCTORS AND TERMINATIONS

A. Branch conductors shall be copper, feeders as indicated on riser diagram. Conductors shall be insulated for 600v number 12 AWG minimum. Provide wires and cables as indicated listed and suitable for temperature, conditions, and location where installed.

## 1.23 MOTORS AND OTHER WIRING

A. The electrical contractor shall provide all required conduit, wiring, and safety switches for all motors, and other electrical equipment, even though the motors and electrical equipment may be supplied by others. The electrical contractor shall include all work and connections required to make the system complete and operational. Provide magnetic starters for equipment as indicated on the drawings.

B. The electrical equipment may include but not be limited to such items as grille motors and interlocks, exterior and interior signage, starting devices, motor controllers, float switches, alarm devices or systems, push buttons, exhaust fans, data systems, intercoms and stereo systems. The electrical contractor shall verify equipment location and sizes with the trade supplying the equipment before installing the conduit or outlets.

## 1.24 ELEVATOR(S)

A. Furnish and install all required electrical components and connections for elevator operation. Refer to elevator shop drawings for complete information. Provide shunt-trip operation for elevator circuit where required. Include connections for shaft, sump pump, pit light, receptacle, cab light, etc. Basis of design hp and circuit characteristics shown on drawings must be verified with elevator supplier prior to rough-in or installation.

## 1.25 SERVICE ENTRANCE AND DISTRIBUTION EQUIPMENT

A. Electrical contractor must submit drawings for permit and receive approval prior to ordering equipment. No allowances will be made for equipment changes that occur prior to receipt of approved plans.

**1.26 NAMEPLATES**

A. Provide permanent nameplate labeling on all disconnects. Include load served, voltage, phase, horsepower, fuse size, and type.

**1.27 MOUNTING**

A. Mount independent of the mechanical unit housing unless specifically accepted by the local code authority. Provide Unistrut support channels mounted in coordination with roof penetration and patching work. Coordinate with general contractor.

**1.28 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS AND EQUIPMENT**

A. Provide grounding and bonding for electrical service in accordance with NEC article 250.

B. All major parts not carrying current, including but not limited to, secondary feeder circuit, equipment and panelboard enclosures, pull and junction boxes, shall be properly grounded. Metallic raceways shall utilize double locknuts and other fittings as required to provide ground continuity.

**1.29 LIGHTING CONTACTORS**

A. Provide lighting contactors as indicated on drawings. 30A, 12-pole lighting contactor in NEMA 1 enclosure.

**1.30 TELEPHONE SYSTEM**

A. Telephone wiring and system provided by owner. Verify system requirements and rough-in locations with owner prior to start of construction. Electrical contractor shall provide plaster ring and pull string from each device location to above accessible ceiling.

**1.31 SECURITY SYSTEM NOTES**

A. Security wiring and system provided by owner. Verify system requirements and rough-in locations with owner prior to start of construction. Provide power for owner's head-end equipment and remote power for secure doors as required.

**1.32 DATA/POS/A-V/SYSTEM NOTES**

A. Data, POS and/or A-V wiring and systems provided by owner. Verify system requirements and rough-in locations with owner prior to start of construction. Electrical contractor shall provide plaster ring and pull string from each device location to above accessible ceiling.

**1.33 FIRE ALARM SYSTEM**

A. Fire alarm system to be design-build by contractor. Contractor shall provide all required drawings and submit to authorities. Refer to architect’s code sheet for relevant design criteria. Submit drawings to Owner/Architect for review prior to submitting to authorities. Provide required items including but not limited to relay modules, monitor modules, return-air detectors, elevator recall, etc. Provide remote annunciator panel(s) at location(s) approved by Architect and authorities.

**END OF SECTION 26000**

# SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.

B. Related Requirements:

1. Section 260513 "Medium-Voltage Cables" for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 2001 to 35,000 V.
2. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2 and 3 control cables.
3. Section 271500 "Communications Horizontal Cabling" for cabling used for voice and data circuits.

### 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 CONDUCTORS AND CABLES

A. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.

B. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THW-2 Type THHN-2-THWN-2 Type XHHW-2 Type UF Type USE and Type S].

C. Multiconductor Cable: Comply with NEMA WC 70/ICEA S-95-658 for armored cable, Type AC metal-clad cable, Type MC nonmetallic-sheathed cable, Type SO with ground wire.

D. VFC Cable:

1. Comply with UL 1277, UL 1685, and NFPA 70 for Type TC-ER cable.
2. Type TC-ER with oversized crosslinked polyethylene insulation, [spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire] [dual spirally wrapped copper tape shields and three bare symmetrically applied ground wires], and sunlight- and oil-resistant outer PVC jacket.

3. Comply with UL requirements for cables in [direct burial] [Classes I and II, Division 2 hazardous location] applications.

2.2 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SYSTEM DESCRIPTION

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

B. Comply with NFPA 70.

**PART 3 - EXECUTION**

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper for feeders smaller than No. 4 AWG; copper or aluminum for feeders No. 4 AWG and larger. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger, except VFC cable, which shall be extra flexible stranded.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type XHHW-2, single conductors in raceway

B. Exposed Feeders: Type THHN-2-THWN-2, single conductors in raceway Type XHHW-2, single conductors in raceway Armored cable, Type AC Metal-clad cable, Type MC

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-2-THWN-2, single conductors in raceway Armored cable, Type AC Metal-clad cable, Type MC

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-2-THWN-2, single conductors in raceway Type XHHW-2, single conductors in raceway

E. Feeders Installed below Raised Flooring: Type THHN-2-THWN-2, single conductors in raceway Armored cable, Type AC Metal-clad cable, Type MC.

F. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-2-THWN-2, single conductors in raceway Armored cable, Type AC Metal-clad cable, Type MC

G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-2-THWN-2, single conductors in raceway Armored cable, Type AC Metal-clad cable, Type MC

H. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-2-THWN-2, single conductors in raceway Type XHHW-2, single conductors in raceway

I. Branch Circuits Installed below Raised Flooring: Type THHN-2-THWN-2, single conductors in raceway Armored cable, Type AC Metal-clad cable, Type MC.

J. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

K. VFC Output Circuits: Type XHHW-2 in metal conduit

## 3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

## 3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Make splices, terminations, and taps that are compatible with conductor material [and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors].

1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches (300 mm) of slack.

## 3.5 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors and conductors feeding the following critical equipment and services for compliance with requirements.

2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.

    a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
    b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

B. Test and Inspection Reports: Prepare a written report to record the following:

1. Procedures used.
2. Results that comply with requirements.
3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

C. Cables will be considered defective if they do not pass tests and inspections.

**END OF SECTION 260519**

# SECTION 260526- GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes grounding and bonding systems and equipment.

### 1.2 ACTION SUBMITTALS

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

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

### 2.2 SYSTEM DESCRIPTION

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

B. Comply with UL 467 for grounding and bonding materials and equipment.

### 2.3 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

### 2.4 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression or exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

## 2.5 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel 3/4 inch by 10 feet

# PART 3 - EXECUTION

## 3.1 APPLICATIONS

A. Contractor to provide grounding and bonding as required for electrical systems. Grounding and bonding is considered means and methods of construction, and should be completed by the electrical contractor in accordance with NEC 250.

B. Any gas piping systems must be bonded per utility provider's installation guidelines where required.

C. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

D. Underground Grounding Conductors: Install bare copper conductor, No. 6 AWG minimum.

1. Bury at least 24 inches below grade.

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 AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

## 3.3 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 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 above to 6 inches below concrete. Seal floor opening with waterproof, non-shrink 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 conductor level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

D. Pad-Mounted Transformers and Switches: Install two ground rods 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. 2 AWG for taps to equipment grounding terminals.

## 3.4 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Retain applicable subparagraphs below.
2. Feeders and branch circuits.
3. Lighting circuits.
4. Receptacle circuits.
5. Single-phase motor and appliance branch circuits.
6. Three-phase motor and appliance branch circuits.
7. Flexible raceway runs.
8. Armored and metal-clad cable runs.
9. 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.
10. X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

D. Water Heater, Heat-Tracing, and Anti-frost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

E. 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.

## 3.5 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.

2. For grounding electrode system, install at least two rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.

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.

E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.

2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.

3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

F. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

## 3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

**END OF SECTION 260526**

# SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

### 1.2 PERFORMANCE REQUIREMENTS

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

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of [five] times the applied force.

### 1.3 ACTION SUBMITTALS

A. Product Data: For steel slotted support systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Equipment supports.

### 1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

### 1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

## PART 2 - PRODUCTS

### 2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
2. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
3. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
4. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

### 2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

## PART 3 - EXECUTION

### 3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by]NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single-bolt conduit clamps

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

### 3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
6. To Steel: [Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts] [Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69] [Spring-tension clamps].
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

## 3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

## 3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi (20.7-MPa) 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

## 3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touchup: Comply with requirements in Section 099600 "High Performance Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

**END OF SECTION 260529**

# SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Metal wireways and auxiliary gutters.
4. Nonmetal wireways and auxiliary gutters.
5. Surface raceways.
6. Boxes, enclosures, and cabinets.
7. Handholes and boxes for exterior underground cabling.

B. Related Requirements:

1. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior duct banks, manholes, and underground utility construction.
2. Section 270528 "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.
3. Section 280528 "Pathways for Electronic Safety and Security" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving electronic safety and security.

### 1.2 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. LEED Submittals:

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

C. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

### 1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of conduit groups with common supports.

2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Seismic Qualification Certificates: For enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal components, from manufacturer.

## PART 2 - PRODUCTS

### 2.1 METAL CONDUITS, TUBING, AND FITTINGS

A. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. GRC: Comply with ANSI C80.1 and UL 6.

C. ARC: Comply with ANSI C80.5 and UL 6A.

D. IMC: Comply with ANSI C80.6 and UL 1242.

E. PVC-Coated Steel Conduit: PVC-coated rigid

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch (1 mm), minimum.

F. EMT: Comply with ANSI C80.3 and UL 797.

G. FMC: Comply with UL 1; zinc-coated steel or aluminum.

H. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

I. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
2. Fittings for EMT:

a. Material: Steel or die cast.
b. Type: Setscrew or compression.

3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.

J. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

### 2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

A. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ENT: Comply with NEMA TC 13 and UL 1653.

C. RNC: Type EPC-40-PVC complying with NEMA TC 2 and UL 651 unless otherwise indicated.

D. LFNC: Comply with UL 1660.

E. Continuous HDPE: Comply with UL 651B.

F. Coilable HDPE: Preassembled with conductors or cables and complying with ASTM D 3485.

G. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

H. Fittings for LFNC: Comply with UL 514B.

I. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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

## 2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 3R unless otherwise indicated, and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

## 2.4 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

A. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.

C. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.

D. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.

E. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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

## 2.5 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Surface Metal Raceways: Galvanized steel with snap on covers complying with UL 5.

C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.

D. Tele-Power Poles:

1. Material: Galvanized steel with ivory baked-enamel finish
2. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

## 2.6 BOXES, ENCLOSURES, AND CABINETS

A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.

D. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

E. Metal Floor Boxes:

1. Material: Cast metal or sheet metal.
2. Type: Fully adjustable
3. Shape: Rectangular.
4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Nonmetallic Floor Boxes: Nonadjustable, rectangular.

1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 lb (23 kg) shall be listed and marked for the maximum allowable weight.

H. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb (32 kg).

1. Listing and labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

I. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

J. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

K. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

L. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep)

M. Gangable boxes are allowed

N. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Fiberglass.
3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

O. Cabinets:

1. NEMA 250, Type 1galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## 2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.

1. Standard: Comply with SCTE 77.
2. Configuration: Designed for flush burial with closed bottom unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC."
6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

C. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of fiberglass.

1. Standard: Comply with SCTE 77.
2. Configuration: Designed for flush burial with closed bottom unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, ["ELECTRIC."]
6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

## PART 3 - EXECUTION

### 3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC
2. Concealed Conduit, Aboveground: EMT
3. Underground Conduit: RNC, Type EPC-80-PVC
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R

B. Indoors: Apply raceway products as specified below unless otherwise indicated.

1. Exposed, Not Subject to Physical Damage: EMT or RNC.
2. Exposed, Not Subject to Severe Physical Damage: EMT
3. Exposed and Subject to Severe Physical Damage: GRC Raceway locations include the following:

    a. Loading dock.
    b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    c. Mechanical rooms.
    d. Gymnasiums.

4. Concealed in Ceilings and Interior Walls and Partitions: EMT
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: GRC or IMC.
7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size: [1/2-inch (16-mm)] [3/4-inch (21-mm)] trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and

fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.

3. EMT: Use setscrew or compression, steel fittings. Comply with NEMA FB 2.10.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface raceways only where indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

## 3.2 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

D. Arrange stub-ups so curved portions of bends are not visible above finished slab.

E. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches (300 mm) of changes in direction.

F. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

G. Support conduit within 12 inches (300 mm) of enclosures to which attached.

H. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot (3-m) intervals.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Arrange raceways to keep a minimum of 2 inches (50 mm of concrete cover in all directions.
4. Do not embed thread-less fittings in concrete unless specifically approved by Architect for each specific location.
5. Change from ENT to GRC before rising above floor.

I. Stub-ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

J. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

K. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

L. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

M. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch (35-mm) trade size and insulated throat metal bushings on 1-1/2-inch (41-mm) trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

N. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

O. Surface Raceways:

1. Install surface raceway with a minimum 2-inch (50-mm) radius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

P. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces.

Q. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service raceway enters a building or structure.
3. Where otherwise required by NFPA 70.

R. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C) and that has straight-run length that exceeds 25 feet (7.6 m).
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

    a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
    b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C temperature change.
    c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
    d. Attics: 135 deg F (75 deg C)] temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per degree F (0.06 mm per meter of length of straight run per degree C) of temperature change for PVC conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

S. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches (1830 mm) of flexible conduit for [recessed and semi-recessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

T. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to [center] [top] [bottom] of box unless otherwise indicated.

U. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between the box and cover plate or the supported equipment and box.

V. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

W. Locate boxes so that cover or plate will not span different building finishes.

X. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

Y. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

Z. Set metal floor boxes level and flush with finished floor surface.

AA. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

## 3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches (150 mm) in nominal diameter.
2. Install backfill as specified in Section 312000 "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."

4. Install manufactured duct elbows for stub-up at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches (75 mm) of concrete for a minimum of 12 inches (300 mm) on each side of the coupling.
    b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

6. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

## 3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.

D. Install handholes with bottom below frost line

E. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

## 3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

## 3.6 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

## 3.7 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

**DOCUMENT 002213 - SUPPLEMENTARY INSTRUCTIONS TO BIDDERS**

**3.8 INSTRUCTIONS TO BIDDERS**

A. Instructions to Bidders for Project consist of the following:

1. AIA Document A701, "Instructions to Bidders," a copy of which is bound in this Project Manual.
2. The following Supplementary Instructions to Bidders that modify and add to the requirements of the Instructions to Bidders.

**3.9 SUPPLEMENTARY INSTRUCTIONS TO BIDDERS, GENERAL**

A. The following supplements modify AIA Document A701, "Instructions to Bidders." Where a portion of the Instructions to Bidders is modified or deleted by these Supplementary Instructions to Bidders, unaltered portions of the Instructions to Bidders shall remain in effect.

**3.10 ARTICLE 2 - BIDDER'S REPRESENTATIONS**

A. Add Section 2.1.3.1:

1. 2.1.3.1 - The Bidder has investigated all required fees, permits, and regulatory requirements of authorities having jurisdiction and has properly included in the submitted bid the cost of such fees, permits, and requirements not otherwise indicated as provided by Owner.

B. Add Section 2.1.6:

1. 2.1.6 - The Bidder has incorporated into the Bid adequate sums for work performed by installers whose qualifications meet those indicated in the Procurement and Contracting Documents.

**3.11 ARTICLE 3 - BIDDING DOCUMENTS**

A. 3.4 - Addenda:

1. Delete Section 3.4.3 and replace with the following:

a. 3.4.3 - Addenda may be issued at any time prior to the receipt of bids.

**3.12 ARTICLE 4 - BIDDING PROCEDURES**

A. 4.1 - Preparation of Bids:

1. Add Section 4.1.8:

    a. 4.1.8 - The Bid shall include unit prices when called for by the Procurement and Contracting Documents. Owner may elect to consider unit prices in the determination of award. Unit prices will be incorporated into the Contract.

2. Add Section 4.1.9:

    a. 4.1.9 - Owner may elect to disqualify a bid due to failure to submit a bid in the form requested, failure to bid requested alternates or unit prices, failure to complete entries in all blanks in the Bid Form, or inclusion by the Bidder of any alternates, conditions, limitations or provisions not called for.

### 3.13 ARTICLE 8 - FORM OF AGREEMENT BETWEEN OWNER AND CONTRACTOR

A. Refer to Section 006000 “Project Forms” for an enumeration of project forms.

**END OF DOCUMENT 002213**

# SECTION 260544- SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:

1. Product Data for Credit EQ 4.1: For sealants, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit EQ 4: For sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## PART 2 - PRODUCTS

### 2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral water stop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.

2. Minimum Metal Thickness:

   a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.

   b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

## 2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

2. Pressure Plates: Carbon steel

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

## 2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, water stop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber water stop collar with center opening to match piping OD.

## 2.4 GROUT

A. Description: Non-shrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, 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.

## 2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

2. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.

## PART 3 - EXECUTION

### 3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

    a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
    b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall, so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed

4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.

5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.

2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

### 3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

### 3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position water stop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

**END OF SECTION 260544**

# SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each electrical identification product indicated.

### 1.3 QUALITY ASSURANCE

A. Comply with ANSI A13.1.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

## PART 2 - PRODUCTS

### 2.1 POWER RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways Carrying Circuits at 600 V or Less:

1. Black letters on an orange field
2. Legend: Indicate voltage and system or service type.

C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

D. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

F. Write-On Tags: Polyester tag, 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

## 2.2 ARMORED AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Colors for Raceways Carrying Circuits at 600 V and Less:

1. Black letters on an orange field
2. Legend: Indicate voltage and system or service type.

C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

D. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50 mm) wide; compounded for outdoor use.

## 2.3 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Write-On Tags: Polyester tag, 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

D. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

## 2.4 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

D. Write-On Tags: Polyester tag, 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

## 2.5 FLOOR MARKING TAPE

A. 2-inch- (50-mm-) wide, 5-mil (0.125-mm) pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

## 2.6 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE

## 2.7 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Baked-Enamel Warning Signs:

1. Pre-printed aluminum signs punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch (6.4-mm) grommets in corners for mounting.
3. Nominal size, 7 by 10 inches (180 by 250 mm).

D. Metal-Backed, Butyrate Warning Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application.
2. 1/4-inch (6.4-mm) grommets in corners for mounting.
3. Nominal size, 10 by 14 inches (250 by 360 mm).

E. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

## 2.8 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. inches (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.

1. Engraved legend with black letters on white face
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm).

C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

## 2.9 EQUIPMENT IDENTIFICATION LABELS

A. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

B. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

C. Stenciled Legend: In nonfading, waterproof, blackink or paint. Minimum letter height shall be 1 inch (25 mm)

## 2.10 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

B. Apply identification devices to surfaces that require finish after completing finish work.

C. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

D. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

E. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.

F. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches (400 mm) overall.

G. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

## 3.2 IDENTIFICATION SCHEDULE

A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30A, and 208V to ground: Install labels at 30-foot (10-m) maximum intervals.

B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

1. Emergency Power.
2. Power.
3. UPS.

C. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase [ and Voltage Level] Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit] conductors.

    a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
    b. Colors for 208/120-V Circuits:

        1) Phase A: Black.
        2) Phase B: Red.
        3) Phase C: Blue.

    c. Colors for 480/277-V Circuits:

        1) Phase A: Brown.
        2) Phase B: Orange.
        3) Phase C: Yellow.

    d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

D. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

E. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.

F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

G. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

1. Limit use of underground-line warning tape to direct-buried cables.
2. Install underground-line warning tape for both direct-buried cables and cables in raceway.

H. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: [Self-adhesive warning labels.

1. Comply with 29 CFR 1910.145.
2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.

4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:

    a. Power transfer switches.
    b. Controls with external control power connections.

J. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

K. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer

L. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

    a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.
    b. Outdoor Equipment: Engraved, laminated acrylic or melamine label
    c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
    d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

**END OF SECTION 260553**

# SECTION 260923- LIGHTING CONTROL DEVICES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Time switches.
2. Photoelectric switches.
3. Indoor occupancy and switchbox-mounted occupancy sensors.

B. Related Requirements:
1. Section 262726 "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

### 1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

### 1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data

## PART 2 - PRODUCTS

### 2.1 INDOOR OCCUPANCY SENSORS

A. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.

B. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

D. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.

E. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.

F. Mounting:

1. Sensor: Suitable for mounting in any position on a standard outlet box.

2. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
3. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door

G. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
1. Bypass Switch: Override the "on" function in case of sensor failure.
2. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lux); turn lights off when selected lighting level is present.

H. PIR Type: Ceiling mounted; detect occupants in coverage area by their heat and movement.
1. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).
2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
3. Detection Coverage (Corridor): Detect occupancy within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling.

I. Ultrasonic Type: Ceiling mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy.
1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. (56 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. (186 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling in a corridor not wider than 14 feet (4.3 m).

J. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

## 2.2 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application [and shall comply with California Title 24].
2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.

B. Wall-Switch Sensor Tag WS1:

1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of [900 sq. ft. (84 sq. m)] [2100 sq. ft (196 sq. m)].
2. Sensing Technology: Dual technology - PIR and ultrasonic.
3. Switch Type: SP, field selectable automatic "on," or manual "on" automatic "off."
4. Voltage: Match the circuit voltage dual-technology type.
5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
7. Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.
8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

C. Wall-Switch Sensor Tag WS2:

1. Standard Range: 210-degree field of view, with a minimum coverage area of 900 sq. ft. (84 sq. m).
2. Sensing Technology: PIR.
3. Switch Type: SP, field selectable automatic "on," or manual "on" automatic "off."
4. Voltage: Match the circuit voltage dual-technology type.
5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
7. Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.
8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

## 2.3 LIGHTING CONTACTORS

A. Description: Electrically operated and electrically held, combination-type lighting contactors with fusible switch, complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.

3. Enclosure: Comply with NEMA 250.

4. Provide with control and pilot devices as indicated on Drawings matching the NEMA type specified for the enclosure.

### 2.4 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

B. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.

C. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

D. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch (13 mm).

E. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."

### 3.2 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to evaluate lighting control devices and perform tests and inspections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Lighting control devices will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

**END OF SECTION 260923**

**SECTION 262416- PANELBOARDS**

**PART 1 - GENERAL**

1.1 **SUMMARY**

A. Section includes distribution panelboards and lighting and appliance branch-circuit panelboards.

1.2 **ACTION SUBMITTALS**

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

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Include evidence of NRTL listing for series rating of installed devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
7. Include wiring diagrams for power, signal, and control wiring.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards.

1.3 **INFORMATIONAL SUBMITTALS**

A. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."

B. Field quality-control reports.

C. Panelboard schedules for installation in panelboards.

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. Comply with NEMA PB 1.

C. Comply with NFPA 70.

1.6 **WARRANTY**

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: One year from date of Substantial Completion.

**PART 2 - PRODUCTS**

2.1 **GENERAL REQUIREMENTS FOR PANELBOARDS**

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."

B. Enclosures: Flush- and surface-mounted cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1

b. Outdoor Locations: NEMA 250, Type 3R

c. Other Wet or Damp Indoor Locations: NEMA 250, Type 3R.

2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.

3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.

4. Directory Card: Inside panelboard door, mounted in transparent card holder.

C. Incoming Mains Location: Top and bottom.

D. Phase, Neutral, and Ground Buses: Tin-plated aluminum.

E. Include instructions in first paragraph below if special sizing or oversizing of lugs is required, if allowing optional use of aluminum for circuits sized for copper conductors, or when upsizing conductors for voltage drop.

F. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.

2. Main and Neutral Lugs: Compression type.

3. Ground Lugs and Bus Configured Terminators: Compression type.

4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

5. Sub-feed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

G. Service Equipment Label: NRTL labeled for use as service equipment for panelboards with one or more main service disconnecting and overcurrent protective devices.

H. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

I. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include size and type of allowable upstream and branch devices and listed and labeled for series-connected short-circuit rating by an NRTL.

J. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

## 2.2 DISTRIBUTION PANELBOARDS

A. Panelboards: NEMA PB 1, power and feeder distribution type.

B. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

C. Mains: Circuit breaker

D. Branch Overcurrent Protective Devices: For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

E. Branch Overcurrent Protective Devices: For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

F. Branch Overcurrent Protective Devices: Fused switches.

## 2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

B. Mains: Circuit breaker

C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

D. Contactors in Main Bus: NEMA ICS 2, Class A, electrically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

1. External Control-Power Source: 120-V branch circuit

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

F. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

## 2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with series-connected rating to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

a. Instantaneous trip.

b. Long- and short-time pickup levels.

c. Long- and short-time time adjustments.

d. Ground-fault pickup level, time delay, and I squared x t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.

5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

6. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).

7. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.

8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

a. Standard frame sizes, trip ratings, and number of poles.

b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.

c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.

d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

e. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.

f. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

B. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

1. Fuses, and Spare-Fuse Cabinet: Comply with requirements specified in Section 262813 "Fuses."

## 2.5 ACCESSORY COMPONENTS AND FEATURES

A. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Receive, inspect, handle, store and install panelboards and accessories according to NECA 407.

B. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

C. Mount top of trim 90 inches above finished floor unless otherwise indicated.

D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

E. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

F. Install filler plates in unused spaces.

G. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

H. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

I. Comply with NECA 1.

## 3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads and incorporating Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

## 3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

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

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

**END OF SECTION 262416**

# SECTION 262726 - WIRING DEVICES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Weather-resistant receptacles.
3. Snap switches and wall-box dimmers.
4. Solid-state fan speed controls.
5. Wall-switch and exterior occupancy sensors.
6. Communications outlets.

### 1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Receptacles for Owner-Furnished Equipment: Match plug configurations.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: List of legends and description of materials and process used for pre-marking wall plates.

### 1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

### 1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

## 2.2 GENERAL WIRING-DEVICE REQUIREMENTS

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

B. Comply with NFPA 70.

C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:

1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
2. Devices shall comply with the requirements in this Section.

## 2.3 STRAIGHT-BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

1.

## 2.4 GFCI RECEPTACLES

A. General Description:

1. Straight blade, non-feed-through type.
2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
1. Where the receptacle is rendered inaccessible by equipment provide GFCI protection at the circuit breaker.

## 2.5 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A:

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

a. Single Pole:

1) Cooper; AH1221.
2) Hubbell; HBL1221.
3) Leviton; 1221-2.
4) Pass & Seymour; CSB20AC1.

b. Two Pole:

1) Cooper; AH1222.
2) Hubbell; HBL1222.
3) Leviton; 1222-2.
4) Pass & Seymour; CSB20AC2.

c. Three Way:

1) Cooper; AH1223.
2) Hubbell; HBL1223.
3) Leviton; 1223-2.
4) Pass & Seymour; CSB20AC3.

d. Four Way:

1) Cooper; AH1224.
2) Hubbell; HBL1224.
3) Leviton; 1224-2.
4) Pass & Seymour; CSB20AC4.

C. Pilot-Light Switches, 20 A:

1. Description: Single pole, with neon-lighted handle, illuminated when switch is "off."

D. Key-Operated Switches, 120/277 V, 20 A:

1. Description: Single pole, with factory-supplied key in lieu of switch handle.

## 2.6 DECORATOR-STYLE DEVICES

A. Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, and UL 498.

B. GFCI, Feed Through Type, Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, UL 498, and UL 943 Class A.

C. Toggle Switches, Square Face, 120/277 V, 15 A: Comply with NEMA WD 1, UL 20, and FS W-S-896.

D. Lighted Toggle Switches, Square Face, 120 V, 15 A: Comply with NEMA WD 1 and UL 20.

1. Description: With neon-lighted handle, illuminated when switch is "off."

## 2.7 RESIDENTIAL DEVICES

A. Fan Speed Controls:

1. Modular, 120-V, full-wave, solid-state units with integral, quiet on-off switches and audible frequency and EMI/RFI filters.
2. Comply with UL 1917.
3. Continuously adjustable toggle switch
4. Three-speed adjustable slider1.5 A.

B. Telephone Outlet:

1. Description: Single RJ-45 jack for terminating 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with [Category 5e] <Insert category>. Comply with UL 1863.

C. Combination TV and Telephone Outlet:

1. Description: Single RJ-45 jack for 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with [Category 5e] <Insert category>. Comply with UL 1863.

## 2.8 WALL-BOX DIMMERS

A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.

C. Incandescent Lamp Dimmers: 120 V; control shall follow square law dimming curve. On-off switch positions shall bypass dimmer module.

1. 600 W; dimmers shall require no derating when ganged with other devices

D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

## 2.9 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Smooth, high-impact thermoplastic 0.035-inch- (1-mm-) thick, satin-finished,
3. Material for Unfinished Spaces: Galvanized steel
4. Material for Damp Locations: [Thermoplastic] [Cast aluminum] with spring-loaded lift cover and listed and labeled for use in wet and damp locations.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant thermoplastic with lockable cover.

## 2.10 FINISHES

A. Device Color:

1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Emergency Power System: Red
3. TVSS Devices: Blue.

B. Wall Plate Color: For plastic covers, match device color.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:

    a. Cut back and pigtail or replace all damaged conductors.
    b. Straighten conductors that remain and remove corrosion and foreign matter.
    c. Pig-tailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors online and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.

I. Adjust locations of service poles to suit arrangement of partitions and furnishings.

## 3.2 GFCI RECEPTACLES

A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

## 3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions remove malfunctioning units and replace with new ones, and retest as specified above.

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

D. Prepare test and inspection reports.

**END OF SECTION 262726**

**SECTION 262813 - FUSES**

**PART 1 - GENERAL**

**1.1 SUMMARY**

A. Section Includes:

1. Cartridge fuses rated 600 V ac and less for use in the following:

a. Control circuits.

b. Motor-control centers.

c. Panelboards.

d. Switchboards.

e. Enclosed controllers.

f. Enclosed switches.

**1.2 ACTION SUBMITTALS**

A. Product Data: For each type of product.

**1.3 CLOSEOUT SUBMITTALS**

A. Operation and maintenance data.

**PART 2 - PRODUCTS**

**2.1 CARTRIDGE FUSES**

A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

1. Type RK-1: 600-V, zero- to 600-A rating, 200 kAIC, time delay.

2. Type RK-5: 600-V, zero- to 600-A rating, 200 kAIC, time delay.

3. Type CC: 600-V, zero- to 30-A rating, 200 kAIC , time delay.

4. Type CD: 600-V, 31- to 60-A rating, 200 kAIC , time delay.

5. Type J: 600-V, zero- to 600-A rating, 200 kAIC, time delay

6. Type L: 600-V, 601- to 6000-A rating, 200 kAIC, time delay.

7. Type T: 600-V, zero- to 800-A rating, 200 kAIC  fast acting

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

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install spare-fuse cabinet(s) in location shown on the Drawings or as indicated in the field by Owner.

**3.2 IDENTIFICATION**

A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

**END OF SECTION 262813**

# SECTION 262816- ENCLOSED SWITCHES AND CIRCUIT BREAKERS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Non-fusible switches.
3. Receptacle switches.
4. Shunt trip switches.
5. Molded-case circuit breakers (MCCBs).
6. Enclosures.

### 1.2 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

### 1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified".

### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

### 1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.

B. Field quality-control reports.

### 1.6 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

### 1.7 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

## PART 2 - PRODUCTS

### 2.1 FUSIBLE SWITCHES

A. Type GD, General Duty, Single Throw, 240-V ac, 800 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with cartridge fuse interiors to accommodate fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

B. Type HD, Heavy Duty, Single Throw, 600V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Six Pole, Single Throw, 600V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Type HD, Heavy Duty, Double Throw, 600V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

E. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Lugs: Suitable for number, size, and conductor material.
5. Service-Rated Switches: Labeled for use as service equipment.

### 2.2 NONFUSIBLE SWITCHES

A. Type GD, General Duty, Single Throw, 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Type HD, Heavy Duty, Double Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

E. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Lugs: Suitable for number, size, and conductor material.

## 2.3 MOLDED-CASE CIRCUIT BREAKERS

A. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

B. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

C. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

1. Instantaneous trip.
2. Long- and short-time pickup levels.
3. Long- and short-time time adjustments.
4. Ground-fault pickup level, time delay, and I2t response.

D. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

E. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
6. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
7. Alarm Switch: One NO contact that operates only when circuit breaker has tripped.

## 2.4 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices.

E. Comply with NECA 1.

### 3.2 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

### 3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

**END OF SECTION 262816**

# SECTION 265100- INTERIOR LIGHTING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Interior lighting fixtures, lamps, and ballasts.
2. Emergency lighting units.
3. Exit signs.
4. Lighting fixture supports.

B. Related Sections:

1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
2. Section 260943.13 "Addressable-Fixture Lighting Controls" and Section 260943.23 "Relay-Based Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.
3. Section 262726 "Wiring Devices" for manual wall-box dimmers for incandescent lamps.
4. Section 265561 "Theatrical Lighting" for theatrical lighting fixtures and their controls.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, and finishes.

B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, from manufacturer.

### 1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

### 1.4 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide product indicated on Drawings

## 2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.

C. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

D. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.

E. Metal Parts: Free of burrs and sharp corners and edges.

F. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.

G. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re-lamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re-lamping and when secured in operating position.

H. Diffusers and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
    a. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
    b. UV stabilized.
2. Glass: Annealed crystal glass unless otherwise indicated.

I. Air-Handling Fluorescent Fixtures: For use with plenum ceiling for air return and heat extraction and for attaching an air-diffuser-boot assembly specified in Section 233713 "Diffusers, Registers, and Grilles."

1. Air-Supply Units: Slots in one or both side trims join with air-diffuser-boot assemblies.
2. Heat-Removal Units: Air path leads through lamp cavity.
3. Combination Heat-Removal and Air-Supply Unit: Heat is removed through lamp cavity at both ends of the fixture door with air supply same as for air-supply units.
4. Dampers: Operable from outside fixture for control of return-air volume.
5. Static Fixture: Air-supply slots are blanked off, and fixture appearance matches active units.

## 2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS

A. General Requirements for Electronic Ballasts:

1. Comply with UL 935 and with ANSI C82.11.
2. Designed for type and quantity of lamps served.
3. Ballasts shall be designed for full light output unless another BF, dimmer, or bi-level control is indicated.
4. Sound Rating: Class A except Class B for T12/HO and T12/Slimline lamp ballasts.
5. Total Harmonic Distortion Rating: Less than 10percent.

6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
7. Operating Frequency: 42 kHz or higher.
8. Lamp Current Crest Factor: 1.7 or less.
9. BF: 0.88 or higher.
10. Power Factor: 0.98 or higher.

B. Luminaires controlled by occupancy sensors shall have programmed-start ballasts.

C. Electromagnetic Ballasts: Comply with ANSI C82.1; energy saving, high-power factor, Class P, and having automatic-reset thermal protection.

1. Ballast Manufacturer Certification: Indicated by label.

D. Single Ballasts for Multiple Lighting Fixtures: Factory wired with ballast arrangements and bundled extension wiring to suit final installation conditions without modification or rewiring in the field.

E. Ballasts for Low-Temperature Environments: Electronic or electromagnetic type rated for 0 deg F starting and operating temperature with indicated lamp types.

F. Ballasts for Residential Applications: Fixtures designated as "Residential" may use low-power-factor electronic ballasts having a Class B sound rating and total harmonic distortion of approximately 30 percent.

G. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.

1. Dimming Range: 100 to 5 percent of rated lamp lumens.
2. Ballast Input Watts: Can be reduced to 20 percent of normal.
3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.
4. Control: Coordinate wiring from ballast to control device to ensure that the ballast, controller, and connecting wiring are compatible.

H. Ballasts for Bi-Level Controlled Lighting Fixtures: Electronic type.

1. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level and off.
    a. High-Level Operation: 100 percent of rated lamp lumens.
    b. Low-Level Operation: 30 percent of rated lamp lumens.
2. Ballast shall provide equal current to each lamp in each operating mode.
3. Compatibility: Certified by manufacturer for use with specific bi-level control system and lamp type indicated.

I. Ballasts for Tri-Level Controlled Lighting Fixtures: Electronic type.

1. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level and off.
    a. High-Level Operation: 100 percent of rated lamp lumens.
    b. Low-Level Operation: 30 and 60 percent of rated lamp lumens.
2. Ballast shall provide equal current to each lamp in each operating mode.

3. Compatibility: Certified by manufacturer for use with specific tri-level control system and lamp type indicated.

## 2.4 BALLASTS FOR COMPACT FLUORESCENT LAMPS

A. Description: Electronic-programmed rapid-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:

1. Lamp end-of-life detection and shutdown circuit.
2. Automatic lamp starting after lamp replacement.
3. Sound Rating: Class A.
4. Total Harmonic Distortion Rating: Less than 20 percent.
5. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
6. Operating Frequency: 20 kHz or higher.
7. Lamp Current Crest Factor: 1.7 or less.
8. BF: 0.95 or higher unless otherwise indicated.
9. Power Factor: 0.98 except fixtures designated as "Residential" may use low-power-factor electronic ballasts or higher.
10. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for non-consumer equipment.

## 2.5 EMERGENCY FLUORESCENT POWER UNIT

A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.

1. Emergency Connection: Operate one fluorescent lamp(s) continuously at an output of 1100 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
2. Nightlight Connection: Operate one fluorescent lamp continuously.
3. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
    a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
4. Battery: Sealed, maintenance-free, nickel-cadmium type.
5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
6. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

## 2.6 BALLASTS FOR HID LAMPS

A. Electromagnetic Ballast for Metal-Halide Lamps: Comply with ANSI C82.4 and UL 1029. Include the following features unless otherwise indicated:

1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
2. Minimum Starting Temperature: Minus 22 deg F for single-lamp ballasts.
3. Rated Ambient Operating Temperature: 104 deg F.
4. Open-circuit operation that will not reduce average life.
5. Low-Noise Ballasts: Manufacturers' standard epoxy-encapsulated models designed to minimize audible fixture noise.

B. Electronic Ballast for Metal-Halide Lamps: Include the following features unless otherwise indicated:

1. Minimum Starting Temperature: Minus 20 deg F for single-lamp ballasts.
2. Rated Ambient Operating Temperature: 130 deg F.
3. Lamp end-of-life detection and shutdown circuit.
4. Sound Rating: Class A.
5. Total Harmonic Distortion Rating: Less than 20 percent.
6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
7. Lamp Current Crest Factor: 1.5 or less.
8. Power Factor: 0.90 or higher.
9. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for non-consumer equipment.
10. Protection: Class P thermal cutout.

C. High-Pressure Sodium Ballasts: Electromagnetic type, with solid-state igniter/starter. Igniter/starter shall have an average life in pulsing mode of 10,000 hours at an igniter/starter-case temperature of 90 deg C.

1. Instant-Restrike Device: Integral with ballast, or solid-state potted module, factory installed within fixture and compatible with lamps, ballasts, and mogul sockets up to 150 W.
2. Minimum Starting Temperature: Minus 40 deg F.

## 2.7 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps for AC Operation: Fluorescent, two for each fixture, 20,000 hours of rated lamp life.
2. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
3. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
    a. Battery: Sealed, maintenance-free, nickel-cadmium type.
    b. Charger: Fully automatic, solid-state type with sealed transfer relay.
    c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

## 2.8 EMERGENCY LIGHTING UNITS

A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.

1. Battery: Sealed, maintenance-free, lead-acid type.

2. Charger: Fully automatic, solid-state type with sealed transfer relay.

3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.

7. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.

## 2.9 FLUORESCENT LAMPS

A. T8 rapid-start lamps, rated 32 W maximum, nominal length of 48 inches, 2800 initial lumens (minimum), CRI 75 (minimum), color temperature 3500K, and average rated life 20,000 hours unless otherwise indicated.

B. T8 rapid-start lamps, rated 17 W maximum, nominal length of 24 inches, 1300 initial lumens (minimum), CRI 75 (minimum), color temperature 3500K, and average rated life of 20,000 hours unless otherwise indicated.

C. Compact Fluorescent Lamps: 4-Pin, CRI 80 (minimum), color temperature 3500K, average rated life of 10,000 hours at three hours operation per start unless otherwise indicated.

1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum).

2. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).

3. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).

4. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).

5. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).

6. 57 W: T4, triple tube, rated 4300 initial lumens (minimum).

7. 70 W: T4, triple tube, rated 5200 initial lumens (minimum).

**LED LUMINAIRES AND DRIVERS**

**A. All Luminaires**

**1. Comply with IES LM-79-08 Approved Method for measuring lumen maintenance of LED light sources.**

**2. Comply with IES LM-80-08 Approved Method for electrical and photometric measurement of SSL product.**

**3. Comply with In-Situ testing for more reliable results.**

**4. LED's shall be Restriction of Hazardous Substances Directive (RoHS) compliant.**

**5. LED arrays shall be sealed, high performance, long life type; minimum 70% rated output at 50,000 hours.**

**6. LED luminaires shall deliver a minimum of 60 lumens per watt.**

**7. Drivers shall be solid state and accept 120 through 277 VAC at 60 Hz input.**

**8. The LED light source shall be fully dimmable with use of compatible dimmers switch designated for low voltage loads.**

**9. LED color temperatures: CRI> 85, 2700K as noted +/- 145K.**

**10. LED color temperatures: CRI> 85, 4000K as noted +/- 275K.**

**11. LED color temperatures: CRI> 85, 5000K as noted +/- 283K.**

**12. Luminaires shall have internal thermal protection.**

**14. Color spatial uniformity shall be within .004 of CIE 1976 diagram.**

**15. Color maintenance over rated life shall be within .007 of CIE 1976.**

**16. Indoor luminaires shall have a minimum CRI of 85.**

**17. Luminaire manufacturers shall adhere to device manufacturer guidelines, certification programs, and test procedures for thermal management**

**18. LED package(s)/module(s)/array(s) used in qualified luminaires shall deliver a minimum 70% of initial lumens, when installed in-situ, for a minimum of 50,000 hours.**

**19. Luminaires shall be fully accessible from below ceiling plane for changing drivers, power supplies and arrays**

B. Power Supplies and Driver

1. Power Factor: 0.90 or higher

2. Maximum driver case temperature not to exceed driver manufacturer recommended in-situ operation.

3. Output operating frequency: 60Hz.

4. Interference: EMI and RFI compliant with FCC 47 CFR Part 15.

5. Total Harmonic Distortion Rating: 20% Maximum.

6. Meet electrical and thermal conditions as described in LM-80 Section 5.0.

7. Primary Current: Confirm primary current with Drawings.

8. Secondary Current: Confirm secondary current specified by individual luminaire manufacturers.

9. Compatibility: Certified by manufacturer for use with individually specified luminaire and individually specified control components.

10. Solid-state control components to be integral or external per each specified luminaire. Remote control gear to be enclosed in Class 1, Class 2, or NEMA 3R enclosures as required.

C. Controller and Control System
1. System electronics driver / controller to use coordinated communication protocols: DMX512, 0-10V, DALI, or proprietary as required

2. The Contractor to ensure that external control equipment is compatible with LED control requirements

3. Provide connector types and wiring as appropriate for un-interrupted communication between devices, considering distance maximums, field obstructions, and accessibility. Ensure that connection points are optically isolated for system noise reduction.

4. For control components that are part of overall area control system see Dimming Controls Specifications.

5. Compatibility: Certified by manufacturer for use with individually specified luminaire and individually specified power supplies and/or drivers

**2.10 LIGHTING FIXTURE SUPPORT COMPONENTS**

A. Comply with Section 260529 "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gauge

E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gauge

F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Provide a new lighting system complete and fully operational and in conformance with code and UL listing requirements. Clean all fixtures at time of job completion utilizing manufacturers approved or recommended cleaning solutions. All fixtures and lamps are provided by this contractor as scheduled unless noted otherwise. Contractor shall furnish all boxes, mounting kits, transformers, controllers, and other components necessary for a complete and fully functional installation.

B. Where dimmers and/or dimming systems are required, contractor to furnish dimmers that are compatible with fixture source and rated for the wattage of the dimming zone. Provide additional dimmers as required to meet zone load requirements.

C. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

D. Comply with NFPA 70 for minimum fixture supports.

E. Suspended Lighting Fixture Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

F. Air-Handling Lighting Fixtures: Install with dampers closed and ready for adjustment.

G. Adjust aimable lighting fixtures to provide required light intensities.

H. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

### 3.2 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

**END OF SECTION 265100**

# SECTION 265600 - EXTERIOR LIGHTING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Exterior luminaires with lamps and ballasts.
2. Luminaire-mounted photoelectric relays.
3. Poles and accessories.

### 1.2 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4-M.

B. [Live Load: Single load of 500 lbf (2224 N), distributed as stated in AASHTO LTS-4-M.]

C. [Ice Load: Load of 3 lbf/sq. ft. (145 Pa), applied as stated in AASHTO LTS-4-M Ice Load Map.]

D. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.

1. Basic wind speed for calculating wind load for poles exceeding 49.2 feet (15 m) in height is [100 mph (45 m/s)]

   a. Wind Importance Factor: [1.0]
   b. Minimum Design Life: [50 years]
   c. Velocity Conversion Factors [1.0]

2. Basic wind speed for calculating wind load for poles 50 feet (15 m) high or less is [100 mph (45 m/s)]

   a. Wind Importance Factor: [1.0]
   b. Minimum Design Life: 25 years]
   c. Velocity Conversion Factors: [1.0]

### 1.3 ACTION SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, and finishes.

### 1.4 QUALITY ASSURANCE

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

B. Comply with IEEE C2, "National Electrical Safety Code."

C. Comply with NFPA 70.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide product indicated on Drawings

### 2.2 GENERAL REQUIREMENTS FOR LUMINAIRES

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

B. [Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.]

### 2.3 2.3 LED DRIVERS AND ARRAYS

A. A. UL 1598 listing.

B. B. LED arrays shall have LED's that produce minimum 55 lumens/watt when operated at 350mA.
1. 1. Lumen Depreciation Data: At 40 deg C ambient, the L70 hours shall be 50,000 at 520 mA driver.
2. 2. LED color: neutral white, 4100 deg K, CRI of 75.

C. C. Drivers shall accept 120 through 480 volts, 50/60 Hz.

D. D. The housing shall have an integral thermal management system with extruded aluminum radiation fins and lateral airways.

E. E. Comply with IES LM-79-08 and LM-90-08 Approved Methods.

F. F. Comply with In-Situ testing for more reliable results.

G. G. LED's shall be Restriction of Hazardous Substances Directive (RoHS) compliant.

### 2.4 FLUORESCENT BALLASTS AND LAMPS

A. Ballasts for Low-Temperature Environments:

1. Temperatures 0 Deg F (Minus 17 Deg C) and Higher: Electronic or electromagnetic type rated for 0 deg F (minus 17 deg C) starting and operating temperature with indicated lamp types.
2. Temperatures Minus 20 Deg F (Minus 29 Deg C) and Higher: Electromagnetic type designed for use with indicated lamp types.

B. Ballast Characteristics:

1. Power Factor: 90 percent, minimum.
2. Sound Rating: Class A.
3. Total Harmonic Distortion Rating: Less than 10 percent.
4. Electromagnetic Ballasts: Comply with ANSI C82.1, energy-saving, high power factor, Class P, automatic-reset thermal protection.
5. Case Temperature for Compact Lamp Ballasts: 65 deg C, maximum.
6. Transient-Voltage Protection: Comply with IEEE C62.41.1 and IEEE C62.41.2, Category A or better.

C. Low-Temperature Lamp Capability: Rated for reliable starting and operation with ballast provided at temperatures 0 deg F (minus 18 deg C) and higher.

## 2.5 BALLASTS FOR HID LAMPS

A. Comply with ANSI C82.4 and UL 1029 and capable of open-circuit operation without reduction of average lamp life. Include the following features unless otherwise indicated:

1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
2. Minimum Starting Temperature: Minus 22 deg F (Minus 30 deg C).
3. Normal Ambient Operating Temperature: 104 deg F (40 deg C).
4. Ballast Fuses: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by ballast manufacturer.

B. [High-Pressure Sodium Ballasts: Electromagnetic type with solid-state igniter/starter and capable of open-circuit operation without reduction of average lamp life. Igniter/starter shall have an average life in pulsing mode of 10,000 hours at an igniter/starter-case temperature of 90 deg C.]

## 2.6 HID LAMPS

A. [High-Pressure Sodium Lamps: ANSI C78.42, CRI 21 (minimum), CCT color temperature [1900] K, and average rated life of 24,000 hours, minimum.]

B. [Metal-Halide Lamps: ANSI C78.43, with minimum CRI 65, and CCT color temperature [4000] K.]

C. [Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and CCT color temperature [4000] <Insert value> K.]

## 2.7 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

A. [Structural Characteristics: Comply with AASHTO LTS-4-M.

1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.
2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of [1.1] to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

1. Materials: Shall not cause galvanic action at contact points.
2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
3. Anchor-Bolt Template: Plywood or steel.

D. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches (65 by 130 mm), with cover secured by stainless-steel captive screws

E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. [Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."]

F. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.

G. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4-M.]

## 2.8 POLE ACCESSORIES

A. Duplex Receptacle: 120 V, 20 A in a weatherproof assembly complying with Section 262726 "Wiring Devices" for ground-fault circuit-interrupter type.

1. Surface mounted, 12 inches (300 mm) above finished grade.
2. Non-metallic polycarbonate plastic or reinforced fiberglass, weatherproof in use, cover, that when mounted results in NEMA 250, Type 3R enclosure.
3. With cord opening.
4. With lockable hasp and latch that complies with OSHA lockout and tag-out requirements.]

B. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

C. Decorative accessories, supplied by decorative pole manufacturer, include the following:

1. Banner Arms:
2. Flag Holders:
3. Ladder Rests:

# PART 3 - EXECUTION

## 3.1 LUMINAIRE INSTALLATION

A. Provide fixtures complete and fully operational and in conformance with code and UL listing requirements. Clean all fixtures at time of job completion utilizing manufacturers approved or recommended cleaning solutions. All fixtures and lamps are provided by this contractor as scheduled unless noted otherwise. Contractor shall furnish all boxes, mounting kits, transformers, controllers, and other components necessary for a complete and fully functional installation.

B. Where dimmers and/or dimming systems are required, contractor to furnish dimmers that are compatible with fixture source and rated for the wattage of the dimming zone. Provide additional dimmers as required to meet zone load requirements.

C. Install lamps in each luminaire.

D. Fasten luminaire to indicated structural supports.

E. Adjust luminaires that require field adjustment or aiming.

## 3.2 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:

1. Fire Hydrants and Storm Drainage Piping: 60 inches (1520 mm).
2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet (3 m).
3. Trees: 15 feet (5 m) from tree trunk.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. [Concrete materials, installation, and finishing requirements are specified in Section 033000 "Cast-in-Place Concrete."]

D. Foundation-Mounted Poles: Mount pole with leveling nuts and tighten top nuts to torque level recommended by pole manufacturer.

1. [Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.]
2. [Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.]
3. Install base covers unless otherwise indicated.
4. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Embedded Poles with Tamped Earth Backfill: Set poles to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.

1. Dig holes large enough to permit use of tampers in the full depth of hole.
2. Backfill in 6-inch (150-mm) layers and thoroughly tamp each layer so compaction of backfill is equal to or greater than that of undisturbed earth.

F. [Embedded Poles with Concrete Backfill: Set poles in augered holes to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.

1. Make holes 6 inches (150 mm) in diameter larger than pole diameter.
2. Fill augered hole around pole with air-entrained concrete having a minimum compressive strength of 3000 psi (20 MPa) at 28 days, and finish in a dome above finished grade.
3. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through concrete dome. Arrange to drain condensation from interior of pole.
4. Cure concrete a minimum of 72 hours before performing work on pole.]

G. [Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch- (150-mm-) wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch (25 mm) below top of concrete slab.]

H. Raise and set poles using web fabric slings (not chain or cable).

## 3.3 BOLLARD LUMINAIRE INSTALLATION

A. Align units for optimum directional alignment of light distribution.

B. Install on concrete base with top 4 inches (100 mm) above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. [Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."]

## 3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTED LUMINAIRES

A. Install on concrete base with top 4 inches (100 mm) above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."]

## 3.5 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

## 3.6 GROUNDING

A. Ground metal poles and support structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole unless otherwise indicated.
2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. Ground nonmetallic poles and support structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole.
2. Install grounding conductor and conductor protector.
3. Ground metallic components of pole accessories and foundations.

**END OF SECTION 265600**

SECTION 270500 - BASIC COMMUNICATIONS REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Reference: Codes and standards may define additional specifications or requirements not specifically called out within this division. The Contractor shall adhere to most stringent requirements as defined herein.

B. Architectural and Engineering specifications may have additional conditions or requirements that affect the work defined by this division of specifications. Contractor shall be responsible for the coordination of all conditions and other trade requirements that may impact schedule, scope of work, work progress, or other factors that may affect the overall ability for contractor to execute the requirements of this division of specifications.

1.2 GENERAL

A. The Communications/Technology package has work (labor and/or materials) to be provided by the General, Electrical, Technology, Plumbing, Fire Suppression or HVAC Contractor or their sub-contractors contractor for communications pathways, grounding, cable tray, etc. The Contractors shall refer to the specifications and drawings for items identified as provided by others on the contract documents and drawings. Understanding that the contractors for mechanical and electrical work could be sub-contractors to the (General) Contractor, such assignments are not intended to restrict the Contractor in assignment of work among the sub-contractor to accommodate trade agreements and practices or the normal conduct of the construction work. All other items as per these contract documents shall be provided by the Telecommunications Contractor.

B. Drawings and Specifications are to be considered as supplementing each other and shall be included within the contract documents. Work described on either document shall be provided and incorporated into the project whether it is specifically identified on the corresponding document.

1.3 CONTRACT DOCUMENTS

A. The drawings accompanying these specifications are complementary each to the other and what is called for by one shall be as if called for by both. When a discrepancy exists between the Drawings and Specifications, whichever has a greater cost in value must be included for bidding purposes. Questions should be submitted prior to bidding for any such discrepancies to achieve the correct costs within the bid.

B. Consult all Contract Drawings that may affect the location of equipment, and cabling and make minor adjustments in location to secure coordination.

C. Coordinate layout of work with other trades. Make minor adjustments in location required for coordination.

D. All changes, except for minor adjustments, shall be submitted to the Construction Manager and/or Architect for approval before proceeding with the work.

## 1.4 PERMITS AND REGULATIONS

A. All electrical work shall be inspected and approved by the local jurisdictional authority.

B. All electrical work shall be inspected and approved by the Ohio Division of Industrial Compliance who will issue the inspection certificate.

C. General: All telecommunications systems shall meet or exceed the latest requirements of all national, state, county, municipal, and other authorities exercising jurisdiction over the telecommunications systems and the Project.

D. Contractor shall obtain and pay for all licenses, permits, and inspection fees required by local agencies and/or other agencies having jurisdiction.

E. Contractor agrees to furnish any additional labor or material required to comply with all local and other agencies having jurisdiction at no additional cost.

F. Contractor shall obtain certificates of inspection and approval from all authorities having jurisdiction, and forward copies of same to Owner's Representative prior to request for Project acceptance inspections, completion inspections, substantial completion inspections, and acceptance testing/demonstrations.

G. All required permits and inspection certificates shall be made available at the completion of the telecommunications system installation and commissioning.

H. Any portion of the telecommunications work which is not subject to the requirements of an electric code published by a specific AHJ shall be governed by the National Electrical Code and other applicable sections of the National Fire Code, as published by the National Fire Protection Association (NFPA).

I. Installation procedures, methods and conditions shall comply with the latest requirements of the Federal Occupational Safety and Health Administration (OSHA).

## 1.5 EXAMINATION

A. General: Prior to submitting a proposal, Contractor shall examine site, review Project drawings and specifications, and determine exact extent of work required. Contractor shall include in their proposals all materials, labor, and equipment required to complete required work indicated. Work that is necessary to obtain complete and usable Project as specified herein shall be included in Contractor's proposal, even if not indicated or specified.

B. Bidders' questions: Should bidders have questions as to intent of drawings and specifications, quality of materials to be used, and work to be performed, questions shall be submitted in writing

to Owner's Representative in manner dictated by Owner's Representative. All answers and clarifications to drawings and specifications will be issued in writing.

C. Extra payment will not be allowed for claims for due to unfamiliarity with work to be performed by other trades, existing conditions at job site, local or state laws and codes, and alterations due to field conditions.

## 1.6 ADDITIONAL COSTS

A. General: Project acceptance inspections, completion inspections, substantial completion inspections, and acceptance testing/demonstrations shall be conducted after verification of system operation and completeness by Contractor.

B. Inspections and testing: For Project acceptance inspections, final completion inspections, substantial completion inspections, and/or testing/demonstrations that require more than one site visit by Owner's Representative or Architect/Engineer to verify Project compliance for same material or equipment, Owner reserves right to obtain compensation from Contractor to defray cost of additional site visits that result from Project construction or testing deficiencies, incompleteness, incorrect information, or non-compliance with Project provisions. Owner's Representative will notify Contractor of hourly rates and travel expenses for additional site visits and will issue an invoice to Contractor for additional site visits. Payment of additional site visit costs by Contractor is required within 30 days of invoicing. Owner reserves right to deduct additional costs defined herein that are indicated on past due invoices from Project amount due Contractor.

C. Exclusions: Contractor shall not be eligible for extensions of Project schedule or additional charges resulting from additional site visits that result from Project construction or testing deficiencies/incompleteness, incorrect information, or non- compliance with Project provisions.

## 1.7 SUMMARY OF WORK

A. This project provides for the complete installation of various communication systems.

B. The scope of the Communications work includes furnishing, installing, testing and warranty of all Communications work and complete Communications systems shown on the Communications drawings and specified herein.

C. Items of labor, material, and equipment not specified in detail or shown on the drawings, but required or necessary for a complete and operational installation of the below systems or work described herein, shall be furnished as if called for by the specifications and the detailed drawings.

D. The Electrical Contractor and Telecommunications Contractor shall coordinate all device locations prior to installation.

E. Owner personnel training on all systems installed.

F. Testing and Commissioning of all systems.

1.8 The Work includes work that is primarily electrical in nature and also includes all equipment, cable and terminations associated with systems. Contractor shall utilize conduit runs and boxes installed by electrical contractor. Contractor shall provide face plates on all boxes as required. Contractor shall provide any supplementary systems required to meet the performance requirements of the system as part of the bid.

1.9 ADDITIONAL REQUIREMENTS

A. **Integration**: Responsibility for overall telecommunications system integration and coordination of work among trades, subcontractors, and suppliers shall rest with Contractor named in construction contract issued by Owner's Representative. Work covered by this division of specifications shall be coordinated with related work indicated on drawings or specified elsewhere under project specifications. Work related to telecommunications system shall be performed under direct supervision of telecommunications system installer in a manner approved by product manufacturer.

B. **Coordination of work:** Contractor shall be responsible for coordination of work among project specification divisions and contractor/subcontractors involved in this project. This coordination of Work Includes following instructions provided the Construction Manager or General Contractor if project is managed by such.

C. **General compliance requirements**: Provide a complete and operable systems in compliance with project drawings, specifications, referenced standards, applicable building codes, and Authority Having Jurisdiction (AHJ) requirements. Scope of this contract includes planning, design, materials, equipment, labor, configuration, programming, testing, startup and commissioning services, and documentation costs for complete and operable systems that meet all requirements indicated on drawings or contained in specifications. Comply with all contract documents, specifications, drawings, manufacturer's instructions, and Owner and AHJ requirements. In case of conflict among applicable documents or standards, contractor shall notify owner's representative in writing of apparent conflict, and then comply with most stringent requirements unless otherwise directed in writing from owner's representative.

D. Information about general construction and architectural features and finishes shall be derived from structural and architectural drawings and specifications only.

E. Items referred to in singular number in Contract Documents shall be provided in quantities necessary to complete work.

F. Work related to telecommunications system shall be installed by an authorized or certified trained installer and supervised by an authorized or certified BICSI RCDD or equal experience. Owner reserves the right to review and approves any personnel assigned to this project in a supervisory or managerial role.

G. Contractor shall have had at least 10 years of comparable experience with telecommunications projects. As part of the proposal, installer shall submit at least three (3) comparable Project reference descriptions with reference contacts. Comparable projects shall equal or exceed size and complexity of work on drawings.

H. Contractor shall provide all administrative and coordination responsibilities for entire project.

1.10 WORK COVERED BY CONTRACT DOCUMENTS

A. Project Identification: Project consists of furnishing and installing electronic communications equipment at:

Owner:

(Insert Owner)

Architect:

(Insert Architect)

Technology Consultant
BCL IT Consultants
5796 Treeside Drive
Liberty Township, Ohio 45044

1.11 CONTRACTOR USE OF PREMISES

A. General: Each Prime Contractor shall limit his use of the premises to the work indicated, to allow for Owner occupancy and use by the public. The work is to be conducted to provide the least possible interference to the activities of the Owner's personnel, students, other building occupants and the public. The normal order of owner business shall be maintained throughout the duration of the project.

B. Use of the Site: Limit use of the premises to work in areas indicated. Confine operations to areas within contract limits indicated. Do not disturb portions of the site beyond the areas in which the Work is indicated.

C. Owner Occupancy: Allow for Owner occupancy and use by the public.

D. Driveways and Entrances: Keep driveways and entrances serving the premises clear and available to the Owner, the Owner's employees, and emergency vehicles always. Do not use these areas for parking or storage of materials. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

E. Materials and Equipment: Do not unreasonably encumber the site with materials or equipment. Confine stockpiling of materials and location of storage sheds to the area indicated. If additional storage is necessary, obtain and pay for such storage off-site.

F. Vehicles: Lock automatic type vehicles such as passenger cars and trucks and other types of mechanized or motorized construction equipment, where parked and unattended, to prevent unauthorized use. Do not leave such vehicles or equipment unattended with the motor running or the ignition key in place.

G. Contractor Use of the Existing Building: Maintain the existing building in a safe and weather tight condition throughout the construction period. Repair damage caused by construction

operations. Take all precautions necessary to protect the building and its occupants during the construction period.

## 1.12 SPECIFICATION FORMATS AND CONVENTIONS

A. The words "shall," "shall be," or "shall comply with," depending on the context, are implied to mean that the equipment or system MUST be configured and/or installed as stated.

## 1.13 CODES AND STANDARDS

A. General: All work, including but not limited to: cabling, pathways, support structures, wiring, equipment, installation and workmanship shall comply with the latest editions of the requirements of the Authority Having Jurisdiction (AHJ), National Electrical Code, National Electrical Safety Code, all applicable local rules and regulations, equipment manufacturer's instructions, and the National Electrical Contractors Association (NECA) Standard of Installation. In case of discrepancy or disagreement between the documents noted above, the Contractor shall satisfy the most stringent requirements.

B. Other sections of this document contain References to Codes and Standards that are applicable to the section.

## 1.14 CODES

A. National Fire Protection Association (NFPA) NFPA 70, National Electrical Code® (NEC®)

B. NFPA 70E, Standard for Electrical Safety Requirements for Employee Workplaces, NFPA 72, National Fire Alarm Code®

C. NFPA 75, Standard for the Protection of Electronic Computer/Data Processing Equipment NFPA 76, Recommended Practice for the Fire Protection of Telecommunications Facilities NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems

D. NFPA 101, Life Safety Code®

E. NFPA 255, Standard Method of Test of Surface Burning Characteristics of Building Materials

F. NFPA 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces

G. NFPA 780, Standard for the Installation of Lightning Protection Systems NFPA 5000™, Building Construction and Safety Code

## 1.15 REFERENCE STANDARDS

A. Telecommunications Industry Association (TIA)

B. ANSI/NECA/BICSI 568

C. TIA-569, Telecommunications Pathways and Spaces

D. ANSI/TIA-526.7-A, Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant

E. ANSI/TIA-606, Administration Standard for Telecommunications Infrastructures

F. ANSI/TIA-862, Structured Cabling Infrastructure Standard for Intelligent Building Systems

G. ANSI/TIA-942, Telecommunications Infrastructure Standard for Data Centers

H. TIA-607, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

I. TIA-598, Optical Fiber Cable Color Coding

J. TIA-604—Fiber Optic Connector Intermateablility Standard

K. TIA TSB-125, Guidelines for Maintaining Optical Fiber Polarity Through Reverse-Pair Positioning

L. TIA-758, Customer-owned Outside Plant Telecommunications Infrastructure Standard

M. TSB-155, Guidelines for the Assessment and Mitigation of Installed Category 6 Cabling to Support 10GBASE-T

N. BICSI Outside Plant Design Reference Manual (OSP), current edition.

O. BICSI Information Transport Systems Installation Methods Manual (ITSIM), current edition

P. BICSI Telecommunications Distribution Methods Manual (TDMM), current edition

Q. Institute of Electrical and Electronic Engineers (IEEE) National Electrical Manufacturers Association (NEMA)

R. Underwriters Laboratories (UL) Cable Certification and Follow Up Program

## 1.16 ABBREVIATIONS, ACRONYMS AND DEFINITIONS

A. Abbreviations and Acronyms
1. ACD Automatic Call Distribution
2. AFF Above Finished Floor
3. AWG American Wire Gauge
4. BICSI Building Industry Consulting Services International
5. CAT5 Category 5 Copper Cable
6. CAT5e Category 5e Copper Cable
7. CAT6 Category 6 Copper Cable
8. CAT6A Category 6A Copper Cable
9.
10. CMP Communications Multipurpose Plenum: cable rating

11. CMR Communications Multipurpose Riser: cable rating
12. ELFEXT Equal-Level Far-End Crosstalk
13. FEXT Far End Crosstalk
14. Gbps Gigabits per second
15. HVAC Heating, Ventilation, and Air Conditioning
16. IDF Intermediate Distribution Frame
17. IEEE Institute of Electrical and Electronics Engineers
18. IM Information Management
19. LAN Local Area Network
20. Mbps Megabits per second
21. MDF Main Distribution Frame, consisting of carrier entrance rooms and head-end
22. MMF Multi-mode fiber optics, 50 -micron laser optimized core
23. MUTOA Multi-User Telecommunications Outlet Assembly
24. NEXT Near End Cross Talk
25. NRTL Nationally Recognized Testing Laboratories
26. OSHA Occupational Safety and Health Act
27. PBX Private Branch Exchange: telephone switch
28. PoE Power over Ethernet
29. POP Point of Presence
30. PSACR Power Sum Attenuation-to-Crosstalk Ratio
31. PSAFEXT Power Sum Alien Far-End Crosstalk
32. PSAELFEXT Power Sum Alien Equal Level Far-End Crosstalk
33. PSANEXT Power Sum Alien Near-End Crosstalk
34. PSELFEXT Power Sum Equal Level Far-End Crosstalk
35. PSNEXT Power Sum Near-End Crosstalk
36. SCC Security Command Center
37. SCS Structured Cabling System, or Structure Connectivity System; a complete cabling system
38. SFF Small Form Factor
39. SM Single-mode fiber optics
40. TE Telecommunications Enclosure
41. TEF Telecommunications Entrance Facility
42. TIA Telecommunications Industry Association
43. TR Telecommunications Room
44. TO Telecommunications Outlet
45. UPS Uninterruptible Power Supply
46. UTP Unshielded Twisted Pair
47. VoIP Voice over Internet Protocol
48. WAO Work Area Outlet
49. WAN Wide Area Network

1.17 DEFINITIONS

A. Access Floor - A floor system that has removable floor panels.

B. Building Backbone Cabling – Cabling used to connect Floor Distributors (FD) or other local collection points to the Building Distributor (BD). Building backbone cabling typically carries aggregate traffic and, as such, impacts multiple network devices and users.

C. Building backbone cabling may include either fiber optic or copper cabling or both.

D. Building Distributor (BD) – Termination point from which all building backbone cabling emanates and interconnection point for the network backbone. Commonly referred to as BDF in Americas, Main Comm Rooms in EMEA and Communication Room, IT Lab or IT Room in AsiaPac. Referred to as BD in international and European industry standards and Intermediate Cross-connect (IC) in American industry standards. There is one BD for each building and it feeds all FD's in the same building. The BD should be located so that all FD's served are within 300 cable meters (984 cable feet). All BD's are linked to the

E. Campus Backbone Cabling – Cabling used to connect Building Distributors (BD) or other key network segments to the Campus Distributor (CD). With rare exceptions, campus backbone cabling carries aggregate traffic and typically impacts entire buildings worth of network devices and users and, as such, link redundancy with diverse routing is highly recommended. Campus backbone cabling almost exclusively consists of fiber optic cabling. Copper cabling may be used in short-distance (< 90m) applications. In such cases, lightning protection will usually be required by code.

F. Campus Distributor (CD) – Termination point from which all campus backbone cabling emanates and highest-level interconnection point for the network backbone. Commonly referred to as NOC in Americas and Main Comm Rooms in EMEA. Referred to as CD in international and European industry standards and Main Cross-connect (MC) in American industry standards. On smaller campuses, there is one CD for the campus. On larger campuses, there might be several CD's with each CD serving several buildings. Besides linking to each of the BD's it serves, the CD is also the network interconnection point for data center links and links to service providers.

G. Category 3 (Cat 3) – A category of transmission performance, defined in TIA standards, that specifies electrical properties up to 10 MHz. Cat 3 is the minimum performance grade permissible and is used typically for analog voice distribution.

H. Category 6 (Cat 6) / Class E – A category/class of transmission performance that specifies electrical properties up to 250 MHz. Refer to the TIA-568-D family of standards for more information on Category 6 and ISO/IEC 11801 for more information on Class E requirements. Also, refer to CENELEC EN50173.

I. Category 6A (Cat 6) / Class EA– A category/class of transmission performance that specifies electrical properties up to 500 MHz and capable of supporting data applications operating at 10Gbps. Refer to the TIA-568-D family of standards for more information on Category 6 and ISO/IEC 11801 for more information on Class EA requirements.

J. Category 7 – backward compatible with Class D/Category 5e and Class E/Category 6. Class F features even stricter specifications for crosstalk and system noise than Class E. To achieve this, shielding has been added for individual wire pairs and the cable as a whole.

K. Category 8 – ratified by the TR43 working group under ANSI/TIA 568-2-D. It is defined up 2000 MHz and only for distances from 30 to 36m depending on the patch cords used. ISO is expected to ratify the equivalent in 2018 but will have 2 options: Class I channel, Category 8.1 cable and Class II channel, Category 8.2 cable. Category 8 is designed only for data centers where distances between switches and servers is short. It is not intended for general office cabling.

L. Certification – The testing and documentation of the transmission performance of a permanent link or channel, based on sweep frequency (where applicable) testing of numerous parameters with results compared to a range of acceptable values. This project requires 100% certification

(with documentation) of all permanent link cabling at the time of installation. Channel certification is optional and is the responsibility of the group using the channel.

M. Channel – The entire physical pathway between active equipment ports, inclusive of all patch cords, patch panels, jacks and cabling segments.

N. Class C – A category of transmission performance, defined in ISO and EN standards, that specifies electrical properties up to 16 MHz

O. Conduit - A raceway of circular cross-section.

P. Entrance Facility (EF) – Termination point of service provider cables that have entered the building and location of service demarcation point (MPOE) and interconnection point to the network. Commonly referred to as Telco Room in Americas, POP Room in EMEA and Building Entrance in AsiaPac. Referred to as Building Entrance Facility in international and European industry standards and Entrance Facility (EF) in American industry standards. The EF is linked to the CD, where present, or to the BD.

Q. Floor Distributor (FD) – Termination point for horizontal cabling and interconnection point for network access. Commonly referred to as IDF in Americas and AsiaPac and as Sub Comms Room in EMEA. Referred to as Floor Distributor (FD) in international and European industry standards and Horizontal Cross-connect (HC) - FD quantities and locations are determined by building size and geometry so that all points served are within 90 cable meters (295 cable feet) of an FD. The FD feeds all Telecommunications Outlets (TO's) in its service zone. All FD's in a building are linked to the building's Building Distributor (BD) via backbone cabling.

R. Horizontal Cabling – Cabling used to connect individual work area outlets to local Floor Distributors (FD) or other collection points. Unlike backbone cabling, horizontal cabling does not typically carry aggregate traffic and, as such, impacts only single network devices or users. In buildings, horizontal cabling almost exclusively consists of copper cabling. Fiber optic cabling may be used where situations dictate but, unlike horizontal copper cabling, horizontal fiber optic cabling is not installed in advance as default building facilities. At this writing, horizontal copper cabling in many networks is capable of supporting Gigabit (1Gb/s) Ethernet applications as well as other applications of similar bandwidth.

S. Permanent Link – A stationary cabling segment, consisting of the permanently installed cable and the permanently affixed jack at both ends (typically at the outlet faceplate and closet patch panel, or on a patch panel on both ends). The concept assumes that, while patch cords might be disconnected or moved over time, the permanent cable and jacks will not be disturbed and the electrical characteristics of the permanent link will remain unaltered.

T. Plenum -A space within the building designed for the movement of environmental air; i.e., a space above a suspended ceiling or below an access floor.

U. Raceway - Any channel designed for holding wires or cables; i.e. conduit, electrical metal tubing, busways, wireways, ventilated flexible cableway.

V. Spine – also called a backbone, the main communications cables in an IDF.

1.18 DRAWINGS AND SPECIFICATIONS

A. General Drawing Specifications: Detail and elevation drawings shall be (36” x 42”) with a minimum scale of 1/4” = 1’0" or larger. ER, TR and other enlarged detail floor plan drawings shall be D size (24” x 36”) with a minimum scale of 1/4” = 1’0" or larger. Building composite floor plan drawings shall be D size (24” x 36”) with a minimum scale of 1/8” = 1’ 0”.

B. Building composite floor plans: Provide building floor plans showing outlet locations and jack configuration, types of jacks, run distance for each jack cable, and cable routing/locations. Identify TO’s that, according to location and available pathway systems, require cable length greater than allowed by standards. Recommend alternatives for Owners Representative’s consideration.

C. Telecommunications space plans/elevations: Include enlarged floor plans of TRs indicating layout of equipment and devices, including receptacles and grounding provisions. Submit detailed plan views and elevations of telecommunications spaces showing racks, termination blocks, and cable paths.

D. Logical Drawings: Provide logical riser or schematic drawings for all systems. Include schematic symbol key.

E. The drawings indicate the general arrangement of the work and are to be followed insofar as possible. The word “provide”, as used, shall mean “furnish and install”. If significant deviations from the layout are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Architect for approval before proceeding with the work.

F. Make all necessary field measurements to ensure correct fitting. Coordinate work with all other trades in such a manner as to cause a minimum of conflict or delay.

G. The drawings and specifications shall be carefully studied during bidding and construction. Any error, omissions or discrepancies encountered shall be referred immediately to the Architect for interpretation or correction, so that misunderstandings later may be avoided. The contract drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Having cable pathways and fittings fabricated and delivered in advance of making actual measurements shall not be sufficient because to avoid making offsets and minor changes as may be necessary to install wireways, fittings and equipment.

H. Where there are quantity discrepancies of equipment shown on drawings and/or specifications, the Contractor shall provide the greater quantity.

I. The Architect shall reserve the right to make minor adjustment in locations of system runs and components where he considers such adjustments desirable in the interest of protecting and concealing work or presenting a better appearance where exposed. Any such changes shall be anticipated and requested sufficiently in advance as to not cause extra work, or unduly delay the work. Coordinate work in advance with all other trades and report immediately any difficulties which can be anticipated.

J. Equipment, ductwork, piping and communications wiring shall not be installed in the dedicated electrical space above or in the working space required around electrical switchgear, motor control centers or panelboards as identified by NEC 110The Communications Contractor shall caution other trades to comply with this stipulation.

K. Where any system runs and components are placed as to cause or contribute to a conflict, it shall be readjusted at the expense of the contractor causing such conflict. The Architect's decisions shall be final regarding the arrangement of conduit, etc., where conflict arises.

L. Provide offsets in system runs, additional fittings, necessary conduit, pull boxes, conductors, switches and devices required to complete the installation, or for the proper operation of the system. Each contractor shall exercise due and particular caution to determine that all parts of the work are made quickly and easily accessible.

M. Should overlap work among the trades become evident, this shall be called to the attention of the Architect. In such event, none of the trades or their suppliers shall assume that he is relieved of the work which is specified under his branch until instructions in writing are received from the Architect.

## 1.19 SUBSTITUTIONS

A. Substitution requests: Substitution requests will be considered only if submitted to Owner's Representative not less than 7 working days prior to project bid date. Acceptance or rejection of proposed substitution is at Owner's Representatives sole discretion. No exceptions. Requests for substitutions shall be considered not approved unless approval is issued in writing by Owner's Representative.

B. Rejection: For equipment, cabling, wiring, materials, and all other products indicated or specified as no substitutions or no alternates, Owner does not expect nor desire requests for substitutions and alternate products other than those specified. Owner reserves right for Owner's Representative to reject proposed substitution requests and submissions of alternates without review or justification.

## 1.20 PRE-INSTALLATION MEETING

A. General: After award, convene a pre-installation meeting at least 14 calendar days prior to commencing work. The meeting must be scheduled at least 14 days in advance. Require attendance of parties directly affecting work of this section, including other trades and utilities if necessary. Review conditions of operations, procedures and coordination with related work.

B. Agenda: Comply with following agenda specifications:
   1. Tour, inspect, and discuss building conditions relating to telecommunications system cabling and equipment, coordination with Telephone Utility Company, Owner's telecommunications system requirements, and coordination with existing conditions and other work in contract.
   2. Review exact location of each item within building construction, casework, and fixtures, and their requirements.
   3. Review required submittals, both completed and yet to be completed.
   4. Review drawings and specifications.
   5. Review proposed equipment, cabling, and related work.
   6. Review and finalize construction schedule related to telecommunications system and verify availability of materials, personnel, equipment, and facilities needed to make progress and avoid delays.
   7. Review required inspections and testing.

8. Review cable routing and support provisions.

## 1.21 ASBESTOS MATERIALS

A. Abatement, removal or encapsulation of existing materials containing asbestos is NOT included in the Communications Contract. Necessary work of this nature will be arranged by the Owner to be done outside of this construction and remodeling project by a company regularly engaged in asbestos abatement. Such work will be scheduled and performed in advance of work in the construction and remodeling project.

B. If, in performance of the Communications work, materials are observed which are suspected to contain asbestos, the Communications Contractor shall immediately inform the Architect/Engineer who in turn will notify the Owner. Work that would expose workers to the inhalation of asbestos particles shall be terminated. Work may be resumed only after a determination has been made and unsafe materials have been removed or encapsulated and the area declared safe.

## 1.22 INSPECTION

A. All work shall be subject to inspection of Federal, State, and local agencies as may be required, and of the Architect and Engineer.

B. Final inspection certification shall be obtained by the Contractor and given to the Owner.

## 1.23 RECORD DRAWINGS

A. The Communications Contractor shall maintain a separate set of prints of the contract documents and shall show all changes or variations, in a manner to be clearly discernible, which are made during construction. Upon completion of the work, these drawings shall be turned over to the Architect in a format required by the Architect (CAD, Revit and PDF). This shall apply particularly to underground and concealed work and to other systems where the installation varies to a degree which would justify recording the change.

## 1.24 OPERATING AND MAINTENANCE MANUALS

A. Electronic copy (PDF Format) of each of operating and maintenance manual shall be assembled for the Communications work by the Contractor.

B. All shop drawings and installation, maintenance and operating instruction pamphlets or brochures, wiring diagrams, parts list, and other information, along with warranties, shall be obtained from each manufacturer of the principal items of equipment. In addition, the Contractor shall prepare a chart listing all items of equipment which are furnished under his contract and indicating the nature of maintenance required, the recommended frequency of checking these points and the type of lubricating media or replacement material required. Major items of equipment shall consist of not less than the following:
   1. Data Cable Distribution System
   2. Security Management System

3. CCTV System
4. Telephone System
5. Audio Visual Systems
6.
7. Network Electronics
8. Paging Systems
9. Sound Systems
10. UPS Systems
11. Misc. Multi-Media Equipment

C. These shall be assembled into indexed PDF files. These shall be submitted to the Architect or Engineer for review. Upon approval, manuals shall be turned over to the Owner.

D. O&M Manuals shall contain the following information at a minimum:

1. Copies of all approved shop drawings with the Engineer's stamp.
2. Owner's manuals for every item of equipment when available from the manufacturer. These shall be the technical manuals provided by the manufacturer and shall not consist of generic sales brochures or copies of website prints. Technical manuals shall provide complete specifications for the equipment as well as complete operating, maintenance, troubleshooting and product repair/replacement information. The Contractor can supply this information electronically in an indexed PDF format.
3. Communications drawings updated with final as-built information. This shall be in the form of a complete set of Communications drawings with as-built information indicated in color based upon actual field conditions. These must be in electronic format. **Hand drawings will not be accepted.**
4. System schematic and block diagrams for every system updated with final as-built information. These drawings shall define the exact arrangement of each system including wiring configuration, device locations and cable types. These shall be submitted in electronic format. **Hand drawings will not be accepted.**
5. Rack elevations for all systems with rack mounted equipment.

## 1.25 FINAL INSPECTION AND PUNCH LIST

A. As the time of work completion approaches, the Contractor shall survey and inspect his work and develop his own punch list to confirm that it is complete and finished. He shall then notify the Architect and request that a final inspection be made. It shall not be considered the Architect's or Engineer's obligation to perform a final inspection until the Contractor has inspected the work and so states at the time of the request for the final inspection.

B. Requests to the Architect, Engineer, or Owner for final inspection may be accompanied by a limited list of known deficiencies in completion, with appropriate explanation and schedule for competing these; this in the interest of expediting acceptance for beneficial occupancy.

C. The Architect and/or Engineer will inspect the work and prepare a punch list of items requiring correction, completion or verification. Corrective action shall be taken by the Contractor to the satisfaction of Architect and Engineer within 30 days of receipt of the Architect/Engineer's punch list.

1.26 CONTRACTOR'S WARRANTY

A. General requirements: Comply with additional requirements in contract general requirements and extended warranties required in other specification sections. Refer to all other 27xxx sections for specific additional warranty requirements that exceed or are in addition to those of this section.

B. Contractor warranty: Provide all services, materials and equipment necessary for successful operation of entire telecommunications system for a period of one year after system acceptance. Scope of warranty includes all equipment, devices, wiring, accessories, software, hardware, installation, programming, and configuration required to maintain a complete and operable system. Provide manufacturer's published recommended preventative maintenance procedures during warranty period. This shall apply to all items except those specifically excluded, or items wherein a longer period of service and warranty is specified or indicated. All warranties shall be effective for one year, minimum, from date Certificate of Final Acceptance is issued. Use of systems provided under this section for temporary services and facilities shall not constitute final acceptance of work nor beneficial use by Owner and shall not institute warranty period. The warranty shall cover repair or replacement of defective materials, equipment, workmanship, and installation that may be incurred during this period. Warranty work is to be done promptly and to Owner's satisfaction. In addition, warranty shall cover correction of damage caused in making necessary repairs and replacements under warranty. Additional warranty responsibilities are:
   1. Obtain written equipment and material warranties offered in manufacturer's published data without exclusion or limitation, in Owner's designated name. Replace material and equipment that require excessive service during guarantee period as determined by Owner.
   2. Provide 2-business day service beginning on date of Substantial Completion and lasting until termination of warranty period. Service shall be at no cost to Owner. Service can be provided by installing contractor or by a separate service organization. Choice of service organization shall be subject to Owner's approval. Submit name and a phone number that will be answered on a 24-hour basis each day of week, for duration of service.
   3. Submit copies of equipment and material warranties to Owner before final acceptance.
   4. At end of warranty period, transfer manufacturers' equipment and material warranties still in force to Owner.

C. If warranty work problems cannot be corrected immediately to Owner's satisfaction, advise Owner in writing, describing efforts to correct situation, and provide analysis of cause for problem. If necessary to resolve problem, provide at no cost services of manufacturer's engineering and technical staff at site in a timely manner to analyze warranty issues, and develop recommendations for correction, for review and approval by Owner.

D. Owner's rights: This section shall not be interpreted to limit Owner's rights under applicable codes and under this Contract.

E. Pathways Material and Installation warranty: Provide all services, materials and equipment necessary to warrant the installation and performance of all pathway materials for a period of one year after beneficial use. Scope of warranty includes all equipment, devices, installation and other work required to maintain a complete and operable system. Provide manufacturers published recommended preventative maintenance procedures during warranty period.

F. Grounding and Bonding Material and Installation warranty: Provide all services, materials and equipment necessary for successful operation of GBS for a period of one year after beneficial use. Scope of warranty includes all equipment, devices, installation and other work required to

maintain a complete and operable system. Provide manufacturers published recommended preventative maintenance procedures during warranty period.

G. Firestopping Material and Installation warranty: Provide all services, materials and equipment necessary to warrant the performance of all Firestopping material for a period of one year after beneficial use, or longer if required by the local AHJ. Scope of warranty includes all equipment, devices, installation and other work required to maintain a complete and operable system. Provide manufacturers published recommended preventative maintenance procedures during warranty period.

H. This provision is intended specifically to cover deficiencies in contract completion or performance which are not immediately discovered after systems are placed in operation. These items include, but are not limited to replacement of malfunctioning equipment and adjusting special equipment and communications systems to obtain optimum performance.

I. This provision shall not be construed to include maintenance items such as making normally anticipated adjustments or correcting adjustment errors on the part of the Owner’s personnel.

J. Provisions of this warranty shall be considered supplementary to warranty provisions under General Conditions.

1.27 SCS MANUFACTURERS EXTENDED WARRANTY

A. SCS Systems will be covered by a two-part certification program provided by a single manufacturer and that manufacturer's certified vendor. Manufacturer shall administer a follow-on program through the Vendor to provide support and service to the purchaser. The first part is an assurance program, which provides that the certified system will support the applications for which it is designed, during the 20- year warranty of the certified system.

B. The second portion of the certification is a 20-year warranty provided by the manufacturer and the vendor on all products within the system (cords, telecommunications outlet/connectors, cables, cross-connects, patch panels, etc.).

C. If the certified system ceases to support the certified application(s), whether at the time of cutover, during normal use or when upgrading, the manufacturer and vendor shall commit to promptly implement corrective action.

D. Documentation proving the cabling system's compliance to the End-to-End Link Performance recommendations, as listed in ANSI/TIA-568-D shall be provided by the Vendor prior to the structured cabling system being installed.

E. The cabling system must conform to the current issue of industry standard TIA-568. All performance requirements of this document must be followed. As well, workmanship and installation methods used shall be equal to or better than that found in the BICSI (Building Industry Consulting Service International) ITSIM manual.

F. Purchaser demands strict adherence to the performance specifications listed in ANSI/TIA-568-C series standards.

G. Manufacturer shall maintain ISO Quality Control registration for the facilities that manufacturer the product used in this cabling system.

## 1.28 COMPLETENESS OF WORK

A. Complete and usable work: The contractor is responsible for providing complete and usable work per contract documents. All materials and equipment shall be provided with all accessories and additional work required for field conditions, as well as additional work and accessories required for complete, usable, and fully functional construction and systems, even if not explicitly specified or indicated. Telecommunications system in this Contract shall be provided as complete and operable systems in full compliance with requirements on drawings and specification requirements. Drawings are diagrammatic and specifications are performance-based, and Contractor shall provide all work required to comply with drawings and specifications, even if not explicitly indicated or specified. Contractor shall be responsible for coordinating installation of electrical systems with all field conditions and work of other trades. Minimum clearances and work required for compliance with NFPA 70, National Electrical Code® (NEC®), and manufacturer's instructions shall be provided. Comply with additional requirements indicated for access and clearances. Contractor shall verify all field conditions and dimensions that affect selection and provision of materials and equipment, and shall provide any disassembly, reassembly, relocation, demolition, cutting and patching required to provide work specified or indicated, including relocation and reinstallation of existing wiring and equipment. Contractor shall protect from damage resulting from Contractor's operations existing facility, equipment, and wiring. Extra charges for completion and contract time extension will not be allowed because of field conditions or additional work required for complete and usable construction and systems. Comply with additional requirements indicated for access and clearances.

B. Drawings and specifications form complementary requirements; provide work specified and not shown, and work shown and not specified as though explicitly required by both. Except where explicitly modified by a specific notation to contrary, it shall be understood that indication or description of any item, in drawings or specifications or both, carries with it instruction to furnish and install item, provided complete.

C. Terms: As used in this specification, provide means furnish and install. Furnish means "to purchase and deliver to project site complete with every necessary appurtenance and support," and install means "to unload at delivery point at site and perform every operation necessary to establish secure mounting and correct operation at proper location in project."

D. Authority approvals: Give notices, file plans, obtain permits and licenses, pay fees, and obtain necessary approvals from authorities that have jurisdiction as required to perform work per all legal requirements and with Specifications, Drawings, Addenda and Change Orders, all of which are part of Contract Documents.

E. Supplementary items: Provide supplementary or miscellaneous items, appurtenances, devices and materials necessary for a sound, secure and complete installation. Examine project drawings and other Sections of specifications for requirements that affect work of this section. Completely coordinate work of this section with work of other Sections and provide a complete and fully functional installation. Refer to all other drawings and other specifications sections that indicate types of construction in which work shall be installed and work of other sections with which work of this section must be coordinated

F. Quantities: Items referred to in singular number in Contract Documents shall be provided in quantities necessary to complete work.

## 1.29 PROJECT CONDITIONS

A. Field verification: Carefully verify location, use and status of all material, equipment, and utilities that are specified, indicated, or deemed necessary for removal. Verify that all materials, equipment, and utilities to be removed are completely inactive and will not be required or in use after completion of project. Replace with equivalent any material, equipment and utilities that were removed by Contractor that are required to be left in place.

B. Existing utilities: As applicable, do not interrupt utilities serving facilities occupied by Owner or others unless permitted under following conditions and then only after arranging to provide temporary utility services per requirements indicated:

C. Notify owner in writing at least 14 days in advance of proposed utility interruptions. Do not proceed with utility interruptions without Owner's written permission.

D. Equipment installation:
   1. Determine suitable path for moving unit substation into place; consider Project conditions.
   2. Verify clearance requirements and locate equipment to meet installation tolerances.
   3. Revise locations and elevations from those indicated to those required to suit Project.

## 1.30 DELIVERY STORAGE AND HANDLING

A. General: Contractor shall be responsible for the deliveries, storing and handling of all materials relative to the SCS systems, including materials supplied by others that are part of the SCS installation contract. Material shall be stored and protected per manufacturer's instructions. Contractor shall be responsible for the security of all material during installation. For all material provided by contractor, or delivered to contractor on site, contractor assumes full responsibility and liability for any material shortages, damage or loss due to storage and handling methods.

# PART 2 - PRODUCTS (Not Used)

# PART 3 - EXECUTION (Not Used)

SECTION 270525 - FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 00 and Division 01 Specifications Sections, apply to this Section.

1.2 DEFINITIONS

A. Firestopping: Material or combination of materials used to retain integrity of fire-rated construction by maintaining an effective barrier against the spread of flame, smoke, and hot gases through penetrations in fire rated wall and floor assemblies.

1.3 GENERAL DESCRIPTION OF THE WORK OF THIS SECTION

A. Only tested firestop systems shall be used in specific locations as follows: Penetrations for the passage of cables, conduit, and other electrical equipment through fire-rated vertical barriers (walls and partitions), horizontal barriers (floor/ceiling assemblies), and vertical service shaft walls and partitions.

1.4 RELATED WORK OF OTHER SECTIONS

A. Coordinate work of this section with work of other sections as required to properly execute the work and as necessary to maintain satisfactory progress of the work of other sections, including:

1) Section 03300 - Cast-In-Place Concrete
2) Section 04200 - Masonry Work
3) Section 07840 – Firestopping
4) Section 09250 - Gypsum Drywall Systems
5) Section 13080 - Sound, Vibration and Seismic Control
6) Section 13900 - Fire Suppression and Supervisory Systems
7) Section 16050 - Basic Electrical Materials and Methods
8) Section 15300 - Fire Protection

1.5 REFERENCES

A. ANSI/TIA-1179-A “Healthcare Facility Telecommunications Infrastructure”.

B. ANSI/TIA-EIA-569-D “Telecommunications Pathways and Spaces”

C. ASTM E90, “Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements”.

D. ASTM E814, “Fire Tests of Through Penetration Firestops”.

E. ASTM E1725, “Standard Test Methods for Fire Tests of Fire-Resistive Barrier Systems for Electrical System Components”.

F. CAN/ULC S115, "Standard Method of Fire Tests of Firestops Systems."

G. UL 1479, “Fire Tests of Through Penetration Firestops”.

H. National Fire Protection Association (NFPA) – NFPA 101: Life Safety Code.

I. National Fire Protection Association (NFPA) – NFPA 70: National Electrical Code.

J. Underwriters Laboratories Inc. (UL) – Fire Resistance Directory

1.6 QUALITY ASSURANCE

A. A manufacturer's direct representative (not distributor or agent) to be on-site during initial installation of firestop systems to train appropriate contractor personnel in proper selection and installation procedures. This will be done per manufacturer's written recommendations published in their literature and drawing details.

B. Firestop System installation must meet requirements of ASTM E814 or UL 1479 tested assemblies that provide a fire rating equal to that of construction being penetrated.

C. Proposed firestop materials and methods shall conform to applicable governing codes having local jurisdiction.

D. Firestop Systems do not reestablish the structural integrity of load bearing partitions assemblies or support live loads and traffic. Installer shall consult the structural engineer prior to penetrating any load bearing assembly.

E. For those firestop applications that exist for which no UL tested system is available through a manufacturer, a manufacturer's engineering judgment derived from similar UL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineering judgment drawings must follow requirements set forth by the International Firestop Council.

1.7 SUBMITTALS

A. Submit Product Data: Manufacturer’s specifications and technical data for each material including the composition and limitations, documentation of UL firestop systems to be used and manufacturer's installation instructions to comply with Section 1300.

B. Manufacturer's engineering judgment identification number and drawing details when no UL system is available for an application. Engineering judgment must include both project name and contractor’s name who will install firestop system as described in drawing.

C. Submit material safety data sheets provided with product delivered to job-site.

1.8 INSTALLER QUALIFICATIONS

A. Engage an experienced Installer who is certified, licensed, or otherwise qualified by the firestopping manufacturer as having been provided the necessary training to install manufacturer's products per specified requirements. A manufacturer's willingness to sell its firestopping products to the Contractor or to an Installer engaged by the Contractor does not in itself confer qualification on the buyer.

1.9 DELIVERY, STORAGE AND HANDLING

A. Deliver materials undamaged in manufacturer's clearly labeled, unopened containers, identified with brand, type, and UL label where applicable.

B. Coordinate delivery of materials with scheduled installation date to allow minimum storage time at jobsite.

C. Store materials under cover and protect from weather and damage in compliance with manufacturer's requirements, including temperature limitations.

D. Comply with recommended procedures, precautions or remedies described in material safety data sheets as applicable.

E. Do not use damaged or expired materials.

1.10 PROJECT CONDITIONS

A. Do not install products when ambient or substrate temperatures are outside limitations recommended by manufacturer.

B. Do not install products when substrates are wet due to rain, frost, condensation, or other causes.

C. Do not use materials that contain flammable solvents.

D. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.

E. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.

F. Schedule installation of firestopping after completion of penetrating item installation but prior to covering or concealing of openings

PART 2 - PRODUCTS

2.1 FIRESTOPPING GENERAL

A. Provide firestopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under

conditions of service and application, as demonstrated by the firestopping manufacturer based on testing and field experience.

B. Provide components for each firestopping system that are needed to install fill material. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.

C. Fire rated cable pathway devices shall be used in fire-rated construction for ALL low-voltage, video, data and voice cabling, optical fiber raceways where frequent cable moves, adds and changes may occur.

## 2.2 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with through penetration firestop systems (XHEZ) listed in Volume II of the UL Fire Resistance Directory, provide products of the following manufacturers as identified below:

1. STI
2. Hilti
3. 3M
4. Substitution requests shall be considered in accordance with contract provisions

## 2.3 MATERIALS

A. Use only firestop products that have been UL 1479 or ASTM E 814 tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire-rating involved for each separate instance.

B. Pre-installed firestop devices for use with noncombustible and combustible pipes (closed and open systems), conduit, and/or cable bundles penetrating concrete floors and/or gypsum walls

C. Firestop Sealants: Single component latex formulations that upon cure do not re-emulsify during exposure to moisture

D. Firestop Putty: Intumescent, non-hardening, water resistant putties containing no solvents, inorganic fibers or silicone compounds

E. Firestop Pillows: Re-enterable, non-curing, mineral fiber core encapsulated on six sides with intumescent coating contained in a flame retardant poly bag

F. Fire-Rated Cable Grommet: Molded, two-piece grommet with an integral fire and smoke sealing foam membrane for sealing individual cable penetrations through framed wall assemblies. Grommet snaps together around cable and locks tightly into the wall.

G. Fire-Rated Cable Pathways: Device modules comprised of steel pathway with self-adjusting intumescent foam pads allowing 0 to 100 percent cable fill

H. Smoke and Acoustical Pathways: Device module comprised of a nonmetallic pathway with integral self-adjusting smoke and sound sealing system for cable penetrations through non-fire-resistance rated wall or floor assemblies

I. Protective Wrap: Endothermic Wrap incorporating foil scrim evaluated for protection of cable pathways, liquid fuel lines, as well as in through-penetration and membrane-penetration firestopping. Testing to incorporate protection of Electrical Metallic Tubing (EMT), Rigid Metallic Conduit (RMC), Cable Trays, single and/or multi containment liquid fuel lines. Wrap to have a maximum weight of no greater than 1.4 lbs/ft2 and allow for the use of steel tie wire when installed around piping, conduits, and/or cable trays.

## PART 3 – EXECUTION

### 3.1 EXAMINATION

A. Before beginning installation, verify that substrate conditions previously installed under other sections are acceptable for installation of firestopping in accordance with manufacturer's installation instructions and technical information.

B. Surfaces shall be free of dirt, grease, oil, scale, laitance, rust, release agents, water repellants, and any other substances that may inhibit optimum adhesion.

C. Provide masking and temporary covering to protect adjacent surfaces.

D. Do not proceed until unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

A. General: Install systems in accordance with Performance Criteria and in accordance with the conditions of testing and classification as specified in the published design.

B. Manufacturer's Instructions: Comply with manufacturer's instructions for installation of products.

### 3.3 FIELD QUALITY CONTROL

A. Keep areas of work accessible until inspection by authorities having jurisdiction.

B. Where deficiencies are found, repair firestopping products so they comply with requirements.

### 3.4 ADJUSTING AND CLEANING

A. Remove equipment, materials, and debris, leaving area in undamaged, clean condition.

B. Clean all surfaces adjacent to sealed openings to be free of excess firestopping materials and soiling as work progresses.

3.5 SCHEDULES

| Penetrant Type | Concrete Floor | Concrete Wall | Gypsum Board Wall |
|---|---|---|---|
| | | | |
| Blank Opening | C-AJ-0100, C-AJ-0101, C-AJ-0113, C-AJ-0116 | C-AJ-0100, C-AJ-0101, C-AJ-0113, C-AJ-0116 | W-L-0020, W-L-0034 |
| Metal Conduits | C-AJ-1080, C-AJ-1240, C-AJ-1353 | C-AJ-1080, W-J-1098, W-J-1100 | W-L-1049, W-L-1222, W-L-1168 |
| Plastic Conduits/ Raceways | C-AJ-2140, C-AJ-2292, F-A-2186, F-A-2210, F-A-2225 | C-AJ-2038, C-AJ-2108, C-AJ-2578, C-AJ-2586, W-J-2018, W-J-2076 | W-L-2059, W-L-2074, W-L-2093, W-L-2241 |
| Cables | C-AJ-3214, C-AJ-3231, F-A-3015, F-A-3021, F-A-3054 | C-AJ-3214, C-AJ-3231, W-J-3098, W-J-3099,W-J-3124, W-J-3150, W-J-3180 | W-L-3219, W-L-3248, W-L-3287, W-L-3356, W-L-3377, W-L-3378, W-L-3379, W-L-3390 |
| Cable Trays | C-AJ-3317, C-AJ-8181, C-AJ-4029, F-A-3015, F-A-3037 | C-AJ-8181, W-J-4021, W-J-4022, W-J-4033, W-J-3098, W-J-3145, W-J-3158 | W-L-3218, W-L-3271, W-L-3286, W-L-3306, W-L-4008, W-L-4029, W-L-4043, W-L-8073 |

3.6 DOCUMENTATION

A. Place system stickers on each side of wall penetrations.

B. Place a reproduction (photo copy) of the UL System description in a document protector and mount to the wall next to the wall penetration
   1. Highlight the section of the system description that list the allowed cable types.

SECTION 270526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Related Sections:
   1. Section 01 00 00 – General Requirements
   2. Section 26 05 26 – Grounding and Bonding for Electrical System
   3. Section 27 06 28 – Pathways for Communication Systems
   4. Section 27 11 00 – Communications Cabinets, Racks, Frames and Enclosures
   5. Section 27 13 00 – Communications Backbone Cabling
   6. Section 27 15 00 – Communications Horizontal Cabling

1.2 SUMMARY

A. Section Includes:

   1. Grounding conductors.
   2. Grounding connectors.
   3. Grounding busbars.
   4. Grounding rods.
   5. Grounding labeling.

1.3 DEFINITIONS

A. AWG – American Wire Gauge – The standardized system for gauging the diameter of round, solid, non–ferrous, electrically–conducting wire.

B. BBC – Bonding Backbone Conductor – A telecommunication bonding connection which interconnects telecommunications bonding backbones. Formerly known as the grounding equalizer.

C. BN – Bonding Network – A set of interconnected conductive structures that provides a low impedance path for the associated telecommunications infrastructure.

D. EF – Entrance Facility – An entrance to a building for both public and private network service cables, including wireless, that includes the entrance point of the building and continues to the entrance room or space.

E. ESD – Electro Static Discharge – The sudden flow of electricity between two electrically–charged objects caused by contact, an electrical short, or dielectric breakdown.

F. Mesh–BN – Mesh Bonding Network – A bonding network to which all associated equipment, such as cabinets, frames, racks, trays, and pathways, are connected using a bonding grid that is connected to multiple points on the common bonding network.

G. PBB – Primary Bonding Busbar – A busbar placed in a convenient and accessible location and bonded, by means of the Telecommunications Bonding Conductor (TBC), to the building's service equipment (power) ground. Formerly known as the Telecommunications Main Grounding Busbar (TMGB).

H. RBB – Rack Bonding Busbar – A busbar within a cabinet, frame, or rack.

I. RBC – Rack Bonding Conductor – A bonding conductor from the rack or Rack Bonding Busbar (RBB) to the Telecommunications Equipment Bonding Conductor (TEBC).

J. SBB – Secondary Bonding Busbar – A common point of connection for telecommunications system and equipment bonding to ground, located in the distributor room. Formerly known as the Telecommunications Grounding Busbar (TGB).

K. TBB – Telecommunications Bonding Backbone – The conductor that interconnects the Primary Bonding Busbar (PBB) to the Secondary Bonding Busbar (SBB).

L. TBC – Telecommunications Bonding Conductor – A conductor that interconnects the telecommunications bonding infrastructure to the building's service equipment (power) ground. Formerly known as the bonding conductor for telecommunications.

M. TEBC – Telecommunications Equipment Bonding Conductor – A conductor that connects the Primary Bonding Busbar (PBB) or Secondary Bonding Busbar (SBB) to equipment racks or cabinets.

N. TR – Telecommunications Room – An enclosed space for housing telecommunications equipment, cable terminations, and cross–connect cabling. It is the recognized location of the cross–connect between the backbone and horizontal facilities.

O. UBC – Unit Bonding Conductor – A bonding conductor from equipment or a patch panel to a Rack Bonding Conductor (RBB) or a Rack Bonding Busbar (RBB).

## 1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For communications equipment room signal reference grid. Include plans, elevations, sections, details, and attachments to other work.

## 1.5 CLOSEOUT SUBMITTALS

A. As–Built Data: Plans showing as–built locations of grounding and bonding infrastructure, including the following:
   1. PBB, SBB, RBB and routing of their bonding conductors

B. Field quality–control reports.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Installation Supervision: Installation shall be under the direct supervision of an ITS Technician, who shall be present at all times when Work of this Section is performed at Project site.
2. Field Inspector: Currently registered by BICSI as a Technician to perform the on-site inspection.

PART 2 - PRODUCTS

2.1 GENERAL

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

B. Comply with UL 486

C. Comply with TIA-607-latest revision.

2.2 MANAUFACTURERS

A. Approved Manufacturers
1. Panduit
2. Erico
3. Chatsworth
4. Or approved equal

2.3 CONDUCTORS

A. Comply with UL 486A-486B.

B. The Telecommunications Bonding Conductor (TBC) shall be a UL listed, stranded conductor insulated with a green jacket. The TBC shall be equal in size to the TBB specified elsewhere in this Section.

C. The Telecommunications Bonding Backbone (TBB) Grounding Conductors shall be:
1. To be bare or insulated copper, of minimum conductor size #6 AWG and sized at 2 kcmil per linear foot up to a maximum size of 750 kcmil. (For details on TBB sizing see "Execution" section at end of this document).
2. Where un–insulated, to be identified with green tape at termination location.
3. Labeled in accordance with recommendations set forth in ANSI/TIA–606 Administration Standard for Telecommunications Infrastructure.

D. The Equipment Bonding Conductors (EBCs)
1. Shall be #12AWG or larger stranded conductor with a green insulating jacket and provide a bolt–on solution for grounding network equipment

E. Bonding Conductor (BC): BC shall be #6 insulated (green) stranded copper conductor.

F. Equipment Jumper Kits (Unit Bonding Conductor or "UBC"):
1. Used to ground large, chassis–style rack mounted equipment that have built–in grounding pads or terminals.
2. Bond network equipment to grounding strip or grounding busbar.

G. Surge Suppressor Jumper Kit: Bonds power or data line surge suppressor to grounding strip or grounding busbar.

H. Armored Cable Grounding Kit:
1. Provides a secure bond to the armor sheath on indoor and indoor/outdoor fiber optic cables at both cassette and enclosure ends.
2. Worm–gear design evenly distributes forces across the armor.
3. Made from steel and aluminum material is compatible with common armor for long term reliability.
4. Black insulating cover protects and hides the connection for an aesthetically pleasing work area.
5. Complies with industry requirements ensuring a high level of reliability and safety.

## 2.4 CONNECTORS

A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

B. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.

C. Signal Reference Grid Connectors: Combination of compression wire connectors, access floor grounding clamps, bronze U-bolt grounding clamps, and copper split-bolt connectors, designed for the purpose.

D. Busbar Connectors: Cast silicon bronze, solderless compression-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch (15.8- or 25.4-mm) centers for a two-bolt connection to the busbar.

E. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

## 2.5 GROUNDING BUSBARS

A. Approved manufacturers
1. Erico
2. Chatsworth
3. B-Line

B. The Primary Bonding Busbar (PBB) shall be:
1. A solid, tinned copper bar, 4 inches wide by 20 inches long by 1/4 inch thick.

2. Meet BICSI and TIA–607 requirements for network systems grounding applications.
3. Employ BICSI hole spacing to fit LCC series 2–hole lugs.
4. Be made of high conductivity copper and tin–plated to inhibit corrosion.
5. Come pre–assembled with brackets and insulators attached for quick installation.
6. Use component labels to identify busbars to meet TIA–606.

C. The Secondary Bonding Busbar (SBB) shall be:
1. A solid, tinned copper bar, 2 inches wide by 10 inches long by 1/4 inch thick.
2. Meet BICSI and TIA–607 requirements for network systems grounding applications.
3. Employ BICSI hole spacing to fit LCC series 2–hole lugs.
4. Be made of high conductivity copper and tin–plated to inhibit corrosion.
5. Come pre–assembled with brackets and insulators attached for quick installation.
6. Use component labels to identify busbars to meet TIA–606.

D. Grounding Busbar for Racks and Enclosures
1. With each enclosure and rack, provide a tinned copper busbar to serve as an extension of the PBB or SBB for the equipment in the cabinet.
2. Shall be manufactured from copper alloy.
3. Horizontal Busbars shall be at least .75 inches (19 mm) wide, 19 inches (483 mm) long, and 0.1875 inches (5 mm) thick.
4. Have at least 14, factory–provided #12–24 threaded holes.
5. Have pre–punched EIA 310 D mountings, which match that of the vertical rail, for attachment to the mounting rail.
6. Vertical Busbars shall be at least 0.67 inches (17 mm) wide, 78.65 inches (2 m) long, and 0.05 inches (1.27 mm) thick and come in threaded rail and cage nut versions.
7. Include a hardware kit with rack installation hardware and with screws for bonding equipment to the busbar.

## 2.6 SHIELDED CABLE SYSTEMS BONDING

A. Patch panels for use with shielded cabling in cabinets and racks shall be bonded to the supplemental telecommunications bonding system. When using Panduit racks and/or cabinets, and installed per Panduit installation instructions, the racks and cabinets are continuously bonded. Use a thread forming screw when, mounting the patch panels. This will create the bond to the already properly grounded rack and/or cabinet.

B. Install at least one screw per patch panel

C. Sheathed cable that does not have a metal jack, or a means of electrically–continuous connection to the patch panel or equipment, must have an individual jumper to tap into the sheathing and to properly bond it to the supplemental telecommunications bonding system.

D. Sheathed cable with a metal jack or means of electrically–continuous connection to the patch panel or equipment, does not need to be individually bonded. However, the equipment must then be properly bonded back to the PBB or SBB via one of the following methods:
1. Bond a jumper from the equipment or cable, via an irreversible compression connection, to a Rack Bonding Conductor (RBC) that is connected to the Telecommunications Equipment Bonding Conductor (TEBC) that is bonded to the PBB or SBB.

2. Bond equipment via a jumper, with a 2–hole grounding lug, to a Rack Bonding Busbar (RBB) (vertical or horizontal) that is properly bonded to the TEBC and to the PBB or SBB.
3. If the equipment is electrically continuous and the rack is electrically continuous and bonded back to the TEBC or directly to the PBB or SBB, bond equipment to the rack via bonding hardware.
4. If the equipment has a 2–hole grounding lug landing area, then to comply with equipment manufacturers' warranties, the landing area must be properly bonded back to the busbar.

## 2.7 OTHER GROUNDING AND BONDING PRODUCTS

A. Pipe Clamps:

B. Used to ground copper code conductor to water pipe or copper tubing.

C. Cast from high strength, electrolytic bronze to provide reliable grounding connections.

D. Plated steel screws provide high strength and inhibit corrosion.

E. Accommodates a wide range of pipe, tube, rod and conductor sizes – minimizes inventory.

F. cULus 467 Listed for grounding and bonding with AWG conductor.

G. Bronze Grounding Clamps for Conduit:
1. Used to ground copper conductor parallel to, or at a right angle to a rod, tube, or pipe.
2. Made from high strength, electrolytic cast bronze.
3. High strength silicon bronze hardware provides long term reliable assembly.
4. Accommodates a wide range of pipe, tube, rod and conductor sizes – minimizes inventory.
5. cULus 467 Listed for grounding and bonding with AWG conductor and suitable for direct burial in earth or concrete.

H. Copper and Aluminum One–Hole Grounding Lay–in Lug for bonding ladder rack
1. Used for quick installation of a continuous grounding conductor.
2. cULus 467 Listed for grounding and bonding, copper lugs. UL Listed for direct burial in earth or concrete.
3. cULus Listed for use up to 600 V and temperature rated 90°C

I. Communication Grounding Rods
1. Material: Copper–clad steel.
2. Size: 3/4–inch by 8 feet long.
3. Standards: Meet requirements of ANSI®/UL 467–1984, CSA, and ANSI/NEMA GR–1.

J. Access Floor Grounding Clamps
1. Bonds crossed grid conductors to each other, and bonds the access floor pedestals to the conductors.
2. Specifically designed to bond perpendicular Mesh–BN (a.k.a. MCBN or Mesh Common Bonding Network) conductors per TIA–942 and TIA–607.
3. Bonds to the pedestal with a single bolt to simplify installation.
4. Accommodates conductor sizes from #6 – 1/0 AWG, minimizing inventory requirements.

5. Bonds both round and square access floor pedestals for greater flexibility.
6. Crossing grounding conductors affixed and bonded using a split bolt quad clamp which requires only one nut to install.
7. Split bolt design allows easy insertion of perpendicular conductors speeding installation and is UL 467 Listed and CSA.
8. Split bolt is UL Listed and CSA Certified for use up to 600 V and temperature rated 90°C.
9. Each clamp accepts up to two conductors for a high–performance bond with faster installation.
10. Wide wire range–taking capability minimizes inventory requirements.
11. Split–bolt made from high strength, electrolytic bronze to provide reliable grounding connections.

K. Universal Beam Grounding Clamp
1. Used to for bonding structural steel (ex: I–beams) into bonding network.
2. Universal, fits on a wide range of standard (angled) and wide flange (parallel) structural steel beams.
3. Provide a mounting pad suitable for a two–hole compression lug.
4. Installs quickly and easily with standard 1/4" key hex wrench tooling.
5. UL 467 Listed and CSA 22.2 Certified for grounding and bonding suitable for direct burial in earth or concrete.
6. Comply with vibration tests per MIL–STD–202G (METHOD 201A).

L. Split Bolt for Bonding Cable Trays
1. Made from high strength copper alloy to resist corrosion and provide premium electrical and mechanical performance.
2. Wire range–taking capability minimizes inventory requirements.
3. Nut hex provides correct fit with socket, box, or open–end wrenches resulting in proper torqueing of electrical connection.
4. Pressure bar provides secure connection on a full range of conductor combinations used with each connector assuring premium wire pull–out strength.
5. UL Listed and CSA Certified with AWG conductor for use up to 600 V and temperature rated 90°C.
6. Available in tin–plated version for bonding to galvanized wire baskets.

M. Auxiliary Cable Brackets (Conductor Pathway)
1. Used for mounting telecommunications bonding conductors outside of cable tray.
2. Maintain minimum 2" separation between bonding conductors and all other types of cabling per TIA 607.
3. Bonds ladder rack, wire basket sections together without drilling holes or applying other split–bolt clamps.
4. Supports grounding conductors in the telecommunications room, allows separation of grounding conductors from other cables.
5. Holds up to four conductors in sizes up to 750 kcmil.
6. Bonds to all 1" and 2" ladder rack rails.
7. Paint piercing teeth provide electrical continuity between cable pathway sections while minimizing debris.
8. Front and back mounting screw options allow easy installation and visual inspection.
9. Can be mounted above or below the cable pathway system for flexibility.
10. Meet requirements TIA–607.
11. Have available bonding jumper kits to bond sections of basket tray or ladder rack.

N. Electrostatic Discharge (ESD) Port Kits and Wrist Strap
   1. Used for dissipating electro–static buildup prior to maintenance work on network equipment.
   2. Accommodate standard ESD wrist strap 4mm plug.
   3. Wrist strap provides rapid and continuous drain of electrostatic charge between a person and the surface to which the wrist strap is bonded, thus preventing damaging static discharge into equipment.
   4. Can be mounted to front or back of rack or cabinet for convenient access.
   5. Bent 45° to act as a hook to hold wrist strap when not in use.
   6. Two–hole configuration provides anti–rotation and prevents loss of bond.
   7. Barrel permanently marked with the protective earth (ground) symbol.
   8. Engineered to comply with US and International grounding requirements.
   9. Versions for threaded racks rails or cabinet cage nuts.

O. Miscellaneous Bonding Accessories
   1. Anti–oxidation Paste (contact aid) For Copper to Copper and Copper to Steel Connections.
   2. Anti–oxidation Paste (contact aid) For Aluminum Pad–to–Pad or Thread–to–Thread Aluminum Connections.
   3. Green thread–forming bonding screws for bonding smaller equipment on threaded rack rails through the equipment mounting flange.
   4. Green bonding cage nuts from bonding smaller equipment on cage nut rails through the equipment mounting flange.
   5. Thread forming screws for bonding two–hole lugs to vertical busbars on threaded rack rails.
   6. Green paint piercing grounding washers for assuring electrical continuity between painted parts of equipment racks, as described in TIA 607 Standard.
   7. Bonding hardware kits (studs) for forming low–resistance bond between the rack or cabinet and painted rack mounted appliances and equipment.

## 2.8 LABELING

2.9 Comply with TIA–606 and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.10 Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV–resistant seal for label.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.

B. Inspect the test results of the ac grounding system measured at the point of BCT connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

## 3.2 INSTALLATION

A. This Specification document describes a generic enterprise communications bonding and grounding system for the construction of a complete and functioning grounding system without prior knowledge of the facilities where it will be used. It is the responsibility of the installing contractor to adapt these general guidelines and principles to the requirements of the actual environments where the systems are to be implemented.

B. System shall provide equipment ground connections (bonds) from the premises entrance facility and outside–plant earthing system to each telecommunication room telecommunication ground busbar, through the racking systems to bond the network equipment.

C. Entire grounding link from equipment to earth should be visually verifiable except where hidden by walls, conduit or pathways.

D. Installing contractor shall label all elements of the communications bonding network according to guidelines defined in TIA–607–B and ANSI/TIA 606–B.

E. It is the responsibility of the installer to be knowledgeable of all previously cited Standards and Codes and to bring to the attention of the Owner any conflicts or discrepancies to achieve a fully functioning, standards–compliant earthing system.

F. Contractors working around or adding to existing legacy systems shall bring to the attention of the Owner previously installed network elements that may not comply with modern grounding requirements for possible remediation.

G. Telecommunications Bonding Backbone (TBB):
   1. Bonding and grounding conductors may be insulated or un–insulated and shall not decrease in size as the grounding path moves closer to earth.
   2. Connections (bonds) between the telecommunications grounding network and associated electrical panels shall be done by a qualified electrician in accordance with guidelines in TIA 607–B and applicable electrical codes.
   3. Bonding Conductors should be continuous and routed in the shortest possible straight–line path, avoiding changes in elevation and sharp bends.
   4. TBB conductors shall be protected from mechanical damage and built to minimize splicing. Where splicing is unavoidable, they shall be done using irreversible compression splices (C–TAPS) built to that purpose. See the "Materials" section of this document for appropriate compression splices.
   5. TBB in multi–story buildings with multiple risers (multiple TBBs) shall employ a grounding equalizer (GE) between vertical grounding backbones at the top floor of the building and minimally at every third floor in between to the lowest floor level. The GE shall be no smaller than the largest sized TBB.

6. Routing grounding conductors through ferrous metal conduit should be avoided, but if it is necessary due to building constraints, any grounding conductor running through ferrous conduit longer than 3 feet shall be bonded at the end using appropriately sized HTAP and Conduit grounding clamps as described TIA 607 using appliances described for that purpose in the "Materials" section of this document.
7. Conductors used to bond TBB to conduit ends shall be of #6 AWG size or larger.
8. Conductor sizing shall be based upon project specification (drawings and notes) for that installation. These sizes are based on TBB length per TIA 607 recommendations. Contractor shall bring to the attention of <<ClientName>> anywhere TBB project specified sizing appears insufficient per the Table below:

| Sizing of the TBB | |
|---|---|
| **TBB Length in Linear Meters (Feet)** | **TBB Size (AWG)** |
| Less than 4 (13) | 6 |
| 4-6 (14-20) | 4 |
| 6-8 (21-26) | 3 |
| 8-10 (27-33) | 2 |
| 10-13 (34-41) | 1 |
| 13-16 (42-52) | 1/0 |
| 16-20 (53-66) | 2/0 |
| 20-26 (67-84) | 3/0 |
| 26-32 (85-105) | 4/0 |
| 32-38 (106-125) | 250 kcmil |
| 38-46 (126-150) | 300 kcmil |
| 46-53 (151-175) | 350 kcmil |
| 53-76 (176-250) | 500 kcmil |
| 76-91 (251-300) | 600 kcmil |
| Greater than 91 (301) | 750 kcmil |

H. Entrance Facilities and Primary Bonding Busbar (PBB), [old terminology – Telecommunications Main Grounding Busbar (TMGB)]:
1. PBB shall be located in the entrance facility, near the electrical panel to which it will be bonded but installed to maintain clearances required by applicable electrical codes.
2. PBB shall be sized according to the anticipated number of bonded connections needed.
3. PBB shall have tinned surface to restrain oxidation and be cleaned and antioxidant paste applied prior to fastening conductors.
4. Connectors on TBB which attach to PBB shall be of two–hole, long–barrel compression lugs of the LCC series as specified in the "Materials" section of this document.

5. Building steel within six feet of the communications grounding system should be bonded into the system with appropriate hardware listed in "Materials" section of this document.
6. All cables containing a metallic shield or armor shall have that shield properly bonded into the communications grounding system using the appropriately sized Armored Cable Grounding Kit listed in the "Materials" section of this document.

I. Telecommunications Rooms and Secondary Bonding Busbar (SBB), [Old terminology Telecommunications Grounding Busbar (TGB)]:
1. Each telecommunications room shall have its own SBB to which equipment and dead steel (building steel and support structures) in that room are bonded.
2. The SBBs shall have a tinned surface to inhibit oxidation and be sized according to the anticipated number of bonded connections that will be needed.
3. SBBs shall be sized according to the anticipated number of bonded connections needed.
4. SBBs shall have tinned surfaces to restrain oxidation and shall be cleaned and have an antioxidant paste applied to both bonding surfaces prior to fastening conductors.
5. Connectors on backbone and rack/cabinet bonding conductors which attach to SBB shall be of two–hole, long–barrel compression lugs of the LCC series as specified in the "Materials" section of this document.
6. Building steel within six feet of the communications grounding system should be bonded into the system with beam clamps and other hardware appropriate to that purpose listed in "Materials" section of this document.
7. Racks and cabinets shall have individual Rack Bonding Conductors (RBC) bonding to the Telecommunications Equipment Bonding Conductor (TEBC) or underfloor "Supplemental Bonding Grid – DAISY CHAINING OR SERIAL CONNECTIONS OF ONE RACK OR CABINET TO ANOTHER WILL NOT BE ACCEPTED.
8. In smaller Telecommunications Rooms (3–5 racks) it is acceptable to have telecommunications equipment bonding conductors (TEBC) that go directly from each individual rack to the SBB. DAISY CHAINING OF RACKS WILL NOT BE ACCEPTED.
9. Rack Bonding Conductors (RBC) or above rack row grounds (TEBC) shall be installed to maintain a minimum of 2" separation from all other types of cable – power or communications.
10. To maintain this segregation of cables some telecommunications rooms may lend themselves to the installation of Auxiliary Conductor Brackets for routing bonding conductors outside of, yet parallel to ladder rack or basket tray. See "Auxiliary Brackets" in "Materials" section of this document.
11. Bonding conductor support systems like auxiliary brackets shall be spaced no further apart than three–foot intervals.
12. All cables containing metallic shielding or armor shall be properly bonded into the communications grounding system using the appropriately sized Armored Cable Grounding Kit listed in the "Materials" section of this document.

J. Supplemental Bonding Grid (SBG) (Underfloor Grounding Grids):
1. Large Equipment Rooms and Data Centers may have Mesh Bonding Network or Mesh–BN which consist of the information technology equipment (ITE), racks and cabinets, underfloor supplemental bonding grids (SBG, a.k.a. underfloor bonding grids), and pathways.
2. Flooring system must be made electrically continuous, with the grid bonded a minimum of every fifth pedestal in each direction as per TIA 607 Standard, using a minimum size #6 AWG stranded copper conductor and the pedestal clamps listed in the "Materials" section of this document. Specifications for individual <<ClientName>> projects

requiring larger conductor sizes or greater clamp density shall take precedent over these guidelines.

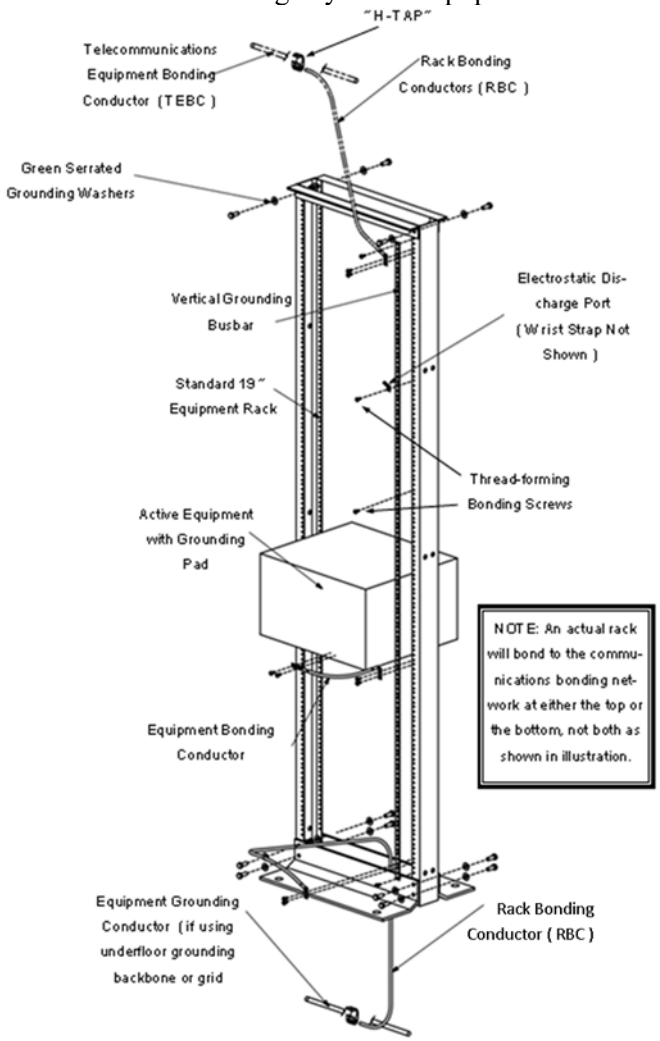
3. Underfloor SBG shall bond to the PBB or SBB in the computer room with a conductor of 1/0 AWG or larger.
4. Racks and cabinets shall bond to the SBG with a conductor size of #6 AWG or larger.
5. Each rack or cabinet will have individual bonding conductors into the grounding grid. Serial connections (or "daisy–chaining") between communications bays is strictly forbidden and will not be accepted.
6. Power Distribution Units (PDU) shall bond into the Mesh–BN per requirements of NEC 250.122 and per manufacturers' recommendations.
7. Heating, ventilating and air–conditioning (HVAC) shall have bonding conductors into the underfloor grid of #6 AWG or larger.
8. Each HVAC unit shall have its own connection and may not be daisy–chained or attached serially.
9. Each steel column in the communications room shall bond into the Mesh–BN with a conductor of minimum size #4 AWG.
10. All metal cable trays shall be bonded into the grid with a minimum conductor size of #6 AWG or larger. These may be bonded in series.
11. All metallic conduits, water pipes and air ducts shall be bonded to the grid with a minimum conductor size of 6 AWG or larger. These may be bonded in series.

K. Bonding within Racks and Cabinets:

1. Racks and Cabinets shall be bonded into the communications bonding network with conductors of #6 AWG or larger.
2. Depending on size of the telecommunications room, Rack Bonding Conductors (RBC) may tap into underfloor or overhead grounding conductors, or for smaller TRs (3–5 racks or cabinets), may go directly from the rack to the wall mounted busbar.
3. Racks, cabinets and similar enclosures shall not be attached serially, (daisy–chained) but must have individual RBC into the grounding system.
4. Newly installed racks and cabinets shall have vertical grounding busbars installed along one rail to provide clean bonding landing point for all rack mount equipment. For part numbers vertical busbars see "Materials" section of this document. Grounding busbars shall not be isolated from the rack or cabinet.
5. All painted components of racks/cabinets shall be assembled using serrated grounding washers and thread–forming screws to ensure electrical continuity between the different structural components of the rack/cabinet.
6. Larger equipment (chassis switches) with integral grounding terminals or pads shall be bonded to the vertical busbar with equipment grounding kits attached to those terminals and bonding them to the rack–mounted busbars. For kit part numbers see the "Materials" section of this document.
7. Anywhere two metallic surfaces are to be bonded, contractor shall clean the contact areas of paint or oxidation using abrasive pads and apply film of anti–oxidation compound between surfaces prior to bonding.
8. All cable fittings shall be of two–hole (LCC series) compression–type. Mechanical screw–lugs on racking systems will not be accepted and must be removed and replaced at contractor's expense.
9. All screws used to affix compression lugs to rack–mounted vertical busbars shall be of the thread forming type made specifically for electrical bonding.
10. Smaller equipment (servers, TOR switches) not having integral grounding pads must be bonded to the rack through the equipment mounting flanges using green thread–forming grounding screws with serrations under the head to cut through paint, coatings and

oxidation that may be present on the equipment flange. Such equipment shall have minimally one grounding screw per piece of equipment.

11. Existing (installed) racking systems containing live active equipment may be retrofitted for Standards–compliant bonding using rack retrofitting kits listed in the "Materials" section of this document.
12. ESD (electro–static discharge) ports and wrist straps shall be provided minimally every other rack or bay to be within reach of any active equipment. On larger 4–post racks or cabinets – ESD ports and wrist straps shall be installed on the front and back to be accessible when servicing any active equipment.
13.




## 3.3 FIELD QUALITY CONTROL

A. On installations confined to a single telecommunications room, the installing contractor shall visually verify continuity of communications bonding system from equipment, through racking systems, to overhead or underfloor backbone to the wall mounted busbar in that telecommunications room.

B. Contractor shall further verify the use of all appropriate bonding accessories in the racking systems such as grounding washers, thread–forming grounding screws and the presence of electro–static discharge ports and wrist straps within reach of all equipment to be maintained.

C. On greenfield (new) projects involving installation of a building–wide telecommunications backbone, installing contractor is further responsible for visually verifying sizing and sound installation of the telecommunications bonding backbone including presence of properly sized and installed grounding equalizer conductors between backbones contained in separate risers.

D. Inspecting Contractor shall verify that any conduit longer than 3 feet through which a grounding conductor passes is properly bonded to the grounding conductor as described in this document.

E. During inspections contractor shall verify compliance with all stipulations specified in this document and compliance with all regulatory references (Standards and Codes) cited.

F. All opens or gaps in the bonding system during final inspections will be recorded in the inspection report and remedied.

G. During inspections, contractor shall check all grounding and bonding system conductors and connections for tightness and proper installation, including checking proper dies were used on compression taps and fittings by checking embossed die numbers on those connections.

H. Owner may request a test of 10% of bonded connections within the grounding system with a volt–ohm meter. Resistance tests taken on either side of a compression or exothermic bond shall be less than .2 (2/10) of one ohm in resistance.

I. Bonded joints to be tested may be random or individually tagged by a representative of the Owner

J. Contractor shall Test system at bonded points indicated and provide results in report form.

K. Based upon test results, the Owner reserves the right to request testing on 100% of exothermic and compression bonds within the installed grounding system.

L. All bonded connections failing the test described above shall be remedied and retested by the installation contractor at contractor's expense.

## 3.4 IDENTIFICATION

A. Provide labeling according to the requirements of:
   1. ANSI/TIA/EIA–606.
   2. Section 27 05 53 Identification for Communications Systems.

B. Primary Bonding Busbar (PBB): Label with “PBB”.

C. Secondary Bonding Busbar (SBB): Label with “SBB”.

D. Telecommunications Bonding Backbone (TBB): Label with “WARNING! TELECOMMUNICATIONS BONDING BACKBONE. DO NOT REMOVE OR DISCONNECT” Labels shall be affixed at both ends and at accessible intermediate points.

E. Grounding Equalizer (GC): “WARNING! TELECOMMUNICATIONS INTERCONNECTING BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT” Labels shall be affixed at both ends and at accessible intermediate points.

F. Bonding Conductor (BC): Label with “WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!” Labels shall be affixed at both ends and at accessible intermediate points.

## 3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a PBB and a SBB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.

    a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.

3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.

    a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the PBB and each SBB Maximum acceptable ac current level is 1 A.

C. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5 ohms, notify Architect promptly and include recommendations to reduce ground resistance.

D. Grounding system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION 270526

SECTION 270528 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 260536 "Cable Trays for Electrical Systems" for cable trays and accessories serving electrical systems.

1.2 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Metallic surface pathways.
4. Nonmetallic surface pathways.
5. Hangers and Supports
6. Flexible Fabric Innerduct
7. Ladder Rack
8. Wire-mesh cable tray
9. Cable tray accessories
10. Sleeves and Seals

1.3 DEFINITIONS

A. ARC: Aluminum rigid conduit.

B. GRC: Galvanized rigid conduit.

C. IMC: Intermediate metal conduit.

D. RTRC: Reinforced thermosetting resin conduit.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected Ceiling Plans and Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of pathway groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

3. Underground ducts, piping, and structures in location of underground enclosures and handholes.
4. Scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.
5. Vertical and horizontal offsets and transitions.
6. Clearances for access above and to side of cable trays.
7. Vertical elevation of cable trays above the floor or below bottom of ceiling structure.

B. Source quality-control reports.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
1. Source Limitations: Obtain cable trays and components from single manufacturer.

B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.

C. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:
1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
3. Load and Safety Factors: Applicable to both side rails and rung capacities.

### 2.2 METAL CONDUITS AND FITTINGS

A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.

B. Approved Manufacturers
1. Eaton
2. Allied Tubing
3. Western Tube and Conduit

C. General Requirements for Metal Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
2. Comply with TIA-569-D.

D. PVC-Coated Steel Conduit: PVC-coated IMC.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch minimum.

E. EMT: Comply with ANSI C80.3 and UL 797.

F. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
2. Fittings for EMT:

    a. Material: Steel.
    b. Type: Set screw or compression.

3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.
4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

## 2.3 FLEXIBLE FABRIC RACEWAY, INNERDUCT OR CONDUIT

A. Basis of Design: Maxcell or Equal

B. Materials & Equipment: Labeled and/or listed as acceptable to the authority having jurisdiction (AHJ) and as suitable for the intended use.

C. Flexible raceway for optical fiber, communications, or power cables.

D. Provide wire management in a building for fiber optic and data and communications cabling.

E. Materials
1. Orange and/or White Polyester resin monofilament
2. Orange and/or White Nylon resin monofilament
3. Orange and/or White textured polyester yarn
4. Pre-applied >2% by weight Polydimethyl Siloxane lubricant (not applied to Premise/Indoor product)
5. Preinstalled pull tape with color coded identification or Polyethylene monofilament jacketed woven rope

F. Fabric Innerduct
1. Standard Outdoor Woven Fabric Innerduct: Product ranging in size from 1” – 4” width for communications cable. Single or Multi-cell polyester/nylon fabric in a non-simple weave partial float zone configuration for minimum pulling tension. All cells along said innerduct will be joined along a continuous seam. Seam stitching offered in multiple thread colors for identification and multi-pack applications. Innerduct will have footage markings every five feet on exterior cell. Each cell containing minimum 1250lb polyester flat woven pull tape or 1250lb woven polyester/ polyethylene rope. Multiple packs may be pulled into a single empty conduit.
2. Detectable Outdoor Woven Fabric Innerduct: Product ranging in size from 1” – 4” width for communications cable. Single or Multi-cell polyester/nylon fabric in a non-simple weave partial float zone configuration for minimum pulling tension. All cells along said innerduct with be joined along a continuous seam. Seam stitching offered in multiple

thread colors for identification and multi-pack applications. Innerduct will have footage markings every five feet on exterior cell. Each cell containing 1250lb polyester flat woven pull tape or 1250lb woven polyester/polyethylene rope. Each pack will contain a minimum 18AWG solid wire, with solid (non-stranded) polyvinyl/nylon conductor for tracing and rated for a minimum of 6 amps and 600 volts. Conductor shall be placed in the sidewall edge fold of the fabric sleeve.

3. Fire Retardant Low Smoke Zero Halogen Fabric Innerduct (Applicable for Riser and Plenum Applications) Product ranging in size from 1" – 4" width single or multi-cell Nylon fabric which meets UL 2024 requirements for flame propagation and optical smoke density for use in air handling spaces. Innerduct will have footage markings every five feet on exterior cell. Innerduct will bear the UL listed logo
4. Plenum-Listed Self Supporting Fabric Innerduct. Product comes in various configuration and will also have a 9/32" galvanized steel strength member with minimum breaking tensile of 900lbs. Product will be low smoke zero halogen and will be pre-installed with 1250lb pull tapes standard. Innerduct will have footage markings every five feet on exterior cell. Product will carry the UL listed seal.
5. Flexible fabric innerduct will meet the pulling tension requirements under the listed parameters as set forth in the table below.
6. Parameters:
    a. 3 or 4"" PVC Schedule 80 stick pipe
    b. 800ft straight pull section
    c. 1250lb rated flat pull tape
    d. Straight section with at least 10ft but less than 50ft of gradient change
    e. 0.50-0.70" HDPE (high density polyethylene) Fiber Optic Cable
7. Fabric Innerduct Fittings
    a. Termination Bags: Inflation-type bags for sealing and securing around one or more fabric innerducts and cables within 2-inch outside diameter or larger conduit.

## 2.4 NONMETALLIC CONDUITS AND FITTINGS

A. Description: Nonmetallic raceway of circular section with manufacturer-fabricated fittings.

B. Approved manufacturers.
1. Thomas and Betts
2. Graybar
3. Dura-Line

C. General Requirements for Nonmetallic Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
2. Comply with TIA-569-D.

D. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

E. Fittings: Comply with NEMA TC 3; match to conduit or tubing type and material.

F. Solvents and Adhesives: As recommended by conduit manufacturer.

## 2.5 SURFACE METAL PATHWAYS

A. Description: Galvanized steel with snap-on covers, complying with UL 5.

B. Approved Manufacturers
   1. Wiremold/Legrand
   2. Hubbell
   3. Panduit

C. Finish: Manufacturer's standard enamel finish in color selected by Architect.

D. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

E. Comply with TIA-569-D.

## 2.6 SURFACE NONMETALLIC PATHWAYS:

A. Description: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC.

B. Approved Manufacturers
   1. Panduit
   2. Wiremold/Legrand
   3. Hubbell

C. Finish: Texture and color selected by Architect from manufacturer's standard colors.

D. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.

E. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

F. Comply with TIA-569-D.

## 2.7 HOOKS

A. Description: Prefabricated sheet metal cable supports for telecommunications cable.

B. Approved Manufacturers
   1. Caddy/nVent
   2. B-Line
   3. Panduit

C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

D. Comply with TIA-569-D.

E. Galvanized or stainless steel, or non-metallic material.

F. J shape.

## 2.8 LADDER RACK TRAY

A. Approved Manufacturers
   1. Chatsworth
   2. B-Line
   3. Hubbell

B. Description:
   1. Configuration: Two longitudinal side rails with transverse rungs swaged or welded to side rails, complying with NEMA VE 1.
   2. Width: 18 inches unless otherwise indicated on Drawings.
   3. Minimum Usable Load Depth: 4 inches
   4. Straight Section Lengths: 10 feet or 12 feet, except where shorter lengths are required to facilitate tray assembly.
   5. Rung Spacing: 6 inches oc
   6. Radius-Fitting Rung Spacing: 9 inches at center of tray's width.
   7. Minimum Cable-Bearing Surface for Rungs: 7/8-inch width with radius edges.
   8. No portion of the rungs shall protrude below the bottom plane of side rails.
   9. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb (90-kg) concentrated load, when tested according to NEMA VE 1.
   10. Fitting Minimum Radius: 12 inches
   11. Class Designation: Comply with NEMA VE 1, Class 5A.
   12. Splicing Assemblies: Bolted type using serrated flange locknuts.
   13. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

C. Materials and Finishes:
   1. Steel:
   2. Finish: Powder-coat enamel paint.
   3. Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
   4. Hardware: Stainless steel, Type 316, ASTM F593 and ASTM F594.

## 2.9 WIRE-MESH CABLE TRAY

A. Approved Manufacturers
   1. Chatsworth
   2. B-Line
   3. Hubbell

B. Description:
   1. Configuration: Galvanized steel wire mesh, complying with NEMA VE 1.
   2. Width: 12 inches unless otherwise indicated on Drawings.
   3. Minimum Usable Load Depth: 4 inches
   4. Straight Section Lengths: 10 feet, except where shorter lengths are required to facilitate tray assembly.

5. Structural Performance: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb (90-kg) concentrated load, when tested according to NEMA VE 1.
6. Comply with NEMA VE 1,
7. Splicing Assemblies: Bolted type using serrated flange locknuts.
8. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

C. Materials and Finishes: Steel
1. Straight Sections and Fittings: Steel complies with the minimum mechanical properties of ASTM A1011/A1011M, SS, Grade 33
2. Steel Tray Splice Plates: ASTM A1011/A1011M, HSLAS, Grade 50, Class 1.
3. Fasteners: Steel complies with the minimum mechanical properties of ASTM A510/A510M, Grade 1008.
4. Finish: Electrogalvanized after fabrication, complying with ASTM B633.
5. Hardware: Galvanized, ASTM B633.

## 2.10 SLEEVES

A. Rounded Sleeves
1. Wall Sleeves, Steel ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends and integral waterstop
2. Pipe Sleeves, PVC ASTM D1785, Schedule 40
3. Molded Sleeves, PVC

B. Rectangular Sleeves
1. Sheet Metal Sleeves, Galvanized Steel, Rectangular
   a. Material: Galvanized sheet steel.
   b. Minimum Metal Thickness:
      1) For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness must be 0.052 inch.
      2) For sleeve cross-section rectangle perimeter not less than 50 inches or with one or more sides larger than 16 inches, thickness must be 0.138 inch .

C. Sleeve Seal Systems
1. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable or between pathway and cable
2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Fiber-reinforced plastic or Stainless steel.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

D. Grout
1. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
2. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
3. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

E. Pourable Sealants
   1. Description: Single-component, neutral-curing elastomeric sealants of pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

## 2.11 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

## 2.12 PULLING MEDIUM

A. Pull Tape: measuring and pulling tape constructed of synthetic fiber, printed with accurate sequential footage marks. Color-coded.

B. Pull Rope – woven rope constructed of a strength core with a polyethylene jacket designed for minimal pulling tension.

## 2.13 PENETRATION SEALING MATERIALS

A. Duct Water Seal: products suitable for closing underground and entrance conduit openings where innerduct or cable is installed, to prevent entry of gases, liquids, or rodents into the structure.

# PART 3 - EXECUTION

## 3.1 PATHWAY APPLICATION

A. Outdoors: Apply pathway products as specified below unless otherwise indicated:

   1. Exposed Conduit: GRC
   2. Concealed Conduit, Aboveground: EMT, PVC.
   3. Underground Conduit: RNC, PVC, direct buried, concrete encased
   4. Boxes and Enclosures, Aboveground: NEMA 250

B. Indoors: Apply pathway products as specified below unless otherwise indicated:

   1. Exposed, Not Subject to Physical Damage: EMT
   2. Exposed, Not Subject to Severe Physical Damage: EMT.
   3. Exposed and Subject to Severe Physical Damage: GRC. Pathway locations include the following:

      a. Loading dock.
      b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.

c. Mechanical rooms.

4. Concealed in Ceilings and Interior Walls and Partitions: EMT
5. Damp or Wet Locations: GRC.
6. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical-fiber-cable pathway, Plenum-type, communications-cable pathway EMT.
7. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: Riser-type, optical-fiber-cable pathway, Riser-type, communications-cable pathway, EMT.
8. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: Plenum-type, communications-cable pathway, EMT.
9. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel units in institutional and commercial kitchens and damp or wet locations.

C. Minimum Pathway Size: 1” trade size for copper and aluminum cables, and 1” for optical-fiber cables.

D. Pathway Fittings: Compatible with pathways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use set-screw or compression, steel fittings. Comply with NEMA FB 2.10.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface pathways only where indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F

## 3.2 INSTALLATION

A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:

1. NECA 1.
2. NECA/BICSI 568.
3. TIA-569-D.
4. NECA 101
5. NECA 102.
6. NECA 105
7. NECA 111.

B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

C. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

D. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling" for sleeves and sleeve seals for communications.

E. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

F. Complete pathway installation before starting conductor installation.

G. Arrange stub-ups so curved portions of bends are not visible above finished slab.

H. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.

I. Conceal rigid conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

J. Support conduit within 12 inches of enclosures to which attached.

K. Pathways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot (3-m) intervals.
2. Arrange pathways to cross building expansion joints at right angles with expansion fittings. Comply with requirements for expansion joints specified in this article.
3. Arrange pathways to keep a minimum of 1 inch of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.

L. Stub-ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for pathways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

M. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.

N. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.

O. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.

P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure, to assure a continuous ground path.

Q. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.

R. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.

S. Surface Pathways:

1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
2. Install surface pathway with a minimum 2-inch radius control at bend points.
3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

T. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:

1. 3/4-Inch Trade Size and Smaller: Install pathways in maximum lengths of 50 feet.
2. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.
3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

U. Install pathway-sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway-sealing fittings according to NFPA 70.

V. Install devices to seal pathway interiors at accessible locations. Locate seals, so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service pathway enters a building or structure.
3. Where otherwise required by NFPA 70.

W. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.

X. Expansion-Joint Fittings:

1. Install in each run of aboveground EMT that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet. Install in each run of aboveground EMT that is located where environmental temperature change may exceed 100 deg F, and that has straight-run length that exceeds 100 feet.

2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

    a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
    b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
    c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
    d. Attics: 135 deg F temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

Y. Hooks:

1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
2. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
3. Hook spacing shall allow no more than 6 inches of slack. The lowest point of the cables shall be no less than 6 inches adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
4. Space hooks no more than 5 feet o.c.
5. Provide a hook at each change in direction.

Z. Boxes

1. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
2. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
3. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.
4. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
5. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
6. Set metal floor boxes level and flush with finished floor surface.
7. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

## 3.3 INSTALLATION OF FABRIC INNERDUCT

A. Provide fabric innerduct in conduit and wire ways, and place fabric innerduct within and under cable trays using continuous unspliced lengths of fabric innerduct between maintenance holes, pull boxes, and/or termination points as indicated on the drawings.

B. Make a 2" incision, approximately 18" from the end of fabric innerduct. If using standard pull tape, pull out and cut off approximately 2 feet of pull-tape. Thus allowing the pull tape ends to retract back into the cells. If using a pull rope, simply make the 2” incision but do not pull out the ropes.

C. Using roughly 3-4 feet of pull tape, tie a non-slip knot to the incision. Then tie 3 to 6 half-hitch knots down to the end of fabric innerduct. Apply black vinyl tape over all knots and the end of fabric innerduct. Using a bowline knot tie a swivel to the end of 3 feet pull tape. For multi-pack installations one swivel is sufficient, but stagger each fabric innerduct.

D. Using a bowline knot, attach the pull rope located in the rigid conduit to the other end of the swivel. Install fabric innerduct – ensuring that no twist is introduced to the innerduct.

E. Provide suitable fabric innerduct slack in the maintenance holes, hand holes, pull boxes, and at turns to ensure there is no kinking or binding of the product.

F. Fabric Innerduct Mountings, Hangers and Attachments: When exposed indoors or in maintenance holes, hold firmly in place using independent support.
   1. Design & install hangers and other similar fittings adequate to support loads and so as to not damage innerduct.
   2. Do not fasten fabric innerduct to steam, water, or other piping, ductwork, mechanical equipment, electrical equipment, electrical raceways, or wires
   3. When securing fabric innerduct, select appropriate cable ties as required by local authority having jurisdiction (i.e. plenum-rated, flame-retardant)

G. Maintenance Hole and Hand Hole Installation:
   1. At locations where fabric innerduct will be continuous through a manhole or hand hole, allow sufficient slack so that the innerduct may be secured to the side of the vault while maintaining the minimum bend radius of the cable being placed.
   2. At maintenance holes serving as the junction location, pull the exposed end of the innerduct to the far end of the vault, install termination bag, and secure to the vault or pulling eyes.

H. Cable Tray and Runway Installation: Cut incisions every 24 inches into the edge of the fabric innerduct and cable wrap to one side of vertical ladder rack or horizontal ladder-type cable tray at each incision.

I. Penetrations
   1. Seal all conduit and fabric innerduct entering structures at the first box or outlet to prevent entrance into the structure of gases, liquids or rodents.
   2. Inspect fire stopping installation by others between building structure and conduit, wire way, and cable tray to verify integrity of installation.
   3. Exposed Fabric Innerduct Penetrations: Install conduit sleeves or fire barrier sealing systems in all openings where open and exposed fabric innerduct passes through fire-

rated walls and floors. After installation, install an AHJ approved fire barrier penetration sealing material between fabric innerduct and sleeves or fire barrier system.

4. Raceway Penetrations: After fabric innerduct installation, install an AHJ fire barrier penetration sealing material between fabric innerduct and conduit or wire way at all exposed penetration locations.
5. Protect adjacent surfaces from damage during water seal or fire stop installation. Repair any damage.

## 3.4 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe of less than 6 inches nominal diameter.
2. Install backfill as specified in Section 312000 "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete around conduit for a minimum of 12 inches on each side of the coupling.
    b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

5. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits, but a minimum of 6 inches below grade. Align planks along centerline of conduit.

## 3.5 CABLE TRAY INSTALLATION

A. Install cable trays according to NEMA VE 2.

B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.

C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.

D. Remove burrs and sharp edges from cable trays.

E. Join aluminum cable tray with splice plates; use four square neck-carriage bolts and locknuts.

F. Fasten cable tray supports to building structure.

G. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb (90 kg).

H. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.

I. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.

J. Support bus assembly to prevent twisting from eccentric loading.

K. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.

L. Locate and install supports according to NEMA VE 2. Do not install more than one cable tray splice between supports.

M. Support wire-basket cable trays with center support hangers, trapeze hangers, or wall brackets.

N. Make changes in direction and elevation using manufacturer's recommended fittings.

O. Make cable tray connections using manufacturer's recommended fittings.

P. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."

Q. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

R. Install cable trays with enough workspace to permit access for installing cables.

S. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.

## 3.6 CABLE TRAY GROUNDING

A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems."

B. Cable trays shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

C. Cable trays with single-conductor power conductors shall be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at 72-inch (1800-mm) intervals. The grounding conductor shall be sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors," and Article 392, "Cable Trays."

D. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.

E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

## 3.7 CABLE INSTALLATION

A. Install cables only when each cable tray run has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.

C. Fasten cables on vertical runs to cable trays every 18 inches.

D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches.

E. Tie MI cables down every 36 inches where required to provide a 2-hour fire rating and every 72 inches elsewhere.

F. In existing construction, remove inactive or dead cables from cable trays.

## 3.8 CONNECTIONS

A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.

B. Connect pathways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

## 3.9 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Comply with NECA 1.

B. Sleeves for Conduits Penetrating Above-Grade, Non-Fire-Rated, Concrete and Masonry-Unit Floors and Walls:
   1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor so no voids remain. Tool exposed surfaces smooth; protect material while curing.
b. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.

C. Sleeves for Conduits Penetrating Non-Fire-Rated Wall Assemblies:
1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for wall assemblies.

D. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

E. Aboveground, Exterior-Wall Penetrations: Seal penetrations using [steel] [cast-iron] pipe sleeves and mechanical sleeve seal systems. Size sleeves to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

F. Underground, Exterior-Wall and Floor Penetrations:
1. Install steelpipe sleeves with integral waterstops. Size sleeves to allow for 1-inch annular clear space between pathway or cable and sleeve for installing sleeve seal system. Install sleeve during construction of floor or wall.
2. Install steel pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between pathway or cable and sleeve for installing sleeve seal system. Grout sleeve into wall or floor opening.

G. Rectangular Sleeve Installation
1. Install sleeves in existing walls without compromising structural integrity of walls. Do not cut structural elements without reinforcing the wall to maintain the designed weight bearing and wall stiffness.
2. Install conduits and cable with no crossings within the sleeve.
3. Fill opening around conduits and cables with expanding foam without leaving voids.
4. Provide metal sheet covering at both wall surfaces and finish to match surrounding surfaces. Metal sheet must be same material as sleeve.

H. Sleeve Seal Systems Installation
1. Install sleeve seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.
2. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

## 3.10 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
   2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
   3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
   4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
   5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
   6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
   7. Check for improperly sized or installed bonding jumpers.
   8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
   9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

## 3.11 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

## 3.12 PROTECTION

A. Protect coatings, finishes, and cabinets from damage or deterioration.

   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 270528

SECTION 270802 - DOCUMENTATION AND CLOSE OUT FOR TECH & SECURITY SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Furnish complete project documentation and close-out functions for the communications project as shown on the Drawings, Specified or otherwise required.

PART 2 - PRODUCTS

2.1 FINAL INSPECTIONS

A. As per General Conditions, Article 10, the Contractor shall:

1. Prepare Contractors Punch List, complete work, make corrections, sign-off on the Contractor's Punch List and submit to the Owner and Engineer with Contractor's request for final inspection.
2. Contractor shall complete and correct all work items noted, sign-off on the Owner and Engineer's Punch Lists and submit with the request for Certificate of Contract Completion.

2.2 PROJECT RECORD DOCUMENT SUBMITTALS

A. The Contractor shall submit completed project documents as per General Conditions.

B. Record Drawings

1. The Contractor shall keep in the field and open to inspection, an accurate, current, progressive record of the actual installation of the data/communication cabling system. Upon completion of the work, the Contractor shall deliver marked up prints showing the actual routing of cable runs, outlet locations, outlet/cable identifications, cable tray sizes and routes, conduit sizes and routes, distribution frame layouts, punch down block locations, coax cable system splitter and tap locations with dB values and signal levels indicating system loading and balancing, etc.
2. Where applicable or otherwise noted on the Engineering Drawings or documents, the Engineer will provide to the Contractor an Auto-Cad file of the appropriate available floor plans and/or drawings as required for the Contractor to update and/or provide the required record documentation.
3. Cable Tray and Conduit Routing Submittal Drawings.

C. Submittals for Inclusion in the Project Manual shall include an Excel Spreadsheet with the following:

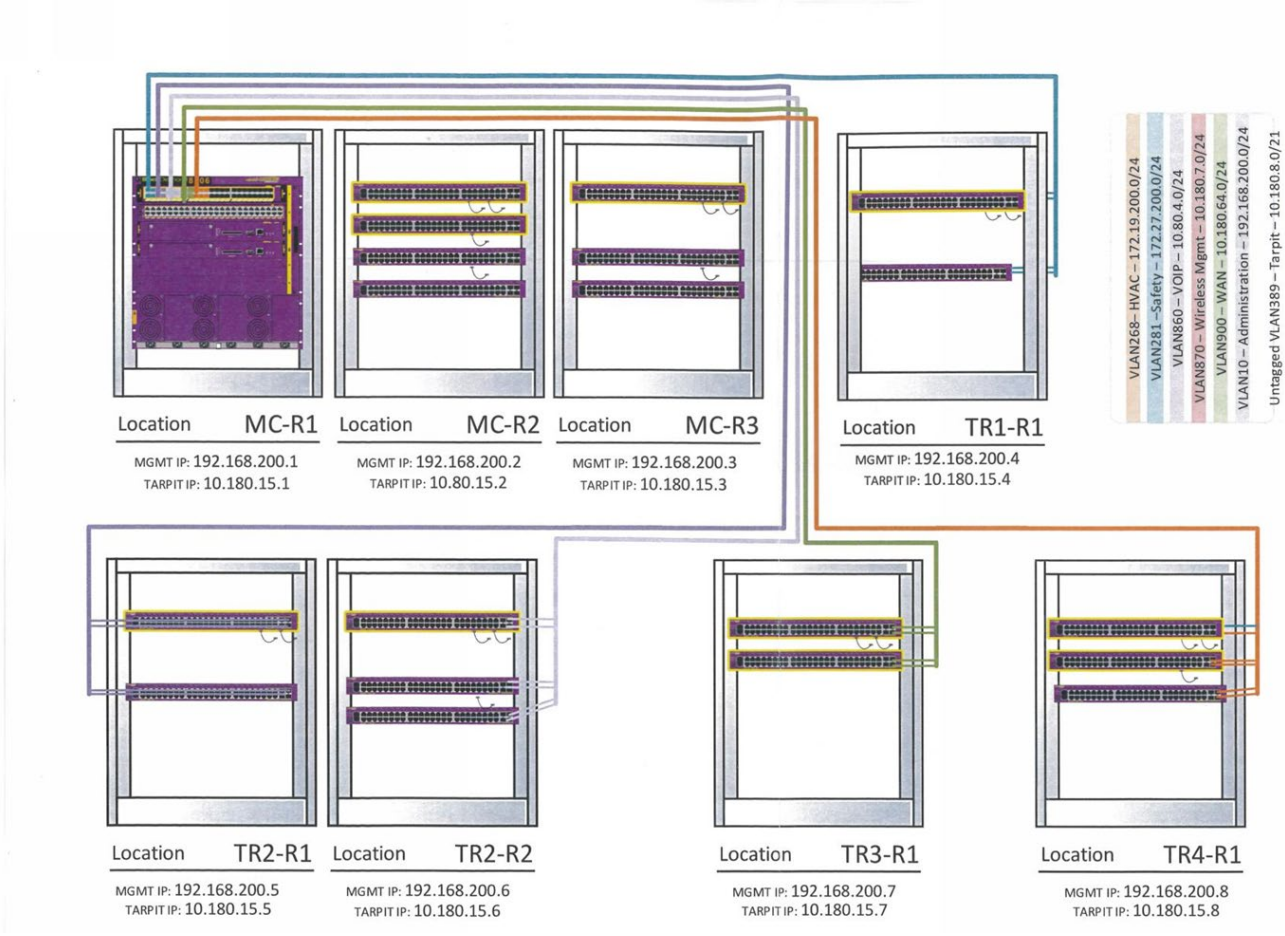
1. PC List
   a. Room No.
   b. Description

c. Part Number
d. Serial Nu. / Service Tag
e. Unit Cost

2. LCD List
   a. Room No.
   b. Description
   c. Part Number
   d. Serial Number
   e. Unit Cost
3. Projector List
   a. Room No.
   b. Description
   c. Part Number
   d. Serial Number
   e. MAC Address
   f. Unit Cost
4. WAP List
   a. Room No.
   b. Description
   c. Part Number
   d. WAP Number
   e. Cable ID
   f. Serial Number
   g. MAC Address
   h. Unit Cost
5. Phone List
   a. Room No.
   b. Description
   c. Part Number
   d. Cable ID
   e. TN Number
   f. Serial Number
   g. MAC Address
   h. Unit Cost
   i. TR Closet
   j. TR Switch I.D.
   k. Switch Port
   l. Room Name
   m. Code
6. Classroom Sound List
   a. Room No.
   b. Description
   c. Part Number
   d. Serial Number
   e. Mic 1 Serial Number
   f. Mic 2 Serial Number
   g. Unit Cost
7. Gym Sound List
   a. Room No.
   b. Description
   c. Part Number

d. Serial Number
e. Mic 1 Serial Number
f. Mic 2 Serial Number
g. Unit Cost

8. Student Dining Sound List
   a. Room No.
   b. Description
   c. Part Number
   d. Serial Number
   e. Mic 1 Serial Number
   f. Mic 2 Serial Number
   g. Unit Cost
9. BCM/SRG Keycodes - Or CS1000 License IDs
   a. Description
   b. License IDs
10. Network Equipment List (by TR or ER)
   a. Part Number
   b. IP / MAC Address
   c. Location/Switch Label
   d. Serial Number
   e. User ID
   f. Password
   g. Unit Cost
11. UPS Equipment List (by TR or ER)
   a. UPS Part Number
   b. Management Card
   c. IP Address
   d. Location
   e. UPS Serial
   f. Card Serial
   g. User ID
   h. Password
   i. Unit Cost
12. Telephone Headend List
   a. Part Number
   b. IP Address
   c. Location
   d. Serial Number
   e. User ID
   f. Password
   g. Unit Cost
13. IP Address Scheme
   a. Subnet
   b. Default Gateway
   c. VLAN Number
   d. VLAN Name
   e. Example of Schematic




14. Patching and VLAN Usage Details
    a. Patch Cable Colors
        1) Uplinks--Yellow
        2) HVAC—Orange
        3) Management—Red
        4) Security—Purple
        5) WAP—Blue
        6) Data—Black
        7) Voice—Dark Grey
        8) End User – All White
    b. End User—All WhitExcel Spreadsheet with cabling and patching details as follows:
        1) One spreadsheet per ER/TR
        2) Three columns: ER-XXX/TR-XXX, Total Cables Installed, Total Patch Cables Provides
        3) Rows: One per patch cable color
15. Edge Switch VLAN Network Breakdown (USERS)
    a. Switch Part#
    b. Switch Type
    c. Switch Name
    d. Switch Port/Usage
    e. VLAN
        1) VLAN 281—Security--Purple
        2) VLAN 10—Copper Network Switch Uplinks—Yellow

3) VLAN 10—Cables for UPS/other management devices--Red
4) VLAN 860—Voice—Dark Grey
   a) All phones shall connect to TARPIT ports and leverage "voice vlan 860" to support tagged VLAN860 traffic for voice signaling/bearer channels. PC's on the back of the phones are in TARPIT VLAN
   b) TARPIT ports shall have black patch cables even if these are phones connected to TARPIT ports that have PCs on the backs of phones
5) VLAN 329—TARPIT—All Data—Black
   a) All TARPIT ports shall be flagged for "voice vlan 860" to support PoE phones that use tagged VLAN 860 for voice signaling/bearer channels and the PCs on the back of the phones use the untagged TARPIT VLAN.
   b) TARPIT ports shall have black patch cables even if these are phones connected to TARPIT ports that have PCs on the backs of the phones.
6) Access Points will be operating in LWAP mode using a CAPWAP tunnel for all SSID trffic back from each AP to the CMSD centralized wireless LAN controller (WLC). The only VLAN is 870 for APs--Blue

f. Switch IP
g. Unit Cost

16. Main Panel and Switching
    a. ER/TR Name
    b. Patch Port
    c. Room #
    d. Room Name
    e. Faceplate Type
    f. Faceplate Label
    g. POE Draw
    h. Usage Switch Port
    i. Switch Part#
    j. Switch Type
    k. Switch Name
    l. PC Serial Number
    m. WAP Part#
    n. WAP Label
    o. WAP Serial#
    p. WAP MAC Address
    q. Phone Part#
    r. Phone Serial#
    s. Phone MAC Address
    t. Unit Cost
17. Total Cable Report
    a. Excel Spreadsheet as follows:
    b. Three Columns: Usage Cable/Color, Total Cables Installed, Total Patch Cables
    c. Rows: One per color-coded patch cable (usage/color referenced)

## 2.3 CONTRACTOR QUALIFICATIONS

A. Testing reports for copper and fiber optic cables as per specifications.

B. Factory Master Reel Test Reports and Contractor's Pre-Installation Copper and Fiber Optic Test Report per specifications. Report is required to be submitted to Owner before horizontal cable installation begins.

C. Record copy of Grounding Test Reports and Diagrams as per specification. Report is required to be submitted to Owner before horizontal cable installation begins.

D. Fire stopping Shop Drawing Submittals as per specification.

E. Product, Equipment and Material Shop Drawings as per specification.

F. Warranties and Guarantees as per specifications.

G. All other miscellaneous submittals as per specification, as required.

PART 3 - PROJECT MANUAL

3.1 Provide complete written Project Manuals, which shall include, but not be limited to the following:

A. First Page: Title of job, Owner, address, date of submittal and name of Contractor.

B. Second Page: Index of Contents

C. Third Page: Introduction to first section containing a cross-reference to the equipment schedule and cable schedule.

D. First Section: One copy each of accepted shop drawings, equipment catalog cuts and manufacturer's instructions for all components and materials utilized in the technology and security systems, including approved fire stopping shop drawings.

E. Second Section: One copy each of all Contractor Qualification Submittals, including references, certifications, registrations, workforce registrations, etc.

F. Third Section: One copy each of all completed, signed and accepted test reports, including Factory Master Reel Tests, Pre-installation tests, grounding, and cable installation verification testing.

1. All voice and data station cable and data riser cable test results will be submitted in their original format as down loaded from the tester in software on one or more CDs or USB drive with a standard protective case.
2. All fiber test results will be submitted on one or more CDs or USB drive with a standard protective case. OTDR test results shall be submitted in their original format and in PDF format on CDs or USB drive.

G. Fourth Section: One copy of all manufacturer's installation and operational manuals.

H. Fifth Section: One copy of all Contractor's, manufacturer's, and vendor's warranties and guarantees.

3.2 PROJECT MANUAL ASSEMBLY AND SUBMITTAL

A. Bind the written system instruction manual's information and materials into a PDF binder of 8½" x 11" size.

B. Submit two (2) digital copies each to the Owner and Engineer for approval.

C. After approval, submit four (4) additional digital copies to the Engineer for delivery to the Architect and Owner.

D. Submit two (2) complete digital sets of record drawings to the Owner and Engineer (one each) for review.

SECTION 271100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Backboards.
2. Boxes, enclosures, and cabinets.
3. Power strips.

B. Related Requirements:

1. Section 270536 "Cable Trays for Communications Systems" for cable trays and accessories.
2. Section 271313 "Communications Copper Backbone Cabling" for copper data cabling associated with system panels and devices.
3. Section 271323 "Communications Optical Fiber Backbone Cabling" for optical-fiber data cabling associated with system panels and devices.
4. Section 271333 "Communications Coaxial Backbone Cabling" for coaxial data cabling associated with system panels and devices.
5. Section 271513 "Communications Copper Horizontal Cabling" for copper data cabling associated with system panels and devices.
6. Section 271523 "Communications Optical Fiber Horizontal Cabling" for coaxial data cabling associated with system panels and devices.
7. Section 271533 "Communications Coaxial Horizontal Cabling" for coaxial data cabling associated with system panels and devices.

1.3 DEFINITIONS

A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.

B. BICSI: Building Industry Consulting Service International.

C. RCDD: Registered communications distribution designer.

D. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.

E. TGB: Telecommunications grounding bus bar.

F. TMGB: Telecommunications main grounding bus bar.

## 1.4 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 equipment racks and cabinets.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

## 1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

B. Seismic Qualification Data: Certificates, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

## 1.6 QUALITY ASSURANCE

A. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of **RCDD**.
2. Installation Supervision: Installation shall be under direct supervision of **Installer 2, Copper or Fiber**, who shall be present at all times when Work of this Section is performed at Project site.
3. Field Inspector: Currently registered by BICSI as **RCDD** to perform the on-site inspection.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Equipment shall withstand the effects of earthquake motions determined according to **ASCE/SEI 7 Telcordia GR-63-CORE requirements for Zone 4 Seismic Earthquake Environments**

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified **and the unit will be fully operational after the seismic event**.

2.2 BACKBOARDS

A. Backboards: Plywood **fire-retardant treated** 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm).

B. Backboard Paint: **Pre-painted**

2.3 BOXES, ENCLOSURES, AND CABINETS

A. Middle Atlantic or approved equal.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets shall be listed and labeled for intended location and use.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, Type FD, with gasketed cover.

E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, with gasketed cover.

H. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

I. Device Box Dimensions: **4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep)** Coordinate "Hinged-Cover Enclosures" Paragraph below with Drawings, if hinged-cover enclosures other than NEMA 250, Type 1 are required, such as for very dusty areas, or if consideration should be given to use of NEMA 250, Type 3R or Type 12 enclosures.

J. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, **Type 4** with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

2. Nonmetallic Enclosures: **Fiberglass**.
3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

K. Cabinets:

1. NEMA 250, **Type 3R** galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## 2.4 POWER STRIPS

A. Comply with requirements in Section 271116 "Communications Racks, Frames, and Enclosures."

B. Power Strips: Comply with UL 1363.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Rack mounting, with **detachable** flanges.
3. Height: **1 RU**.
4. Housing: **Metal**
5. **Six**, **20-A, 120-V ac, NEMA WD 6, Configuration 5-20R** receptacles.
6. **Front**-facing receptacles.
7. LED indicator lights for power and protection status.
8. LED indicator lights for reverse polarity and open outlet ground.
9. Circuit Breaker and Thermal Fusing:

    a. When protection is lost, circuit opens and cannot be reset.
    b. Unit continues to supply power if protection is lost.

10. **Close-coupled, direct plug-in**
11. Rocker-type on-off switch, illuminated when in on position.
12. Surge Protection: UL 1449, Type 3.

    a. Maximum Surge Current, Line to Neutral: **27 kA**.
    b. Protection modes shall be line to neutral, line to ground, and neutral to ground.
    c. UL 1449 Voltage Protection Rating for line to neutral and line to ground shall be **500 V** for neutral to ground.

## PART 3 - EXECUTION

### 3.1 ENTRANCE FACILITIES

A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.

B. Comply with requirements in Section 270528 "Pathways for Communications Systems" for materials and installation requirements for pathways.

### 3.2 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI's "Telecommunications Distribution Methods Manual" for layout of communications equipment spaces.

C. Comply with BICSI's "Information Technology Systems Installation Methods Manual" for installation of equipment in communications equipment spaces.

D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

E. Coordinate layout and installation of communications equipment in tracks and in room. Coordinate service entrance configuration with service provider.

1. Meet jointly with systems providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
2. Record agreements reached in meetings and distribute them to other participants.
3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize configurations and space requirements of communications equipment.
4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.

F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

G. Backboards:

1. Install from 6 inches (150 mm) to 8 feet, 6 inches (2588 mm) above finished floor. If plywood is fire rated, ensure that fire-rating stamp is visible after installation.
2. Paint all sides of backboard with two coats of paint **leaving fire rating stamp visible**.
3. Comply with requirements for backboard installation in BICSI's "Information Technology Systems Installation Methods Manual" and TIA-569-D.

## 3.3 SLEEVE AND SLEEVE SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

## 3.4 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI's "Information Technology Systems Installation Methods Manual," "Firestopping Practices" Ch.

END OF SECTION 271100

SECTION 271513 - COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Category 6 twisted pair cable.
2. Category 6a twisted pair cable.
3. Twisted pair cable hardware, including plugs and jacks.
4. Multiuser telecommunications outlet assembly.
5. Cable management system.
6. Cabling identification products.
7. Grounding provisions for twisted pair cable.
8. Source quality control requirements for twisted pair cable.

B. Related Requirements:

1. Section 270513 "Conductors and Cables for Communications Systems" for data cabling associated with system panels and devices.

1.2 DEFINITIONS

A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

B. EMI: Electromagnetic interference.

C. FTP: Shielded twisted pair.

D. F/FTP: Overall foil screened cable with foil screened twisted pair.

E. F/UTP: Overall foil screened cable with unscreened twisted pair.

F. IDC: Insulation displacement connector.

G. LAN: Local area network.

H. Jack: Also commonly called an "outlet," it is the fixed, female connector.

I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.

J. RCDD: Registered Communications Distribution Designer.

K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

L. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

M. S/FTP: Overall braid screened cable with foil screened twisted pair.

N. S/UTP: Overall braid screened cable with unscreened twisted pairs.

O. UTP: Unscreened (unshielded) twisted pair.

## 1.3 COPPER HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C, and the equipment outlet, otherwise known as "Cabling Subsystem 1," in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.

1. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.
2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.
3. Bridged taps and splices shall not be installed in the horizontal cabling.

B. The work area is approximately 100 sq. ft. (9.3 sq. m), and includes the components that extend from the equipment outlets to the station equipment.

C. The maximum allowable horizontal cable length is 295 feet (90 m). This maximum allowable length does not include an allowance for the length of 16 feet (4.9 m) to the workstation equipment or in the horizontal cross-connect.

## 1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Reviewed and stamped by RCDD.

1. System Labeling Schedules:

    a. Electronic copy of labeling schedules, in software and format selected by Owner.
    b. Electronic copy of labeling schedules that are part of cabling and asset identification system of software.

2. Cabling administration Drawings and printouts.
3. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:

    a. Telecommunications rooms plans and elevations.
    b. Telecommunications pathways.
    c. Telecommunications system access points.
    d. Telecommunications grounding system.
    e. Telecommunications conductor drop locations.
    f. Typical telecommunications details.
    g. Mechanical, electrical, and plumbing systems.

C. Twisted pair cable testing plan.

D. Sustainable Design Submittals:

E. Samples: For telecommunications jacks and plugs

F. Field Quality-Control Submittals:

1. Field quality-control reports.

## 1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For **RCDD** installation supervisor, and field inspector.

B. Product Certificates: For each type of product.

C. Source quality-control reports.

## 1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For splices and connectors to include in maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On USB media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Connecting Blocks: [**One**] <**Insert number**> of each type.
2. Cover Plates: [**One**] <**Insert number**> of each type.
3. Jacks: [**Ten**] <**Insert number**> of each type.
4. Multiuser Telecommunications Outlet Assemblies: [**One**] <**Insert number**> of each type.
5. Patch-Panel Units: [**One**] <**Insert number**> of each type.
6. Plugs: [**Ten**] <**Insert number**> of each type.

## 1.8 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings[ **and cabling administration Drawings**][**, cabling administration Drawings, and field testing program development**] by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of [**Technician**] [**Level 2 Installer**], who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

## 1.9 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test each pair of twisted pair cable for open and short circuits.

## 1.10 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

## 1.11 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

# PART 2 - PRODUCTS

## 2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

C. Grounding: Comply with TIA-607-B.

## 2.2 GENERAL CABLE CHARACTERISTICS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:

1. Communications, Non-Plenum Rated:

    a. Type CMR complying with UL 1666[ **and ICEA S-103-701**].
    b. Type CMP or Type CMR in listed plenum or riser communications raceway.
    c. Type CMP or Type CMR in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: **25**
2. Smoke-Developed Index: **50 or** less.

C. RoHS compliant.

## 2.3 CATEGORY 6 TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250 MHz.

B. Approved Manufacturers:
1. General
2. Siemon
3. Berk-Tek
4. Approved equal

C. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.

D. Conductors: 100-ohm, 23 AWG solid copper.

E. Shielding/Screening: **Unshielded twisted pairs (UTP)**

F. Cable Rating: **Non-Plenum**.

G. Jacket: **Blue** thermoplastic.

H. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.

1. Features:

    a. Universal T568A and T568B wiring labels.
    b. Labeling areas adjacent to conductors.
    c. Replaceable connectors.
    d. 24 or 48 ports.

2. Construction: 16-gauge steel and mountable on 19-inch (483 mm) equipment racks.
3. Number of Jacks per Field: One for each four-pair [**cable indicated**] [**conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria**].

I. Patch Cords: Factory-made, four-pair cables in **36-inch** lengths; terminated with an eight-position modular plug at each end.
   1. Blue in color.
   2. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
   3. Patch cords shall have color-coded boots for circuit identification.

J. Plugs and Plug Assemblies:
   1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
   2. Standard: Comply with TIA-568-C.2.
   3. Marked to indicate transmission performance.

K. Jacks and Jack Assemblies:
   1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
   2. Designed to snap-in to a patch panel or cover plate.
   3. Standard: Comply with TIA-568-C.2.
   4. Blue in color.
   5. Marked to indicate transmission performance.

L. Cover Plate:
   1. **Four** port, vertical single gang cover plates designed to mount to single gang wall boxes.
   2. **Eight** port, vertical double gang cover plates designed to mount to double gang wall boxes.
   3. Plastic Cover Plate: High-impact plastic. Coordinate color with Section 260533 "Raceway and Boxes for Electrical Systems."
   4. Metal Cover Plate: **Stainless steel**, complying with requirements in Section 260533 "Raceway and Boxes for Electrical Systems."
   5. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.
      a. Flush mounting jacks, positioning the cord at a 45-degree angle.

M. Legend:
   1. Machine printed, in the field, using adhesive-tape label.
   2. Snap-in, clear-label covers and machine-printed paper inserts.

## 2.4 CABLE MANAGEMENT SYSTEM

A. Description: Computer-based cable management system, with integrated database capabilities.

B. Approved Manufacturers:
   1. CPI
   2. Middle Atlantic

3. Hubbell
4. Approved equal

C. Document physical characteristics by recording the network, TIA details, and connections between equipment and cable.

D. Information shall be presented in database view[**, schematic plans, or technical drawings**].

1. REVIT drawing software shall be used as drawing and schematic plans software.

E. System shall interface with the following testing and recording devices:

1. Direct upload tests from circuit testing instrument into the personal computer.
2. Direct download circuit labeling into labeling printer.

## 2.5 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

## 2.6 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables on reels according to TIA-568-C.1.

C. Factory test twisted pair cables according to TIA-568-C.2.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

# PART 3 - EXECUTION

## 3.1 WIRING METHODS

A. Routing:

1. Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters[ **and except in accessible ceiling spaces, attics, and gypsum board partitions where unenclosed wiring method may be used**]. Conceal raceway and cables, except in unfinished spaces.

a. Install plenum cable in environmental air spaces, including plenum ceilings.
b. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."

2. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

B. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.

## 3.2 INSTALLATION OF PATHWAYS

A. Comply with requirements for demarcation point, cabinets, and racks specified in Section 271100 "Communications Equipment Room Fittings."

B. Comply with Section 270528 "Pathways for Communications Systems."

C. Comply with Section 270529 "Hangers and Supports for Communications Systems."

D. Comply with Section 270536 "Cable Trays for Communications Systems."

E. Drawings indicate general arrangement of pathways and fittings.

## 3.3 INSTALLATION OF TWISTED-PAIR HORIZONTAL CABLES

A. Comply with NECA 1 and NECA/BICSI 568.

B. General Requirements for Cabling:

1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
2. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM), Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Do not untwist twisted pair cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.
5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
6. MUTOA shall not be used as a cross-connect point.
7. Consolidation points may be used only for making a direct connection to equipment outlets:

    a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
    b. Locate consolidation points for twisted-pair cables at least 49 feet (15 m) from communications equipment room.

8. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
9. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
10. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI Information

Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.

11. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.
12. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
13. In the communications equipment room, install a 10-foot- (3-m-) long service loop on each end of cable.
14. Pulling Cable: Comply with BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches (200 mm) above ceilings by cable supports not more than [**60 inches (1524 mm)**] <**Insert dimension**> apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable [**6 feet (1800 mm)**] <**Insert size**> long not less than [**12 inches (300 mm)**] <**Insert size**> in diameter below each feed point.

E. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:

1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (600 mm).

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).

b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).

4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

## 3.4 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with "Firestopping Systems" Article in BISCI's "Telecommunications Distribution Methods Manual."

## 3.5 GROUNDING

A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."

C. Comply with TIA-607-B and NECA/BICSI-607.

D. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.

E. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

## 3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."

1. Administration Class: **Class 4.**
2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Paint and label colors for equipment identification shall comply with TIA-606-B for **Class 4** level of administration **including optional identification requirements of this standard.**

C. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

E. Cable and Wire Identification:

1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
4. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.
    a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
    b. Label each unit and field within distribution racks and frames.
5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

F. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

## 3.7 FIELD QUALITY CONTROL

A. **Acceptance** Testing Preparation:

1. Contract must provide test results in native format (ie Fluke is .ftw) along with .PDF.

B. Tests and Inspections:

1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.

D. Nonconforming Work:

1. End-to-end cabling will be considered defective if it does not pass tests and inspections.
2. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

E. Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services:

1. Engage factory-authorized service representative to [**support**] [**supervise**] field tests and inspections.

## 3.8 MAINTENANCE

A. Software Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software service agreement includes software support for one year.

2. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within one year from date of Substantial Completion.

    a. Upgrade Notice: No fewer than **30** days to allow Owner to schedule and access the system **and to upgrade computer equipment if necessary**.

3. Upgrade Reports: Prepare report after each update, documenting upgrades installed.

END OF SECTION 271513

SECTION 274000 – MEDIA COMMUNICATION SYSTEMS (**Alternate Pricing**)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Specification, in conjunction with the Drawings, establishes the requirements necessary to achieve the intended performance and function of the Media Communications Systems (MCS)

B. Provide the services necessary to engineer, furnish, install, train, and to provide maintenance support to MCS including an integrated system of peripheral apparatus conforming to acceptable industry standards. All work shall be in accordance with the true intent of these Drawings and Specifications, and as required to leave the MCS complete and in satisfactory operating condition, excluding those items listed under "Work by Others."

C. The MCS shall be new, of modern design, and current standard production of the manufacturer.

D. Verify dimensions and conditions at the job site prior to installation, and perform installation in accordance with these Specifications, Manufacturers recommendations and the latest edition or revision of all applicable codes and standards.

E. Furnish and install an MCS incorporating but not limited to audio/video source devices, audio/video distribution, local video origination, touch panel control system, and appropriate testing equipment to perform testing as hereinafter described.

1.3 RELATED WORK PROVIDED BY OTHERS

A. The conduit system, outlet boxes, and power systems are being provided and installed by the Electrical Contractor.

B. All personal computers shall be furnished by the Owner.

1.4 EQUIPMENT MANUFACTURER QUALIFICATIONS

A. The system shall be built and tested by a manufacturer who has regularly engaged in the production of the components of similar MCS systems for a minimum of five years to assure one source of supply and responsibility.

## 1.5 EQUIPMENT SUPPLIER QUALIFICATIONS

A. The supplier of the MCS shall maintain permanent service facilities in the area of the installations. The facilities shall include a permanent source of factory trained service technicians experienced in servicing this type of equipment and shall provide warranty and routine maintenance service to afford the Owner maximum coverage. He shall also provide a central source of support to guarantee immediate answers to Owner's problems resulting from misunderstanding of the operation of the equipment.

## 1.6 EQUIPMENT INSTALLER QUALIFICATIONS

A. The installation of the MCS shall be performed by fully qualified personnel having had experience on the installation of this type of system and able to certify that they have had no less than five years of continuous experience in this area and have made installations similar to this and of this size or larger.

B. This Contractor must include references of similar jobs. Final determination of equipment installer qualifications shall be the decision of the Owner and may include inspections of recent work.

C. The Contractor shall use expertly trained and certified staff to set-up and configure the network. The Contractor shall provide a copy of the certificate bearing the name of the network technician. Documentation of the Contractor’s certified network installers continuing education must be submitted. Certified network installers training shall be commensurate with one of the following certifications and as appropriate with the Contractors network solution:

1. Cisco Certified Network Associate (CCNA)
2. Aruba Certified Switching Associate (ACSA)
3. Dell/EMC Certified Associate | Networking
4. Engineer Approved Equal

D. The Contractor shall use expertly trained and certified staff to install all audio-visual equipment and infrastructure. The Contractor shall provide a copy of the certificate bearing the name of the AV engineer and technicians. Documentation of the Contractor’s certified audio-visual personnel’s continuing education must be submitted. Audio-visual training shall be commensurate with one of the following certifications:

1. AVIXA: CTS-D (mandatory for engineer); CTS-I or CTS (at least one)
2. Engineer Approved Equal

## 1.7 SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.

1. Shop drawings shall be provided for all custom assemblies including distribution racks, audio/video distribution equipment room control equipment, projectors, cabinets, etc. Submit samples of lettering/label size and typeface to be employed on panels and other equipment.
2. Shop drawings shall be provided indicating proposed mounting arrangements and details of all equipment, including positioning devices, framework supports and interface with adjacent architecture.
3. Shop drawings shall be provided indicating equipment cabinets, equipment cabinet elevations, punch down blocks, layouts, cable labeling schemes, outlet labeling schemes, and rack outlet labeling scheme, cable routes and the location of ancillary items.
4. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
5. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
6. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.
7. Shop drawings shall be submitted for the following equipment and systems:

    a. Audio/Video distribution equipment, terminators, etc.
    b. Cable types for all audio, video, and control.
    c. Equipment cabinet elevation, components, and wiring diagrams.
    d. Audio video outlets.
    e. Display devices.
    f. Audio video switchers
    g. Decks and outboard equipment
    h. Control processors
    i. Presentation systems and touch panels (GUI).
    j. Videoconference equipment.
    k. Amplifiers, speakers, and backboxes.

## 1.8 GUARANTEE, SERVICE AND TRAINING

**A.** All systems and components shall be guaranteed free of defects in materials and workmanship for a period of one (1) year from the date of acceptance and shall be repaired or replaced within twenty-four (24) hours following report of such defects by the Owner. The date of acceptance shall be defined as the date, the Certificate of Substantial Completion is signed by the Architect/Engineer and the Owner. If the manufacturer provides a warranty greater than one (1) year, the extended warranty shall be extended to the Owner at no additional cost to the Owners.

B. The MCS Contractor, this includes all system providers or his representative, shall be available on call and shall respond on site within four (4) hour notice, and without cost to the Owner, during the first twelve (12) months of full scale operation, following acceptance of the system, to assist the Owner and/or his representatives in any problems that may arise during the initial period of operation.

C. Training (Media Communications System):
1. The Contractor shall be required to provide instruction on the operation of the system and its maintenance to the Owner’s personnel and their designee.
2. A complete training syllabus shall be coordinated with the Owner and submitted including an in-service teaching guide and system operator’s manual.
3. The Contractor shall include time for training Owner’s personnel on system operation and time for training Owner’s personnel on system maintenance in his base proposal. Include no

less than forty (40) hours of training time to be held at the site and shall be scheduled with the Owner.

1.9 MAINTENANCE CONTRACT

A. Maintenance and Service Contract: Submit an optional maintenance and service contract with service rates covering all labor and materials necessary to repair damages to the system. The service contract shall include a differentiation between and definitions of “emergency” and “non-emergency” service with applicable rates for each. Provide descriptions in reference to response time as it pertains to emergency and non-emergency maintenance calls and time required to replace and or repair all items.

B. Submit an optional maintenance and service contract for Second Year Maintenance Service: Beginning 12 months after Substantial Completion, provide 12 months’ full maintenance service by skilled, competent employees of the video system provider. Include monthly preventative maintenance repair or replacement of worn or defective components, lubrication, cleaning and adjusting as required for proper operation. Use parts and supplies as used in the manufacture and installation of original equipment. State your services, obligations and terms for the agreement.

1.10 SPARE PARTS

A. Guarantee the availability of all spare parts and maintain locally an adequate compliment of components that are applicable to the MCS.

1.11 SCOPE OF WORK

A. Furnish and install all wiring and specialty cover plates as required for a complete system. Standard electrical boxes will be furnished and installed by the electrical Contractor.

B. The following section specifically lists the acceptable equipment types and items for this project. Where quantities are not noted, they may be obtained from the Drawings.

2.1 TV’S
2.2 LOOSE CABLES
2.3 WIRE AND CABLES

PART 2 - PRODUCTS

2.1 TV’S

A. All TV’s shall be located as indicated on the Drawings. All interface cables for audio/video shall originate from their locations.

B. The following are the minimum requirement for the TV’s for the media communications systems:

1. Diagonal Measurement 65”
2. Pixel Resolution 4K
3. Tuning System ATSC / QAM

4. Aspect Ratio 16:9
5. Response Time 4ms1
6. HDMI™ Inputs: Min 2
7. RS-232C Input 9-pin x 1

C. Install universal wall mount brackets unless otherwise noted. The Contractor will also be responsible for the installation of any required VESA adapter plates necessary for a finished installation.

D. TV's will be installed in mounting brackets and secured with tamperproof hardware. A set of removal tools shall be furnished.

E. Manufacturer
LG
NEC
Sony
Samsung

2.2 SOUND BAR (**Alternate Pricing**)

A. All sound bars shall be located where there is a TV.

B. Contractor is responsible for procuring and installing sound bars.

C. Approved manufacturers
1. Sony
2. Samsung
3. LG

2.3 LOOSE CABLES

A. 25-Foot HDMI Cables
1. Provide the quantity of Eight (8) 25-foot HDMI Cables for the project.
2. The 25-foot HDMI Cables shall meet the following requirements:
   a. Triple-shielded with 85% tinned copper braid; Inner 100% Aluminum Mylar Wrap, Outer 100% Aluminum Mylar Wrap
   b. X-tra Flex UL/CL3 rated jacket
   c. HDMI Male-to-Male molded 24K gold-plated connectors
   d. Lifetime warranty

3.

| Manufacturer | Model |
|---|---|
| Comprehensive | HD18G-25PROBLKA |

2.4 WIRE AND CABLES

A. Antenna Cable and Connectors
1. Antenna Cable: installed in cable tray and ceiling areas used as return air plenum coaxial, solid #12 AWG center conductor, 95% braided; 50 ohm; plenum rated
   a. West Penn 25810
   b. Approved Equivalent

2. BNC Video Connector, crimp type, for Type 1 and Type 2(A) video cables
   a. Kings 2065-3-9 Series; or
   b. Approved Equivalent
3. Video Receptacle, recessed BNC jack double ended feed through with insulated bulkhead
   a. Canare BCJ-JRU; or
   b. Approved Equivalent

B. Audio-Visual Systems AC Power and Conduits

1. AC power service will be provided to the equipment rack location by Others. The Contractor shall be responsible for providing distribution and connection of AC power circuits within the audio-visual equipment racks.
2. Within equipment racks, provide multi-receptacle AC power strip for each AC circuit with at least two spare receptacles provided in each circuit.

## PART 3 - EXECUTION

### 3.1 MATERIAL AND WORKMANSHIP

A. Material, workmanship, wire, and wiring methods shall be performed as specified.

B. It shall be the responsibility of the Contractor to cooperate at all times, and to the fullest extent, with all trades and Contractors doing work in the building, to the end that lost time, work stoppages, interference, and inefficiencies do not occur. Communicate installation scheduling with the general Contractor, Owner, architect, and coordinate with other trades.

### 3.2 INSTALLATION – MEDIA COMMUNICATIONS SYSTEMS

A. The Contractor shall identify all audio-visual cabling clearly marking every cable in the system (both ends). All markings shall include purpose destination and origination of the wire or cable. All labeling shall be completed prior to final system equalization.

B. The Contractor shall loosely bundle cables with Velcro wraps, suitable for Plenum environments, every twenty (20) feet.

C. All cables shall be installed in conduits and raceways or an Engineer approved raceway system. Where conduits do not exist, provide “J” hooks sized appropriately for the bundle. MCS cable supports shall be separate and distinct from all other low voltage system cable supports i.e. security, alarm, voice and data, etc. The Contractor shall not fasten supports to pipes, ducts, mechanical equipment or conduit. The Contractor shall obtain permission from the Owner or the Technology Designer before drilling or cutting structural members. Powder actuated anchoring devices shall not be used to anchor any cable support or raceway system components.

D. Cabling shall be run parallel and perpendicular to building walls. All cabling installed in ceiling spaces shall be plenum rated.

E. The Drawings indicate cable type to be used. Further, the Drawings indicate a manufacturer's catalog number for reference of quality and functionality.

F. Communication bonding and grounding shall be in accordance with the NEC® and NFPA. Horizontal cables shall be grounded in compliance with ANSI/NFPA 70 and local requirements and practices. Horizontal equipment includes cross connect frames, patch panels and racks, active telecommunication equipment and test apparatus and equipment.

G. The Contractor shall not place any distribution cabling alongside power lines, or share the same conduit, channel or sleeve with electrical apparatus.

H. The Contractor shall provide any necessary screws, anchors, clamps, tie wraps, distribution rings, miscellaneous grounding and support hardware, etc., necessary to facilitate the installation of the system.

I. It shall be the responsibility of the Contractor to furnish any special installation equipment or tools necessary to properly complete the system. This may include, but is not limited to, tools for terminating cables, testing and splicing equipment for copper/fiber cables, communication devices, jack stands for cable reels, or cable wenches

J. All cabling shall be continuous from termination to termination and free from splices, reverses, or other connections. Provide a 5-foot minimum service loop above accessible ceiling for each terminated cable to accommodate future changes. Cable slack shall be stored in a fashion as to protect it from damage.

K. Remove only the amount of cable jacket necessary for termination. Carefully lay all cable with appropriate radius of curvature and protect at bends and corners. Observe minimum bend radius and tension limitations as specified by EIA/TIA.

L. All cables must be routed and managed for a neat and aesthetically pleasing appearance. All work must be installed in a neat and workman like manner.

M. The Contractor shall assure that at the completion of cable installation, cables are free from twists, kinks, sharp bends, cuts, gouges or any other physical damage that might cause alterations to the electrical or optical characteristics of the cables.

N. Install multimedia projector mounts at locations indicated to comply with manufacturer's written instructions.

O. All equipment needing to be operated from the front panel will be rack mounted.

P. The Contractor shall deliver a copy of the un-compiled programming source code, for the control system(s), to the Owner. Code for any/all rooms shall be provided and is the sole property of the Owner.

Q. Terminal block, boards, strips, or connectors shall be furnished for all cables, which interface with racks, cabinets, consoles, or equipment modules.

R. Cabling within racks shall be contained in finger-style wireway or wire-tied to the side of the rack in a neat and orderly fashion. All cables shall be grouped according to the signals being carried in order to reduce signal cross-talk. Separate groups shall be formed for the following cables:

1. Group one: Power Cables
2. Group two: Video Cables

S. Power cables, control cables, and high-level cables shall be run on the left side of an equipment rack, as viewed from the rear. All other cables shall be run on the right side of the equipment rack, as viewed from the rear. All installation shall follow broadcast wiring and installation practice, with note given to installation instructions given in the equipment section of these Specifications.

T. Supply all jacks, racks, wire, cabinetry, connectors, materials, parts, equipment and labor necessary for the complete installation of the systems, in full accordance with the recommendations of the equipment manufacturers and with the requirements of the Specifications and Drawings.

U. Observe proper circuit polarity and loudspeaker wiring polarity. Properly and clearly label all connections and wires as to function and polarity. No cables shall be wired with a polarity reversal between connections, at either end.

V. All equipment shall be held firmly in place with proper types of mounting hardware. All equipment shall be installed to provide reasonable safety to the operator. Supply adequate ventilation for all enclosed equipment items, which produce heat.

## 3.3 GROUNDING PROCEDURES

A. To minimize problems resulting from improper grounding, and to achieve maximum signal-to-noise ratios, the following grounding procedures shall be adhered to:

1. Under no circumstances shall the racks contact the conduit raceway system, the steel structure of the building, or ventilation ducts.
2. Under no conditions shall the AC neutral conductor, at any location, be used for a system ground.
3. Audio Cable Shields: All audio cable shields shall be grounded at one point only. There shall be no exceptions. For inter- and intra-rack wiring this requires that the shield be connected at the one end only. On un-grounded portable equipment, such as microphones, the shield shall be connected at both ends but grounded at one end only.

B. There shall be no deviations from the above unless specifically required by the manufacturer of the equipment or when necessary to minimize crosstalk and to maximize signal-to-noise ratios in the audio, video, and control systems.

## 3.4 CONTRACTOR SYSTEM CHECK

A. Before final testing is scheduled, the Contractor shall perform a system check. This work shall include the following:

1. Testing of all Microphone inputs and Tie-lines
2. Testing of all Speaker Lines and Jacks
3. Testing of any other wires or components
4. Test all Audio and Video for compliance with the Performance Standards.
5. Check all controls functions for specified operation.
6. Align all equipment for optimum performance and to meet manufacturers published specifications.

## 3.5 SYSTEM PERFORMANCE, TESTS AND ADJUSTMENTS

A. Testing Personnel: The Contractor shall have a minimum of two persons knowledgeable as to the systems as installed available for testing and adjustment with the Consultant.

1. Installing Contractor shall allow for up to (8) eight hours of testing and adjustments with the Consultant.
2. Failure of the Contractor to provide adequate personnel or testing equipment causing lost time to the Consultant shall result in the Contractor paying the Consultant's standard hourly rate for additional time and expenses, as necessary.

B. Test Equipment:

1. All equipment for testing and adjustments to the sound system shall be furnished by the Installing Contractor. Test equipment shall include:
   a. High Quality Multi-meter: Fluke or Similar
   b. Sweepable Tone Generator

2. The Consultant may choose to bring and use some of his/her own test equipment.

3. Furnish make, model, and serial number of all test equipment to be used to the Consultant prior to performing any test and adjustments to the system.

C. Loudspeaker Impedances: Measure and record the impedance of each loudspeaker line. For high frequency drivers take impedance measurement at 4000 Hz. For mid-range drivers take impedance measurement at 1000 Hz. For low frequency drivers take impedance measurements at 100 Hz. Results of all impedance tests shall be recorded and furnished to the Owner for future system repair and troubleshooting.

D. Noise and RF Pickup:
1. Set up system for each specified mode of operation.
2. Check to ensure that system is free of noise, hum, and radio frequency interference.

E. Buzzes, Rattles, Distortion:
1. Apply high-quality music signal to the system. Adjust the system for frequent peaks at its specified maximum sound pressure level.
2. Apply sinewave sweep from 50 to 5,000 Hz at 10 dB below full amplifier power.
3. In both cases, listen carefully for buzzes, rattles and objectionable distortion.
4. Correct all causes of such defects. If cause is outside system, promptly notify the Owner indicating cause and suggested corrective procedures.

F. Equalization:
1. Prior to system commissioning furnish names of personnel involved in project management, final adjustment, and tuning. Furnish a profile of experience and training of the personnel completing the tuning.
2. Final equalization and setup shall be done under the supervision of the Consultant. As described in the above sections.

G. SPL Recording:

1. Measure the SPL at a minimum of eight points within the space to confirm that coverage at octave band center frequencies from 63 Hz to 8000Hz is a maximum of +/- 3dB.

## 3.6 FINAL TESTING AND EQUALIZATION

A. The testing work shall be performed after the installation work has been completed, but prior to any use of the system. During the testing work, the installer shall have on the job, one competent technician who is familiar with the project, and who shall be prepared to stay if his/her services are needed.

B. Prior to the testing, the installer shall insure that the system is free of short circuits, ground loops, parasitic oscillations, and excessive system noise beyond published specifications of the equipment.

C. The Contractor, at the Contractor's expense, shall rectify any components not found to function in a satisfactory manner as defined by this specification.

D. The Final Testing shall be made in the presence of the Owner or Owner's Authorized Representative.

## 3.7 DRAWINGS AND DOCUMENTATION

A. All tuning and adjustment shall have hard copy data bound and turned over to the Engineer and Consultant. Submit record drawings and Documentation of Tests, Measurements and Adjustments performed. All submittals shall be furnished before final payment is released.

B. A copy of all DSP settings shall be burned to CD and placed in the rack after the completion and acceptance of all work and testing.

C. Fully detailed documentation and record drawings of installation layout and performance shall be submitted for review within thirty (30) days of completion of work and shall include as a minimum:

1. Marked drawings showing distance and routing of all inside cable with gauge, type and numbering scheme.
2. Location of outlets with their identification number prepared on most recent installation drawing.
3. Drawings showing distribution frame layouts, cable routing from rooms.
4. Drawings showing layout of panels and equipment in cabinets.
5. Drawings shall accurately record actual locations of each item of fixed equipment and show interconnecting wiring. Drawings will indicate location of equipment and tagged circuits. A functional block diagram will also be required.

D. Documentation Requirements

1. Drawings, whenever submitted, shall be submitted with three (3) copies to the Owner.

2. Cable and outlet identification, locations, performance and test results will be entered into Excel or approved PC based spreadsheet. The Contractor spreadsheet template and format will be approved by the Owner.

3. Final record drawings shall be submitted as one (1) ANSI C drawing, two (2) sets of scaled 20# bond drawings and two (2) CD-ROM in PDF format. Drawings shall be professionally done. Hand drawings and notations will not be accepted.

E. All drawings and the information contained therein become the sole property of the Owner.

3.8 FINAL INSPECTION

A. At the final inspection, a factory-trained representative of the manufacturer of the major equipment shall demonstrate that the systems function properly in every respect. The demonstration shall be made in the presence of the Owner or Owner's Authorized Representative.

B. The Contractor, at the Contractor's expense, shall rectify any components not found to function in a satisfactory manner as defined by this specification.

SECTION 275116 - PUBLIC ADDRESS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Battery backup power unit.
2. Preamplifiers.
3. Power amplifiers.
4. Transfer to standby amplifier.
5. Microphones.
6. Volume limiter/compressor.
7. Control console.
8. Equipment cabinet.
9. Equipment rack.
10. Telephone paging adapter.
11. Tone generator.
12. Monitor panel.
13. Loudspeakers.
14. Noise-operated gain controller.
15. Conductors and cables.

1.3 DEFINITIONS

A. Channels: Separate parallel signal paths, from sources to loudspeakers or loudspeaker zones, with separate amplification and switching that permit selection between paths for speaker alternative program signals.

B. VU: Volume unit.

C. Zone: Separate group of loudspeakers and associated supply wiring that may be arranged for selective switching between different channels.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Power, signal, and control wiring.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, required clearances, method of field assembly, components, and location and size of each field connection.
3. Console layouts.
4. Control panels.
5. Rack arrangements.
6. Calculations: For sizing backup battery.
7. Wiring Diagrams: For power, signal, and control wiring.

    a. Identify terminals to facilitate installation, operation, and maintenance.
    b. Single-line diagram showing interconnection of components.
    c. Cabling diagram showing cable routing.

C. Delegated-Design Submittal: For supports and seismic restraints for control consoles, equipment cabinets and racks, and components indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of supports and seismic restraints for control consoles, equipment cabinets and racks, and components.

## 1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings are shown and coordinated with each other, using input from installers of the items involved.

B. Qualification Data: For **Installer**

C. Seismic Qualification Certificates: For control consoles, equipment cabinets and racks, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Include qualification data for testing agency.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control reports.

## 1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For public address systems to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017700 "Closeout Procedures" and Section 017823 "Operation and Maintenance Data," include the following:

    a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
    b. Operating instructions laminated and mounted adjacent to operating console location.
    c. Training plan.

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Microphone: **One**
2. Microphone Desk Stand(s): **One**

## 1.8 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

1. Personnel certified by NICET as Audio Systems Level **II** Technician.

B. Testing Agency Qualifications: Qualified agency, with the experience and capability to conduct testing indicated.

1. Testing Agency's Field Supervisor: Currently certified by NICET at Level III to supervise on-site testing.

# PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

1. Bogen

B. Source Limitations: Obtain public address system from single source from single manufacturer.

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

D. Comply with NFPA 70.

## 2.2 FUNCTIONAL DESCRIPTION OF SYSTEM

A. System Functions:

1. Selectively connect any zone to any available signal channel.
2. Selectively control sound from microphone outlets and other inputs.
3. "All-call" feature shall connect the all-call sound signal simultaneously to all zones regardless of zone or channel switch settings.
4. Telephone paging adapter shall allow paging by dialing an extension from any local telephone instrument and speaking into the telephone.
5. Produce a program-signal tone that is amplified and sounded over all speakers, overriding signals currently being distributed.
6. Reproduce high-quality sound that is free of noise and distortion at all loudspeakers at all times during equipment operation including standby mode with inputs off; output free of nonuniform coverage of amplified sound.

## 2.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports and seismic restraints for control consoles, equipment cabinets and racks, and components, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Seismic Performance: Supports and seismic restraints for control consoles, equipment cabinets and racks, and components shall withstand the effects of earthquake motions determined according to **ASCE/SEI 7**.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified.

## 2.4 SYSTEM DESCRIPTION

A. Compatibility of Components: Coordinate component features to form an integrated system. Match components and interconnections for optimum performance of specified functions.

B. Equipment: Comply with UL 813. Equipment shall be modular, using solid-state components, and fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.

C. Equipment Mounting: Where rack, cabinet, or console mounting is indicated, equipment shall be designed to mount in a 19-inch (483-mm) housing complying with EIA/ECA-310-E.

D. Weather-Resistant Equipment: Listed and labeled by a qualified testing agency for duty outdoors or in damp locations.

## 2.5 PREAMPLIFIERS

A. Preamplifier:

1. Separately mounted.
2. Integral to power amplifier.

B. Output Power: Plus 4 dB above 1 mW at matched power-amplifier load.

C. Total Harmonic Distortion: Less than 1 percent.

D. Frequency Response: Within plus or minus 2 dB from 20 to 20,000 Hz.

E. Input Jacks: Minimum of three. One matched for low-impedance microphone; one USB port; and the other matchable to DVD or CD player, or radio tuner signals without external adapters.

F. Minimum Noise Level: Minus 55 dB below rated output.

G. Controls: On-off, input levels, and master gain.

## 2.6 POWER AMPLIFIERS

A. Mounting: **Rack**.

B. Output Power: 70-V balanced line. **80 percent of the sum of wattage settings of connected** for each station and speaker connected in all-call mode of operation, plus a **15 percent** allowance for future stations.

C. Total Harmonic Distortion: Less than 3 percent at rated power output from 50 to 12,000 Hz.

D. Minimum Signal-to-Noise Ratio: 80 dB, at rated output.

E. Frequency Response: Within plus or minus 3 dB from 20 to 12,000 Hz.

F. Output Regulation: Less than 2 dB from full to no load.

G. Controls: On-off, input levels, and low-cut filter.

H. Input Sensitivity: Matched to preamplifier and to provide full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on speaker microphone or handset transmitter.

## 2.7 TRANSFER TO STANDBY AMPLIFIER

A. Monitoring Circuit and Sensing Relay: Detect reduction in output of power amplifier of 40 percent or more and, in such event, transfer load and signal automatically to standby amplifier.

## 2.8 MICROPHONES

A. Paging Microphone:

1. Type: Dynamic, with **cardioid** polar characteristic.
2. Impedance: **250** ohms.
3. Frequency Response: Uniform, 50 to 15,000 Hz.
4. Sensitivity: Minus 70 dB.
5. Output Level: Minus 58 dB, minimum.
6. Cable: Braided shield cable with **Neutrik** XLR connectors. Coordinate impedance with microphone impedance.
7. Mounting: Desk stand with integral-locking, press-to-talk switch.

## 2.9 VOLUME LIMITER/COMPRESSOR

A. Minimum Performance Requirements:

1. Frequency Response: 45 to 15,000 Hz, plus or minus 1 dB minimum.
2. Reduction Ratio: Automatically vary compression ratio, and attack and release times for voice and music inputs.

    a. Compression Ratio Range: 3:1 to 10:1 minimum.
    b. Averaging Compressor Attack Time: Up to 500 milliseconds.
    c. Signal Fast Compression Attack Time: Less than 10 milliseconds.
    d. Release time: Up to 500 milliseconds.

3. Distortion: 0.5 percent, maximum.
4. Rated Output: Minimum of plus 14 dB.
5. Inputs: Minimum of two inputs with variable front-panel gain controls and VU or decibel meter for input adjustment.
6. Rack mounted.

## 2.10 CONTROL CONSOLE

A. Cabinet: Modular, desktop; complying with EIA/ECA-310-E.

B. Housing: Steel, 0.0478 inch (1.2 mm) minimum, with removable front and rear panels. Side panels are removable for interconnecting side-by-side mounting.

C. Panel for Equipment and Controls: Rack mounted.

D. Controls:

1. Switching devices to select signal sources for distribution channels.
2. Program selector switch to select source for each program channel.
3. Switching devices to select zones for paging.
4. All-call selector switch.

E. Indicators: A visual annunciation for each distribution channel to indicate source being used.

F. Self-Contained Power and Control Unit: A single assembly of basic control, electronics, and power supply necessary to accomplish specified functions.

G. Spare Positions: 20 percent spare zone control and annunciation positions on console.

H. Microphone jack.

## 2.11 EQUIPMENT CABINET

A. Comply with EIA/ECA-310-E.

B. House amplifiers and auxiliary equipment at each location.

C. Cabinet Housing:

1. Constructed of 0.0478-inch (1.2-mm) steel, minimum, with front- and rear-locking doors and standard EIA/ECA-310-E-compliant, 19-inch (483-mm) racks.
2. Arranged for floor or wall mounting as indicated.
3. Sized to house all equipment indicated, plus spare capacity.
4. Include **20**percent minimum spare capacity for future equipment.

D. Power Provisions: A single switch in cabinet shall disconnect cabinet power distribution system and electrical outlets, which shall be uniformly spaced to accommodate ac-power cords for each item of equipment.

E. Ventilation: A low-noise fan for forced-air cabinet ventilation. Fan shall be equipped with a filtered input vent and shall be connected to operate from 105- to 130-V ac, 60 Hz; separately fused and switched; arranged to be powered when main cabinet power switch is on.

## 2.12 EQUIPMENT RACK

A. Racks: 19 inches (483 mm) standard, complying with EIA/ECA-310-E.

B. Power-Supply Connections: Compatible plugs and receptacles.

C. Enclosure Panels: Ventilated rear and sides and solid top. Use louvers in panels to ensure adequate ventilation.

D. Finish: Uniform, baked-enamel factory finish over rust-inhibiting primer.

E. Power-Control Panel: On front of equipment housing, with master power on-off switch and pilot light; and with cartridge fuse protection for rack equipment power.

F. Service Light: At top rear of rack with an adjacent control switch.

G. Vertical Plug Strip: Grounded receptacles, 12 inches (300 mm) o.c.; the full height of rack for public address system equipment use only.

H. Maintenance Receptacles: Duplex convenience outlets supplied independent of vertical plug strip and located in front and bottom rear of rack.

I. Spare Capacity: **20** percent in rack for future equipment.

## 2.13 TELEPHONE PAGING ADAPTER

A. Adapters shall accept voice signals from telephone extension dialing access and automatically provide amplifier input and program override for preselected zones.

1. Minimum Frequency Response: Flat, 200 to 2500 Hz.
2. Impedance Matching: Adapter matches telephone line to public address equipment input.
3. **Rack** mounted.

## 2.14 TONE GENERATOR

A. Tone generator shall provide clock and program interface with public address system.

B. Signals: Minimum of seven distinct, audible signal types including wail, warble, high/low, alarm, repeating and single-stroke chimes, and tone.

C. Pitch Control: Chimes and tone.

D. Volume Control: All outputs.

E. Activation-Switch Network: Establishes priority and hierarchy of output signals produced by different activation setups.

F. Mounting: **Cabinet**.

## 2.15 MONITOR PANEL

A. Monitor power amplifiers.

B. Components: VU or dB meter, speaker with volume control, and multiple-position rotary selector switch.

C. Selector Switch and Volume Control: Selective monitoring of output of each separate power amplifier via VU or dB meter and speaker.

D. Mounting: **Cabinet**.

## 2.16 LOUDSPEAKERS

A. Cone-Type Loudspeakers:

1. Minimum Axial Sensitivity: 91 dB at 1 m, with 1-W input.
2. Frequency Response: Within plus or minus 3 dB from 50 to 15,000 Hz.
3. Size: **8 inches (200 mm)** with 1-inch (25-mm) voice coil and minimum 5-oz. (140-g) ceramic magnet.
4. Rated Output Level: **10** W.
5. Minimum Dispersion Angle: 100 degrees.
6. Matching Transformer: Full-power rated with four taps. Maximum insertion loss of 0.5 dB.
7. Surface-Mounted Units: Ceiling, wall, or pendant mounted, as indicated, in steel back boxes, acoustically dampened. Front face of at least 0.0478-inch (1.2-mm) steel and whole assembly rust proofed and shop primed for field painting.
8. Flush-Ceiling-Mounted Units: In steel back boxes, acoustically dampened. Metal ceiling grille with **white** baked enamel.

B. Horn-Type Loudspeakers:

1. Type: Single-horn units, double-reentrant design, with minimum full-range power rating of 15 W.

2. Matching Transformer: Full-power rated with four standard taps. Maximum insertion loss of 0.5 dB.
3. Frequency Response: Within plus or minus 3 dB from 250 to 12,000 Hz.
4. Dispersion Angle: 130 by 110 degrees.
5. Mounting: Integral bracket.
6. Units in Damp, Wet, or Outdoor Locations: Listed and labeled for environment in which they are located.
7. Units in Hazardous (Classified) Locations: Listed and labeled for environment in which they are located. Provide any accessories required to maintain listing.

## 2.17 NOISE-OPERATED GAIN CONTROLLER

A. Gain controller shall be designed to continuously sense space noise level and automatically adjust signal level to local speakers.

B. Frequency Response: 20 to 20,000 Hz, plus or minus 1 dB.

C. Level Adjustment Range: 30 dB minimum.

D. Maximum Distortion: 0.5 percent.

E. Control: Permits adjustment of sensing level of device.

## 2.18 OUTLETS

A. Volume Attenuator Station: Wall-plate-mounted autotransformer type with paging priority feature.

1. Wattage Rating: 10 W unless otherwise indicated.
2. Attenuation per Step: 3 dB, with positive off position.
3. Insertion Loss: 0.4 dB maximum.
4. Attenuation Bypass Relay: SPDT. Connected to operate and bypass attenuation when all-call, paging, program signal, or prerecorded message features are used. Relay returns to normal position at end of priority transmission.
5. Label: "PA Volume."

B. Microphone Outlet: Three-pole, polarized, locking-type, microphone receptacles in single-gang boxes. Equip wall outlets with brushed stainless-steel device plates. Equip floor outlets with gray tapered rubber or plastic cable nozzles and fixed outlet covers.

C. Headphone Outlet (for the Hearing Impaired): Microphone receptacles in single-gang boxes. Equip wall outlets with brushed stainless-steel device plates. Equip floor outlets with gray tapered rubber or plastic cable nozzles and fixed-outlet covers.

## 2.19 BATTERY BACKUP POWER UNIT

A. Unit shall be rack mounted, consisting of time-delay relay, sealed lead-calcium battery, battery charger, on-off switch, "normal" and "emergency" indicating lights, and adequate capacity to supply maximum equipment power requirements for one hour of continuous full operation.

B. Unit shall supply public address equipment with 12- to 15-V dc power automatically during an outage of normal 120-V ac power.

C. Battery shall be on float charge when not supplying system and able to transfer automatically to supply system after three to five seconds of continuous outage of normal power, as sensed by time-delay relay.

D. Unit shall automatically retransfer system to normal supply when normal power has been reestablished for three to five seconds continuously.

## 2.20 CONDUCTORS AND CABLES

A. Jacketed, twisted pair and twisted multipair, untinned solid copper.

1. Insulation for Wire in Conduit: Thermoplastic, not less than 1/32 inch (0.8 mm) thick.
2. Microphone Cables: Neoprene jacketed, not less than 2/64 inch (0.8 mm) thick, over shield with filled interstices. Shield No. 34 AWG, tinned, soft-copper strands formed into a braid or approved equivalent foil. Shielding coverage on conductors is not less than 60 percent.
3. Plenum Cable: Listed and labeled for plenum installation.

## 2.21 PATHWAYS

A. Conduit and Boxes: Comply with Section 270528 "Pathways for Communications Systems."

1. Outlet boxes shall be not less than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

# PART 3 - EXECUTION

## 3.1 WIRING METHODS

A. Wiring Method:

1. Install cables in pathways and cable trays except within consoles, cabinets, desks, and counters **, and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used**. Conceal pathway and cables except in unfinished spaces.

a. Install plenum cable in environmental air spaces, including plenum ceilings.
b. Comply with requirements for pathways and boxes specified in Section 270528 "Pathways for Communications Systems."

2. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

B. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

## 3.2 INSTALLATION OF PATHWAYS

A. Comply with requirements in Section 270528 "Pathways for Communications Systems." for installation of conduits and wireways.

B. Install manufactured conduit sweeps and long-radius elbows whenever possible.

## 3.3 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Cable Installation Requirements:

1. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.
2. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
3. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
5. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
6. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend speaker cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceiling by cable supports not more than **60 inches (1524 mm)** apart.
3. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.

D. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate pathways or, where exposed or in same enclosure, separate conductors at least 12 inches (300 mm) apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other communication equipment conductors as recommended by equipment manufacturer.

## 3.4 INSTALLATION

A. Coordinate layout and installation of system components and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

B. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.

C. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.

D. Equipment Cabinets and Racks:

1. Group items of same function together, either vertically or side by side, and arrange controls symmetrically. Mount monitor panel above the amplifiers.
2. Arrange all inputs, outputs, interconnections, and test points so they are accessible at rear of rack for maintenance and testing, with each item removable from rack without disturbing other items or connections.
3. Blank Panels: Cover empty space in equipment racks so entire front of rack is occupied by panels.

E. Volume Limiter/Compressor: Equip each zone with a volume limiter/compressor. Install in central equipment cabinet. Arrange to provide a constant input to power amplifiers.

F. Wall-Mounted Outlets: Flush mounted.

G. Floor-Mounted Outlets: Conceal in floor and install cable nozzles through outlet covers. Secure outlet covers in place. Trim with carpet in carpeted areas.

H. Conductor Sizing: Unless otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than No. 18 AWG and conductors from microphone receptacles to amplifiers not smaller than No. 22 AWG.

I. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or exposed to weather, install consistent with requirements of weatherproof rating.

J. Speaker-Line Matching Transformer Connections: Make initial connections using tap settings indicated on Drawings.

K. Connect wiring according to Section 271500 "Communications Horizontal Cabling" and Section 280513 "Conductors and Cables for Electronic Safety and Security."

## 3.5 GROUNDING

A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.

C. Install grounding electrodes as specified in Section 270526 "Grounding and Bonding for Communications Systems."

## 3.6 FIELD QUALITY CONTROL

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

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

1. Schedule tests with at least seven days' advance notice of test performance.
2. After installing public address system and after electrical circuitry has been energized, test for compliance with requirements.
3. Operational Test: Perform tests that include originating program and page messages at microphone outlets, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and that system is free of noise and distortion.
4. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:

    a. Disconnect microphone at connector or jack closest to it and replace it in the circuit with a signal generator using a 1000-Hz signal. Replace all other microphones at corresponding connectors with dummy loads, each equal in impedance to microphone it replaces. Measure signal-to-noise ratio.
    b. Repeat test for each separately controlled zone of loudspeakers.
    c. Minimum acceptance ratio is 50 dB.

5. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 50, 200, 400, 1000, 3000, 8000, and 12,000 Hz into each preamplifier channel. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 3 percent total harmonics.
6. Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at five locations in each zone. For spaces with seated audiences, maximum permissible variation in level is plus or minus 2 dB. In addition, the levels between locations in same zone and between locations in adjacent zones must not vary more than plus or minus 3 dB.
7. Power Output Test: Measure electrical power output of each power amplifier at normal gain settings of 50, 1000, and 12,000 Hz. Maximum variation in power output at these frequencies must not exceed plus or minus 1 dB.
8. Signal Ground Test: Measure and report ground resistance at public address equipment signal ground. Comply with testing requirements specified in Section 270526 "Grounding and Bonding for Communications Systems."

E. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.

F. Public address system will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

1. Include a record of final speaker-line matching transformer-tap settings and signal ground-resistance measurement certified by Installer.

## 3.7 STARTUP SERVICE

A. Perform startup service.

1. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.
2. Complete installation and startup checks according to manufacturer's written instructions.

## 3.8 ADJUSTING

A. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.

B. Occupancy Adjustments: When requested within **12** months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

## 3.9 DEMONSTRATION

A. **Train** Owner's maintenance personnel to adjust, operate, and maintain the public address system and equipment. Refer to Section 017900 "Demonstration and Training."

SECTION 280520 - BASIC SECURITY MATERIALS AND METHODS

PART 1 - GENERAL

1.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 00 and Division 01 Specifications Sections, apply to this Section.

1.2 TEMPORARY ELECTRONIC SAFETY AND SECURITY SERVICES

A. The temporary Electronic Safety and Security for construction is provided by the Electronic Safety and Security Contractor. Refer to Division 01 – General Requirements.

B. The use of the permanent Electronic Safety and Security system for temporary services during the latter stages of construction shall be allowed. Expedite completion of system as practicable to this end. Maintain the system during this period.

C. Warranty periods on equipment, materials and systems shall commence upon Owner acceptance of the building or systems. Temporary use shall not jeopardize or alter warranty requirements.

D. The complete temporary service shall comply with Owner Facility, OSHA and all Code requirements.

1.3 CONTINUITY OF SERVICE

A. Work shall be so planned and executed as to provide reasonable continuous service of existing systems throughout the construction period. Where necessary to disrupt services for short periods of time for connection, alteration or switch-over, the Owner shall be notified in advance and outages scheduled at the Owner's reasonable convenience.

B. Submit, on request, a written step-by-step sequence of operations proposed to accomplish this work. The outline must include tentative dates, times of day for disruption, downtime and restoration of services. Submit the outline sufficiently in advance of the proposed work to allow the Architect or Engineer to review the information with the Owner. Upon approval, final planning and the work shall be done in close coordination with the Owner.

C. Shutdown of systems and work undertaken during shutdowns shall be bid as being done during normal working hours. If the Owner should require such work be performed outside of normal working hours, reimbursement shall be made for premium time expenses only, without mark-up.

PART 2 - PRODUCTS

2.1 ACCESS PANELS

A. Ceiling and wall access panels shall be provided where indicated on the drawings, or where otherwise required to gain access to concealed junction boxes, pull boxes, devices and equipment requiring service or adjustment.

B. Access panels (refer to paragraph C. below for more specialized drywall ceiling access panels) shall be steel construction (except where aluminum or stainless steel is specified) with concealed hinge and door with screwdriver lock. Locks in “secured” areas of the building shall have tamperproof screws. Panels shall be 18" x 18" size unless larger panels are shown or required. Mounting frames shall be compatible with the material in which they are installed. Access panels shall be:

1. Standard flush type with overlapping flange for masonry and tile walls.
2. Recessed type having the door recessed to accept a drywall panel insert, for drywall ceilings and walls.
3. Standard flush type for drywall ceilings and walls.

C. Access panels in drywall ceilings shall be glass reinforced gypsum drywall lay-in panels with flush mounting frames. Corners of panels shall be rounded. Panels shall be 18" x 18" unless larger panels are shown or required.

D. Access panels in fire rated shaft walls and in fire rated ceilings shall be "B" label or greater to match the rating of the wall or ceiling.

E. Materials used in plenums shall be rated for plenum use conforming to the 25/50 smoke development and flame spread restrictions.

PART 3 - EXECUTION

3.1 WORKMANSHIP

A. Materials and equipment shall be installed and supported in a first-class and workmanlike manner by mechanics skilled in their particular trades. Workmanship shall be first-class in all respects, and the Architect shall have the right to stop the work if highest quality workmanship is not maintained.

B. Electrical work shall be performed by a licensed Electrical Contractor in accordance with requirements of the jurisdiction.

C. Electronic Safety and Security work shall be performed by certified contractor in accordance with the respective specification and system requirements.

3.2 PROTECTION

A. Each Contractor shall be entirely responsible for all material and equipment furnished in connection with his work. Special care shall be taken to properly protect all parts thereof from theft, damage or deterioration during the entire construction period in such a manner as may be necessary, or as directed by the Architect.

B. The Owner's property and the property of other contractors shall be scrupulously respected at all times. Provide drop cloths and visqueen or similar barriers where dust and debris is generated, to protect adjacent areas.

3.3 CUTTING AND PATCHING NEW BUILDINGS

A. Refer to Division 01 - General Requirements for information regarding cutting and patching.

B. Plan the work well ahead of the general construction. Where conduits, wireways and cable trays are to pass thru walls, partitions, floors, roof or ceilings, place sleeves in these elements or arrange with the General Contractor to provide openings where sleeves are not practical. Where sleeves or openings have not been installed, saw-cut or core drill holes and patch as required for the installation of this work, or pay other trades for doing this work when so directed by the Architect. Any damage caused to the building in this work shall be repaired or rectified.

C. All sleeves and openings not used or partially used shall be closed to prevent passage of smoke and fire.

3.4 PAINTING

A. In addition to any painting specified for various individual items of equipment, the following painting shall be included in the Electronic Safety and Security Contract:

1. Ferrous metal which is not factory or shop painted or galvanized and which remains exposed to view in the building including finished areas, mechanical rooms, storage rooms, and other unfinished areas shall be given a prime coat of paint and two finish coats of paint.
2. Ferrous metal installed outside the building which is not factory or shop painted or galvanized shall be given a prime coat of paint and two finish coats of paint.
3. Equipment and materials which have been factory or shop coated (prime or finished painted or galvanized), on which the finish has been damaged or has deteriorated, shall be cleaned and refinished equal to its original condition. The entire surface shall be repainted if a uniform appearance cannot be accomplished by touch-up.
4. Apply Z.R.C. Galvilite / 221 cold galvanizing compound, or approved equal, for touch-up and repair of previously galvanized surfaces.

B. Each backboard shall be painted with a minimum of two coats of flame retardant paint, all sides; gray enamel primer with gray matte enamel finish.

C. Paint, surface preparation and application shall conform to applicable portions of the Painting section of Division 01 of the Specifications. All rust must be removed before application of paint.

D. Finish painting is included in the General Contract except where otherwise required under remodeling work. Refer to the Cutting and Patching paragraph in this Section for finishing requirements.

## 3.5 ACCESS PANELS

A. Access panels shall be turned over to the General Contractor for installation.

B. Access locations thru HVAC ductwork must be coordinated with the ductwork installer. Location of the hinged access door with latch must be coordinated in advance with the HVAC Contractor.

C. Location of access panels shall be planned to clear ceiling lights, ceiling support grids and other obstructions so as to allow, wherever possible, full shoulder clearance beside the device to be inspected, adjusted or repaired.

D. Panels with recessed doors are to be fitted with insert panels of drywall or, those for plaster, infilled with plaster. Caution the Installing Contractor to provide appropriate framing with drywall or plaster beading to ensure a finished appearance. Shim strips may be required to bring the insert panel flush with the plane of the door and wall / ceiling.

## 3.6 BACKBOARDS

A. Where shown on the drawings, backboards shall be provided for wall mounting of disconnect switches, devices and Electronic Safety and Security equipment. The Contractor may opt to mount additional groups of disconnect switches on backboards.

B. General

1. Backboard shall be 0.75” thick waterproof flame retardant plywood secured to structure.
2. Each board shall be painted.
3. Electronic Safety and Security backboards shall be normally 4 ft. x 8 ft. mounted 6” above floor where located on drawings. Where other sizes are required, they will be noted on the drawings.

C. Each terminal cabinet for Electronic Safety and Security systems, relays, etc., shall be fitted with a full size 0.50” thick backboard for mounting terminal strips, equipment, etc.

END OF SECTION 280520

SECTION 280526 - GROUNDING AND BONDING FOR SECURITY SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 00 and Division 01 Specifications Sections, apply to this Section.

1.2 TECHNOLOGY GROUNDING DESCRIPTION

A. Provide a Telecommunications Main Ground Bar (TMGB) in TC-01. This ground bar shall be electrically bonded to the Building Main Electrical Service Ground with a minimum insulated, #2/0, copper grounding conductor.

B. Provide a Telecommunications Ground Bar (TGB) in each TC and at the telephone and CATV service entrance points.

C. Provide a Telecommunications Bonding Conductor (TBC) from each TGB to a local electrical panelboard ground bus. This backbone shall consist of a minimum #6, bare copper grounding conductor. The TBC shall be bonded to the ground bars at each end. Provide a warning label attached to each Telecommunications Bonding Conductor Backbone at each end stating “WARNING: Building telecommunications grounding system. Do not remove or disconnect without prior approval from building Telecommunications Department.”

D. Provide bonding between all joints of cable tray and ladder rack. Provide bonding to all conduit sleeves. Provide bonding to all technology equipment racks and cabinets within each wiring closet. Provide bonding from the Technology grounding system to the telephone and CATV demarc equipment and protector panels. Coordinate this grounding prior to installation of telephone and CATV services.

E. This contract shall be responsible for providing all equipment, cable tray, ladder rack, conduit and sleeve grounding in each TC to the grounding system installed under Division 26.

F. All work shall be in compliance with NEC, Article 250 and EIA/TIE J-STD-607.

PART 2 - PRODUCTS

2.1 GENERAL

A. Grounding rods shall be copper clad, molten-welded copper to steel; unless otherwise designated, 0.625" diameter x 10 ft. long.

B. Clamps and continuity devices shall be non-ferrous material, UL approved. Connections to ground rods and all underground connections shall be "Thermoweld" or "Cadweld".

C. Ground conductors shall be insulated, identified by green insulation or by painting or taping green at all accessible locations and shall be connected with approved connectors and terminators to boxes, devices, equipment, etc. and to ground bars in panels.

## 2.2 TELECOMMUNICATIONS MAIN GROUND BAR (TMGB)

A. Ground bar shall be solid copper, 4" high, .25" thick, minimum 36" long with pre-drilled holes for standard-sized Lugs and must be UL listed. Provide final length as required to accommodate grounding lug attachments.

B. Ground bars shall be provided with insulated stand-off brackets for wall mounting providing a minimum of 2" wall clearance. Insulators shall have a minimum voltage rating of 600V and a minimum Short Time Electrical Strength of 55kVv.

C. Manufactured by StormCopper or equal by B-Line, Andrew, Tessco Technologies.

## 2.3 TELECOMMUNICATIONS GROUND BAR (TGB)

A. Ground bar shall be solid copper, 4" high, .25" thick, minimum 12" long with pre-drilled holes for standard-sized Lugs and must be UL listed. Provide final length as required to accommodate grounding lug attachments.

B. Ground bars shall be provided with insulated stand-off brackets for wall mounting providing a minimum of 2" wall clearance. Insulators shall have a minimum voltage rating of 600V and a minimum Short Time Electrical Strength of 55kVv.

C. Bus bar and standoff assembly manufactured by StormCopper or equal by B-Line, Andrew, Tessco Technologies, Hubbell.

## 2.4 TELECOMMUNICATIONS BONDING CONDUCTOR (TBC)

A. Insulated Conductors - Soft, annealed bare copper per ASTM B-3. Concentric, compressed stranded (class B or C Alternate ASTmB-787) per ASTM B-8, UL-83 and UL-854. Insulation Jacket: Nylon per UL-83. Insulation: High dielectric polyvinyl chloride per UL-83 and UL-854.

B. Uninsulated Conductor: Soft, annealed bare copper per ASTM B-3. Stranded as specified herein. Overall Finish: Gray polyvinyl chloride (PVC) per UL-824.

C. RATINGS - Cables conform to the following standards:

1. UL-83 for THHN-THWN Cdrs.
2. Federal Specification J-C-30B

D. Cable as manufactured by Superior/Essex, Rome, AIWC.

2.5 BONDING CONDUCTORS

A. Conductor shall be minimum #6AWG and may be either stranded or solid, insulated or bare.

B. Cable as manufactured by Superior/Essex, Rome, AIWC.

PART 3 - EXECUTION

3.1 Wiring devices shall be connected with grounding jumper from ground pole on device to grounding screw in the outlet box.

3.2 The complete metal conduit system shall be used for the equipment grounding system. Conduit systems and associated fittings and terminations shall be made mechanically tight to provide a continuous electrical path to ground and shall be safely grounded at all equipment by bonding all metallic conduit to the equipment enclosures with locknuts cutting thru paint or enclosures. Bond all conduits entering primary switchgear, pad-mount transformers, unit substations, emergency generator control panel and main breaker panel, and secondary service entrance switchboard with a ground wire connecting the grounding type bushings to the equipment ground bar. Conductors shall be sized per NEC Tables 250-66 and 250-122. Bond all communications conduit systems to ground.

3.3 In addition to using the conduit system for grounding, a complete auxiliary green wire equipment grounding system shall be installed, continuous from main ground, thru distribution and branch circuit panelboards and paralleling all feeders and branch circuit wiring. Grounding conductor sizes shall comply with NEC Table 250-122, minimum size shall be #12 copper except #14 on control circuits. This shall apply to all circuits rated 100 volts or more above ground potential.

A. Connect ground terminal on wiring devices to auxiliary green wire equipment grounding system.

3.4 Ground neutral of all transformers for separately derived systems. Grounds may be to the street side of the main water service, thru a set of interconnected ground rods, or to other NEC approved electrodes.

3.5 Cord connected appliance frames shall be grounded to the equipment grounding system thru a green wire in the cord.

3.6 A green grounding conductor shall be installed in each non-metallic conduit and all flexible conduits, including exterior underground conduits.

3.7 System neutral connections shall be insulated from metal enclosures except at the neutral of the service entrance equipment and on the neutral of a separately derived system. Connections to the main switchgear enclosure shall be by means of bonding jumpers.

3.8 The building neutral shall be identified throughout with white conductors. Where there are neutral conductors from a separately derived system (such as 120/208 volt, 3 phase, 4 wire where the main building service is 277/480 volt, 3 phase, 4 wire) the neutrals of the two systems shall be separately identifiable per NEC Article 200.

3.9 GROUNDING/BONDING CONNECTIONS

A. Ground all backbone cable sheaths, shield drain wires from all voice/data horizontal cable, equipment racks and equipment to the local TGB / MTGB.

B. All grounding and bonding shall be in conformance with the National Electric Code, article 250 and as recommended by EIA/TIA-607.

C. All joints of all cable tray and ladder rack shall be bonded together. When bonding to painted equipment, methods shall be utilized to ensure continuity of grounding connection.

D. Telephone and CATV Service entrance equipment and primary protection panels, shall be bonded to the technical grounding system. Coordinate with serving utilities regarding configuration of grounding connections.

E. All connection to ground bars (TGB, TMGB) shall be made using listed lugs appropriate for mounting provisions in the supplied ground bar.

3.10 TESTING GENERAL

A. The Contractor shall be responsible for testing the complete technology grounding system.

B. No testing shall be executed until the entire system has had the Owner approved labeling scheme applied and accepted.

C. Test reports shall be provided to indicate.

1. Impedance values across each TBB from the TMGB to the TGB.
2. Impedance values across the TBC from the TMGB to the main electrical service ground.
3. Impedance values across each GE between TGB on a common floor.

D. Tests shall be witnessed by Architect / Engineer / Owner and shall be monitored by a recorder.

E. System testing shall be performed with final test results turned over to the Owner prior to acceptance of the system. Missing or incomplete test results will not be reviewed and the system will not be commissioned by the Owner / Architect / Engineer.

F. Instruments and labor required for tests shall be furnished by the Contractor. All system test equipment shall be approved by the Owner/ Architect / Engineer prior to application.

G. Instruments required for tests shall be furnished by the Contractor.

3.11 LABELING

A. The Contractor shall be responsible for labeling all telecommunications grounding equipment, cable, etc. in accordance with the guidelines as described herein.

B. Each telecommunications ground bar shall be provided with a warning label to read:

1. "WARNING: Building telecommunications grounding system. Do not remove or disconnect without prior approval from building Telecommunications Department."

C. Each Telecommunications Bonding Conductor (TBC, TBB, GE, etc.) to be provided with a label indicating source and destination ground bars.

3.12 AS-BUILT DOCUMENTATION

A. Refer to Section 27 05 00 for submittal requirements.

B. Copies of all approved shop drawings with the Engineer's stamp.

C. Copy of all test reports.

D. Technology drawings updated with final as-Built information. This shall be in the form of a complete set of Technology drawings with as-built information indicated in colored pen based upon actual field conditions.

E. System schematic and block diagrams for technology grounding system updated with final as-built information. These drawings shall define the exact arrangement of each system including wiring configuration, device locations and cable types.

END OF SECTION 280526

SECTION 280528 - SECURITY SYSTEMS PATHWAYS AND SUPPORT EQUIPMENT

PART 1 - GENERAL (Not Used)

PART 2 - PRODUCTS

2.1 Cable Management System

A. Provide pre-manufactured cable supports as manufactured by Panduit, Caddy, Mineralac or Rayco. Cable supports shall be secured to building structure through threaded rod, beam clamps or other UL approved supports as required by site conditions. Components shall provide a minimum cable support point spacing of 48".

B. Cable management devices must be sized to accommodate 100% spare capacity of the final installed cable base.

C. Cable management system support components shall be designed with wide support surfaces that do not cause cables to be bend, crushed or otherwise deformed when installed within component loading parameters. Cable management system shall meet UL standards and be UL labeled. Utilizing elements of the building's structure such as beams, joists, etc. to hang cable from will not be acceptable.

D. Bridle rings shall not be acceptable.

PART 3 - EXECUTION

3.1 General Installation

A. Refer to drawings for pathway types, locations and routing.

B. Cable pathways shall provide the following minimum clearances:

1. Motors and transformers – 4 ft.
2. Conduit and cable used for electrical power distribution – 1 ft.
3. Fluorescent lighting – 5 inches.
4. Power lines up to 5 kV – 5 inches.
5. Power lines over 5 kV. – 24 inches.

C. Backboards and cabinets shall be installed in Electronic Safety and Security rooms/spaces to support Electronic Safety and Security equipment and wiring. Coordinate locations of backboards and cabinets with the Owner prior to installation.

D. Restore fire rating and smoke stoppage integrity where all wireways, raceways and cable trays pierce walls, floors and ceilings by sealing with approved means.

E. Provide necessary pathways in areas that have exposed structure or plastered ceilings to provide a wiring path for cables from area above suspended ceilings to respective backboards.

F. No non-metallic or combustible materials shall be installed in ceiling or other plenums used for circulating room air used for heating, ventilation, or cooling.

3.2 Conduit Systems

A. No section of conduit shall be longer than 100 feet between pulling points.

B. No more than two 90 deg. bends in a section of conduit between pulling points.

C. Each section of conduit shall be labeled for length, destination closet and origination closet.

D. Refer to EIA/TIA 569-A for specific conduit and pull box requirements.

E. Conduit and wiring above accessible ceilings shall be run as high as possible, above piping and ductwork, so as to not interfere with mechanical trades, access to mechanical and electrical devices and to allow freedom to remove ceiling panels.

F. Provide a No. 12 gauge pull wire or nylon pull cord in each empty conduit run.

3.3 Wireways

A. Wireways shall be supported with factory made hangers designed expressly for this purpose and 0.375" diameter solid hanger rods approximately 5 ft. on center or approved strap hangers for surface mounting.

3.4 Cable Management System

A. The drawings do not indicate specific routes for cables. The Electronic Safety and Security Contractor is responsible for developing all cabling routes utilizing existing cable management pathways and systems or providing supplemental management pathways and systems so that all structured cabling adhere to specific codes and standards specifically developed for the installation of such cables. Where the use of existing cable management systems and pathways would cause the structured cable system to violate specific codes and standards regarding cable lengths, environments, proximity to EMI and RF noise sources, etc., the Electronic Safety and Security Contractor shall be responsible for developing alternative pathways and shall include all labor and material for doing so within the scope of this work.

B. In areas where there is not an installed raceway system (conduits or cable tray) and a cable support system is required, this contract shall be responsible for providing a cable management system. Where cables are installed open wired through the use of cable management systems, they shall be installed such that there is a minimum sag of 4 inches for every 4 feet of horizontal run. Cable pathways shall provide the following minimum clearances:

1. Motors and transformers – 4'.
2. Conduit and cable use for electrical power distribution – 1'.

3. Fluorescent lighting – 5".
4. Power lines up to 2kVA – 5".
5. Power lines over 5kVA – 24" cable management system shall be secured to building structure utilizing manufactured approved methods and hardware.

C. Cable management system support components shall be designed with wide support surfaces that do not cause cables to be bent, crushed or otherwise deformed when installed within component loading parameters. Cable management system shall meet UL standards and be UL labeled. Utilizing elements of the building's structure such as beams, joists, etc. to hang cable from will not be acceptable.

3.5 Identification / Labeling

A. All continuous Electronic Safety and Security pathways such as conduit, cable tray, etc. shall be labeled to indicate origination and destination. Label shall be applied every 50' wherever accessible or subject to administration. Coordinate label information with Owner.

B. Label shall consist of mechanically printed, permanent adhesive label, applied to cleaned / prepped area of raceway.

3.6 As-Built Documentation

A. Provide a complete set of architectural floor plan drawings indicating final communications pathway systems with accurate "as-built" locations to show the actual route for the communications systems pathways.

B. Drawings shall indicate each pathway type and provide sizing information such as conduit/innerduct diameter, cable tray width, cable management ring size, etc.

C. Component Service Manuals: Include information for testing, repair, troubleshooting, assembly, disassembly, and required / recommended maintenance intervals for all types of pathways.

3.7 FIRESTOPPING

A. Restore fire rating and smoke stoppage integrity where all wireways, raceways and cable trays pierce walls, floors and ceilings by sealing with approved means.

Note: When using cable tray and tray rated cables in industrial establishments, coordinate any specific fire ratings / protection with Owner and Plumbing Designer – Factory Mutual, Industrial Risk Insurers (IRI) and ISO may require added fire rating requirements such as special cable insulation or foaming open cables in cable trays. Also, be aware of spaces above ceilings being used for air plenums.

END OF SECTION 280528

SECTION 281300 - ACCESS CONTROL SOFTWARE AND DATABASE MANAGEMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Security access central-control station.
2. One or more security access networked workstations.
3. Security access operating system and application software.
4. Security access controllers connected to high-speed electronic-data transmission network.

B. Related Requirements:

1. Section 281500 "Access Control System Hardware Devices" for access control system hardware, such as keypads, card readers, and biometric identity devices.

1.3 DEFINITIONS

A. Credential: Data assigned to an entity and used to identify that entity.

B. DTS: Digital Termination Service. A microwave-based, line-of-sight communication provided directly to the end user.

C. Identifier: A credential card; keypad personal identification number; or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.

D. Location: A Location on the network having a workstation-to-controller communications link, with additional controllers at the Location connected to the workstation-to-controller link with a TIA 485-A communications loop. Where this term is presented with an initial capital letter, this definition applies.

E. Workstation: Personal computer. Applies to the central station, workstations, and file servers.

F. RAS: Remote access services.

G. RF: Radio frequency.

H. ROM: Read-only memory. ROM data are maintained through losses of power.

I. TCP/IP: Transport control protocol/Internet protocol.

J. TWAIN: Technology without an Interesting Name. A programming interface that lets a graphics application, such as an image editing program or desktop publishing program, activate a scanner, frame grabber, or other image-capturing device.

K. WMP: Windows media player.

L. Wiegand: Patented magnetic principle that uses specially treated wires embedded in the credential card.

M. WYSIWYG: What You See Is What You Get. Text and graphics appear on the screen the same as they will in print.

## 1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Reference each product to a location on Drawings. Test and evaluation data presented in Product Data shall comply with SIA BIO-01.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Diagrams for cable management system.
2. System labeling schedules, including electronic copy of labeling schedules that are part of the cable and asset identification system of the software specified in Parts 2 and 3.
3. Wiring Diagrams. For power, signal, and control wiring. Show typical wiring schematics including the following:

    a. Workstation outlets, jacks, and jack assemblies.
    b. Patch cords.
    c. Patch panels.

4. Cable Administration Drawings: As specified in "Identification" Article.
5. Battery and charger calculations for central station, workstations, and controllers.

C. Product Schedules.

D. Samples: For workstation outlets, jacks, jack assemblies, and faceplates. For each exposed product and for each color and texture specified.

## 1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

## 1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For security system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Workstation operating system documentation.
2. Workstation installation and operating documentation, manuals, and software for the workstation and all installed peripherals. Software shall include system restore, emergency boot diskettes, and drivers for all installed hardware. Provide separately for each workstation.
3. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on **USB** media of the hard-copy submittal.
4. System installation and setup guides with data forms to plan and record options and setup decisions.

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Laser Printers: Three toner cassettes and one replacement drum unit.
2. Credential card blanks, ready for printing. Include enough credential cards for all personnel to be enrolled at the site plus an extra
3. Fuses of all kinds, power and electronic, equal to percent of amount installed for each size used, but no fewer than three units.

## 1.8 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

1. Cable installer must have on staff an RCDD certified by Building Industry Consulting Service International.

B. Source Limitations: Obtain central station, workstations, controllers, Identifier readers, and all software through one source from single manufacturer.

## 1.9 DELIVERY, STORAGE, AND HANDLING

A. Central Station, Workstations, and Controllers:

1. Store in temperature- and humidity-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 50 and 85 deg F (10 and 30 deg C), and not more than 80 percent relative humidity, noncondensing.
2. Open each container; verify contents against packing list; and file copy of packing list, complete with container identification, for inclusion in operation and maintenance data.

3. Mark packing list with the same designations assigned to materials and equipment for recording in the system labeling schedules that are generated by software specified in "Cable and Asset Management Software" Article.
4. Save original manufacturer's containers and packing materials and deliver as directed under provisions covering extra materials.

## 1.10 PROJECT CONDITIONS

A. Environmental Conditions: System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Control Station: Rated for continuous operation in ambient conditions of 60 to 85 deg F (16 to 30 deg C) and a relative humidity of 20 to 80 percent, noncondensing.
2. Indoor, Controlled Environment: NEMA 250, Type 1 enclosure. System components, except the central-station control unit, installed in **temperature-controlled,** indoor environments shall be rated for continuous operation in ambient conditions of **36 to 122 deg F (2 to 50 deg C)** dry bulb and 20 to 90 percent relative humidity, noncondensing.
3. Indoor, Uncontrolled Environment: NEMA 250, **Type 3R** enclosures. System components installed in **non-temperature-controlled** indoor environments shall be rated for continuous operation in ambient conditions of **0 to 122 deg F (minus 18 to plus 50 deg C** dry bulb and 20 to 90 percent relative humidity, noncondensing.
4. Outdoor Environment: NEMA 250, NEMA 250,**Type 4X** enclosures. System components installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of **minus 30 to plus 122 deg F (minus 34 to plus 50 deg C)** dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation where exposed to rain as specified in NEMA 250, winds up to 85 mph (137 km/h) **and snow cover up to 24 inches (610 mm) thick**.
5. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.
6. Corrosive Environment: For system components subjected to corrosive fumes, vapors, and wind-driven salt spray in coastal zones, provide NEMA 250, **Type 4X** enclosures.

# PART 2 - PRODUCTS

## 2.1 ACCESS CONTROL SOFTWARE

A. DSX

B. Kantech

C. Keyscan

D. Approved Equal

## 2.2 DESCRIPTION

A. Security Access System: Workstation-based central station and field-installed controllers, connected by a high-speed electronic-data transmission network.

B. System Software: Based on **64**-bit, central-station, workstation operating system, server operating system, and application software. Software shall have the following capabilities:

1. Multiuser and multitasking allow for independent activities and monitoring to occur simultaneously at different workstations.
2. Graphical user interface to show pull-down menus and a menu-tree format that complies with interface guidelines of the operating system.
3. System license for the entire system including capability for future additions that are within the indicated system size limits specified in this Section.
4. Open-architecture system that allows importing and exporting of data and interfacing with other systems that are compatible with operating system.
5. Password-protected operator login and access.
6. Open-database-connectivity compliant.

C. Network connecting the central station and workstations shall be a **LAN** using TCP/IP with a capacity of connecting up to **99** workstations. System shall be portable across multiple communication platforms without changing system software.

D. Network(s) connecting workstations and controllers shall consist of one or more of the following:

1. Local area, IEEE 802.3 Fast Ethernet, star topology network based on TCP/IP.
2. Local area, IEEE 802.11 compatible wireless mesh network, based on TCP/IP.
3. Direct-connected, RS-232 cable from the COM port of the central station to the first controller, then RS-485 cable to interconnect the remaining controllers at that Location.

## 2.3 OPERATION

A. Security access system shall use a single database for access-control and credential-creation functions.

B. Distributed Processing: A fully distributed processing system.

1. Access-control information, including time, date, valid codes, access levels, and similar data, shall be downloaded to controllers so each controller can make access-control decisions.
2. Intermediate controllers for access control are prohibited.
3. In the event that communications with the central controller are lost, controllers shall automatically buffer event transactions until communications are restored, at which time buffered events shall be uploaded to the central station.

C. Number of Locations:

1. Support at least **32,000** separate Locations using a single workstation with combinations of direct-connect, or TCP/IP LAN connections to each Location.

2. Each Location shall have its own database and history in the central station.
3. Locations may be combined to share a common database.

D. Data Capacity:

1. **130** different card-reader formats.
2. **999** comments.
3. **48** graphic file types for importing maps.

E. Location Capacity:

1. **1024** reader-controlled doors.
2. **50,000** total-access credentials.
3. **2048** supervised alarm inputs.
   **2048** programmable outputs.
4. **32,000** custom action messages per Location to instruct operator on action required when alarm is received.

F. System Network Requirements:

1. System components shall be interconnected and shall provide automatic communication of status changes, commands, field-initiated interrupts, and other communications required for proper system operation.
2. Communication shall not require operator initiation or response and shall return to normal after partial- or total-network interruption such as power loss or transient upset.
3. System shall automatically annunciate communication failures to the operator and shall identify the communications link that has experienced a partial or total failure.
4. Communications controller may be used as an interface between the central-station display systems and the field device network. Communications controller shall provide functions required to attain the specified network communications performance.

G. Central station shall provide operator interface, interaction, display, control, and dynamic and real-time monitoring. Central station shall control system networks to interconnect all system components, including workstations and field-installed controllers.

H. Field equipment shall include controllers, sensors, and controls.

1. Controllers shall serve as an interface between the central station and sensors and controls.
2. Data exchange between the central station and the controllers shall include down-line transmission of commands, software, and databases to controllers.
3. The up-line data exchange from the controller to the central station shall include status data such as intrusion alarms, status reports, and entry-control records.
4. Controllers are classified as alarm-annunciation or entry-control type.

I. System Response to Alarms:

1. Field device network shall provide a system end-to-end response time of **one** second(s) or less for every device connected to the system.

2. Alarms shall be annunciated at the central station within one second of the alarm occurring at a controller or at a device controlled by a local controller, and within 100 ms if the alarm occurs at the central station.
3. Alarm and status changes shall be displayed within 100 ms after receipt of data by the central station.
4. All graphics shall be displayed, including graphics-generated map displays, on the console monitor within five seconds of alarm receipt at the security console.
5. This response time shall be maintained during system heavy load.

J. False-Alarm Reduction: The design of the central station and controllers shall contain features to reduce false alarms. Equipment and software shall comply with SIA CP-01.

K. Error Detection:

1. Use a cyclic code method to detect single- and double-bit errors, burst errors of eight bits or fewer, and at least 99 percent of all other multibit and burst errors between controllers and the central station.
2. Interactive or product error-detection codes alone will not be acceptable.
3. A message shall be in error if one bit is received incorrectly.
4. Retransmit messages with detected errors.
5. Allow for an operator-assigned two-digit decimal number to each communications link representing the number of retransmission attempts.
6. Central station shall print a communication failure alarm message when the number of consecutive retransmission attempts equals the assigned quantity.
7. Monitor the frequency of data transmission failure for display and logging.

L. Data Line Supervision: System shall initiate an alarm in response to opening, closing, shorting, or grounding of data transmission lines.

M. Door Hardware Interface:

1. Comply with requirements in Section 087100 "Door Hardware" and Section 087111 "Door Hardware (Descriptive Specification)" for door hardware required to be monitored or controlled by the security access system.
2. Electrical characteristics of controllers shall match the signal and power requirements of door hardware.

## 2.4 PERFORMANCE REQUIREMENTS

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

B. Comply with NFPA 70, "National Electrical Code."

C. Comply with SIA DC-03

## 2.5 APPLICATION SOFTWARE

A. System Software: Based on 64-bit, Microsoft Windows central-station and workstation operating system and application software.

1. Multiuser multitasking shall allow independent activities and monitoring to occur simultaneously at different workstations.
2. Graphical user interface shall show pull-down menus and a menu-tree format.
3. Capability for future additions within the indicated system size limits.
4. Open architecture that allows importing and exporting of data and interfacing with other systems that are compatible with operating system.
5. Password-protected operator login and access.

B. Peer Computer Control Software: Detect a failure of a central computer and cause the other central computer to assume control of all system functions without interruption of operation. Both central computers shall have drivers to support this mode of operation.

C. Application Software: Interface between the alarm annunciation and entry-control controllers to monitor sensors, operate displays, report alarms, generate reports, and help train system operators.

1. Reside at the central station, workstations, and controllers as required to perform specified functions.
2. Operate and manage peripheral devices.
3. Manage files for disk I/O, including creating, deleting, and copying files; and automatically maintain a directory of all files, including size and location of each sequential and random-ordered record.
4. Import custom icons into graphics to represent alarms and I/O devices.
5. Globally link I/O so that any I/O can link to any other I/O within the same Location without requiring interaction with the host workstation. This operation shall be at the controller.
6. Globally code I/O links so that any access-granted event can link to any I/O with the same Location without requiring interaction with the host workstation. This operation shall be at the controller.
7. Messages from workstation to controllers and controllers to controllers shall be on a polled network that utilizes check summing and acknowledgment of each message. Communication shall be automatically verified, buffered, and retransmitted if message is not acknowledged.
8. Selectable poll frequency and message time-out settings shall handle bandwidth and latency issues for TCP/IP, RF, and other workstation-to-controller communications methods by changing the polling frequency and the amount of time the system waits for a response.
9. Automatic and encrypted backups for database and history backups shall be automatically stored at **the central-control workstation** and encrypted with a nine-character alphanumeric password that must be used to restore or read data contained in backup.
10. Operator audit trail for recording and reporting all changes made to database and system software.
11. Support network protocol and topology, TCP/IP, Novel Netware, Digital Pathworks, Banyan Vines, LAN/WAN, and RAS.

D. Workstation Software:

1. Password levels shall be individually customized at each workstation to allow or disallow operator access to program functions for each Location.
2. Workstation event filtering shall allow user to define events and alarms that will be displayed at each workstation. If an alarm is unacknowledged (not handled by another workstation) for a preset amount of time, the alarm will automatically appear on the filtered workstation.

E. Controller Software:

1. Controllers shall operate as autonomous, intelligent processing units.

    a. Controllers shall make decisions about access control, alarm monitoring, linking functions, and door-locking schedules for their operation, independent of other system components.
    b. Controllers shall be part of a fully distributed processing-control network.
    c. The portion of the database associated with a controller, and consisting of parameters, constraints, and the latest value or status of points connected to that controller, shall be maintained in the controller.

2. The following functions shall be fully implemented and operational within each controller:

    a. Monitoring inputs.
    b. Controlling outputs.
    c. Automatically reporting alarms to the central station.
    d. Reporting of sensor and output status to the central station on request.
    e. Maintaining real time, automatically updated by the central station at least once a day.
    f. Communicating with the central station.
    g. Executing controller resident programs.
    h. Diagnosing.
    i. Downloading and uploading data to and from the central station.

3. Controller Operations at a Location:

    a. Up to **64** controllers connected to TIA 485-A communications loop. Globally operating I/O linking and anti-passback functions between controllers within the same Location without central-station or workstation intervention. Linking and anti-passback shall remain fully functional within the same Location even when the central station or workstations are off-line.
    b. In the event of communication failure between the central station and a Location, there shall be no degradation in operations at the controllers at that Location. Controllers at each Location shall be connected to a memory buffer with a capacity to store up to 10,000 events; there shall be no loss of transactions in system history files until the buffer overflows.
    c. Buffered events shall be handled in a first-in-first-out mode of operation.

4. Individual Controller Operation:

a. Controllers shall transmit alarms, status changes, and other data to the central station when communications circuits are operable. If communications are not available, controllers shall function in a stand-alone mode; operational data, including the status and alarm data normally transmitted to the central station, shall be stored for later transmission to the central station. Storage capacity for the latest 1024 events shall be provided at each controller.
b. Card-reader ports of a controller shall be custom configurable for at least **120** different card-reader or keypad formats. Multiple reader or keypad formats may be used simultaneously at different controllers or within the same controller.
c. Controllers shall provide a response to card readers or keypad entries in less than 0.25 seconds, regardless of system size.
d. Controllers that are reset, or powered up from a nonpowered state, shall automatically request a parameter download and reboot to their proper working state. This shall happen without any operator intervention.
e. Initial Startup: When controllers are brought on-line, database parameters shall be automatically downloaded to them. After initial download is completed, only database changes shall be downloaded to each controller.
f. On failure for any reason, controllers shall perform an orderly shutdown and force controller outputs to a predetermined failure-mode state, consistent with the failure modes shown and the associated control device.
g. After power is restored, following a power failure, startup software shall initiate self-test diagnostic routines, after which controllers shall resume normal operation.
h. After controller failure, if the database and application software are no longer resident, controllers shall not restart but shall remain in the failure mode until repaired. If database and application programs are resident, controllers shall immediately resume operation. If not, software shall be restored automatically from the central station.

5. Communications Monitoring:

a. System shall monitor and report status of TIA 485-A communications loop of each Location.
b. Communication status window shall display which controllers are currently communicating, a total count of missed polls since midnight, and which controller last missed a poll.
c. Communication status window shall show the type of CPU, the type of I/O board, and the amount of RAM for each controller.

6. Operating systems shall include a real-time clock function that maintains seconds, minutes, hours, day, date, and month. The real-time clock shall be automatically synchronized with the central station at least once a day to plus or minus 10 seconds. The time synchronization shall be automatic, without operator action and without requiring system shutdown.

F. Workstation-to-Controller Communications:

1. Central-station or workstation communications shall use the following:

a. Direct connection using serial ports of the workstation.
b. TCP/IP LAN interface cards.
c. Dial-up or cable modems for connections to Locations.

2. Each serial port used for communications shall be individually configurable for "direct communications," "modem communications incoming and outgoing," or "modem communications incoming only," or as an ASCII output port. Serial ports shall have adjustable data transmission rates and shall be selectable under program control.
3. Use multiport communications board if more than two serial ports are needed.

    a. Use a 4-, 8-, or 16-serial port configuration that is expandable to 32- or 64-serial ports.
    b. Connect the first board to an internal PCI bus adapter card.

4. Direct serial, TCP/IP, and dial-up, cable, or satellite communications shall be alike in the monitoring or control of the system except for the connection that must first be made to a dial-up or voice-over IP Location.
5. TCP/IP network interface card (NIV) shall have an option to set the poll-frequency and message-response time-out settings.
6. Workstation-to-controller and controller-to-controller communications (direct, dial-up, or TCP/IP) shall use a polled-communication protocol that checks sum and acknowledges each message. All communications in this subparagraph shall be verified and buffered, and retransmitted if not acknowledged.

G. Direct Serial or TCP/IP Workstation-to-Controller Communications:

1. Communication software on the workstation shall supervise the workstation-to-controller communications link.
2. Loss of communications to any controller shall result in an alarm at all workstations running the communication software.
3. When communications are restored, all buffered events shall automatically upload to the workstation, and any database changes shall be automatically sent to the controller.

H. Broadband Workstation-to-Controller Communications:

1. Communication software on the workstation shall supervise the workstation-to-controller communications link during dial-up modem connect times.
2. Communication software shall be programmable to routinely poll each of the remote dial-up or cable modem Locations, collecting event logs and verifying phone lines at operator-selectable time intervals for each Location.
3. System shall be programmable for dialing and connecting to all dial-up or cable modem Locations and for retrieving the accrued history transactions on an automatic basis as often as once every **10** minutes.
4. Time offset capabilities shall be present so that Locations in a different geographical time zone than the host workstation will be set to, and maintained at, the proper local time. This feature shall allow for geographical time zones that are ahead of or behind the host workstation.
5. The controller connected to a dial-up or cable modem shall automatically buffer all normal transactions until its buffer reaches 80 percent of capacity. When the transaction buffer reaches 80 percent, the controller shall automatically initiate a call to the central station and upload all transactions.
6. Alarms shall be reported immediately.

I. Controller-to-Controller Communications:

1. TIA 485-A, four-wire, point-to-point, regenerative (repeater) communications network methodology.
2. TIA 485-A communications signal shall be regenerated at each controller.

J. Database Downloads:

1. All data transmissions from workstations to a Location, and between controllers at a Location, shall include a complete database checksum to check the integrity of the transmission. If the data checksum does not match, a full data download shall be automatically retransmitted.
2. If a controller is reset for any reason, it shall automatically request and receive a database download from the workstation. The download shall restore data stored at the controller to their normal working state and shall take place with no operator intervention.

K. Operator Interface:

1. Inputs in system shall have two icon representations, one for the normal state and one for the abnormal state.
2. When viewing and controlling inputs, displayed icons shall automatically change to the proper icon to display the current system state in real time. Icons shall also display the input's state, whether armed or bypassed, and if the input is in the armed or bypassed state due to a time zone or a manual command.
3. Outputs in system shall have two icon representations, one for the secure (locked) state and one for the open (unlocked) state.
4. Icons displaying status of the I/O points shall be constantly updated to show their current real-time condition without prompting by the operator.
5. The operator shall be able to scroll the list of I/Os and press the appropriate toolbar button, or right click, to command the system to perform the desired function.
6. Graphic maps or drawings containing inputs, outputs, and override groups shall include the following:

    a. Database to import and store full-color maps or drawings and allow for input, output, and override group icons to be placed on maps.
    b. Maps to provide real-time display animation and allow for control of points assigned to them.
    c. System to allow inputs, outputs, and override groups to be placed on different maps.
    d. Software to allow changing the order or priority in which maps will be displayed.

7. Override Groups Containing I/Os:

    a. System shall incorporate override groups that provide the operator with the status and control over user-defined "sets" of I/Os with a single icon.
    b. Icon shall change automatically to show the live summary status of points in that group.
    c. Override group icon shall provide a method to manually control or set to time-zone points in the group.
    d. Override group icon shall allow the expanding of the group to show icons representing the live status for each point in the group, individual control over each point, and the ability to compress the individual icons back into one summary icon.

8. Schedule Overrides of I/Os and Override Groups:

    a. To accommodate temporary schedule changes that do not fall within the holiday parameters, the operator shall have the ability to override schedules individually for each input, output, or override group.
    b. Each schedule shall be composed of a minimum of two dates with separate times for each date.
    c. The first time and date shall be assigned the override state that the point shall advance to when the time and date become current.
    d. The second time and date shall be assigned the state that the point shall return to when the time and date become current.

9. Copy command in database shall allow for like data to be copied and then edited for specific requirements, to reduce redundant data entry.

L. Operator Access Control:

1. Control operator access to system controls through password-protected operator levels. System operators and managers with appropriate password clearances shall be able to change operator levels for operators.
2. Three successive attempts by an operator to execute functions beyond their defined level during a 24-hour period shall initiate a software tamper alarm.
3. A minimum of **1024** unique user accounts shall be available with the system software. System shall display the operator's name or initials in the console's first field. System shall print the operator's name or initials, action, date, and time on the system printer at login and logoff.
4. The password shall not be displayed or printed.
5. Each password shall be definable and assignable for the following:

    a. Selected commands to be usable.
    b. Access to system software.
    c. Access to application software.
    d. Individual zones that are to be accessed.
    e. Access to database.

M. Operator Commands:

1. Command Input: Plain-language words and acronyms shall allow operators to use the system without extensive training or data-processing backgrounds. System prompts shall be a word, a phrase, or an acronym.
2. Command inputs shall be acknowledged and processing shall start in not less than one second(s).
3. Tasks that are executed by operator's commands shall include the following:

    a. Acknowledge Alarms: Used to acknowledge that the operator has observed the alarm message.
    b. Place Zone in Access: Used to remotely disable intrusion-alarm circuits emanating from a specific zone. System shall be structured so that console operator cannot disable tamper circuits.
    c. Place Zone in Secure: Used to remotely activate intrusion-alarm circuits emanating from a specific zone.

d. System Test: Allows the operator to initiate a system-wide operational test.
e. Zone Test: Allows the operator to initiate an operational test for a specific zone.
f. Print reports.
g. Change Operator: Used for changing operators.
h. Security Lighting Controls: Allows the operator to remotely turn on or turn off security lights.
i. Display Graphics: Used to show any graphic displays implemented in the system. Graphic displays shall be completed within 20 seconds from time of operator command.
j. Run system tests.
k. Generate and format reports.
l. Request help with the system operation.

1) Include in main menus.
2) Provide unique, descriptive, context-sensitive help for selections and functions with the press of one function key.
3) Provide navigation to specific topic from within the first help window.
4) Help shall be accessible outside the application program.

m. Entry-Control Commands:

1) Lock (secure) or unlock (open) each controlled entry and exit.
2) Arm or disarm each monitored input up to **four** times a day through time-zone programming.
3) Enable or disable readers or keypads up to **two** times a day through time-zone programming.
4) Enable or disable cards or codes up to **four** times a day per entry point through access-level programming.

4. Command Input Errors: Show operator input assistance when a command cannot be executed because of operator input errors. Assistance screen shall use plain-language words and phrases to explain why the command cannot be executed. Error responses that require an operator to look up a code in a manual or other document are not acceptable. Conditions causing operator assistance messages include the following:

a. Command entered is incorrect or incomplete.
b. Operator is restricted from using that command.
c. Command addresses a point that is disabled or out of service.
d. Command addresses a point that does not exist.
e. Command is outside the system's capacity.

N. Alarms:

1. System Setup:

a. Assign manual and automatic responses to incoming-point status change or alarms.
b. Automatically respond to input with a link to other inputs, outputs, or operator-response plans; unique sound with use of WAV files; and maps or images that graphically represent the point location.
c. Sixty-character message field for each alarm.

d. Operator-response-action messages shall allow message length of at least 65,000 characters, with database storage capacity of up to 32,000 messages.
e. Secondary messages shall be assignable by the operator for printing to provide further information and shall be editable by the operator.
f. Allow 25 secondary messages with a field of four lines of 60 characters each.
g. Store the most recent 1000 alarms for recall by the operator using the report generator.

2. Software Tamper:

a. Annunciate a tamper alarm when unauthorized changes to system database files are attempted. Three consecutive unsuccessful attempts to log onto system shall generate a software tamper alarm.
b. Annunciate a software tamper alarm when an operator or other individual makes three consecutive unsuccessful attempts to invoke functions beyond the authorization level.
c. Maintain a transcript file of the last 5000 commands entered at each central station to serve as an audit trail. System shall not allow write access to system transcript files by any person, regardless of their authorization level.
d. Allow only acknowledgment of software tamper alarms.

3. Read access to system transcript files shall be reserved for operators with the highest password authorization level available in system.
4. Animated Response Graphics: Highlight alarms with flashing icons on graphic maps; display and constantly update the current status of alarm inputs and outputs in real time through animated icons.
5. Multimedia Alarm Annunciation: WAV files to be associated with alarm events for audio annunciation or instructions.
6. Alarm Handling: Each input may be configured so that an alarm cannot be cleared unless it has returned to normal, with options of requiring the operator to enter a comment about disposition of alarm. Allow operator to silence alarm sound when alarm is acknowledged.
7. Alarm Automation Interface: High-level interface to central-station alarm automation software systems. Allows input alarms to be passed to and handled by automation systems in the same manner as burglar alarms, using a TIA 232-F ASCII interface.
8. CCTV Alarm Interface: Allow commands to be sent to CCTV systems during alarms (or input change of state) through serial ports.
9. Camera Control: Provides operator ability to select and control cameras from graphic maps.

O. Alarm Monitoring: Monitor sensors, controllers, and DTS circuits and notify operators of an alarm condition. Display higher-priority alarms first and, within alarm priorities, display the oldest unacknowledged alarm first. Operator acknowledgment of one alarm shall not be considered acknowledgment of other alarms nor shall it inhibit reporting of subsequent alarms.

1. Displayed alarm data shall include type of alarm, location of alarm, and secondary alarm messages.
2. Printed alarm data shall include type of alarm, location of alarm, date and time (to nearest second) of occurrence, and operator responses.
3. Maps shall automatically display the alarm condition for each input assigned to that map if that option is selected for that input location.

4. Alarms initiate a status of "pending" and require the following two handling steps by operators:

    a. First Operator Step: "Acknowledged." This action shall silence sounds associated with the alarm. The alarm remains in the system "Acknowledged" but "Un-Resolved."
    b. Second Operator Step: Operators enter the resolution or operator comment, giving the disposition of the alarm event. The alarm shall then clear.

5. Each workstation shall display the total pending alarms and total unresolved alarms.
6. Each alarm point shall be programmable to disallow the resolution of alarms until the alarm point has returned to its normal state.
7. Alarms shall transmit to the central station in real time except for allowing connection time for dial-up locations.
8. Alarms shall be displayed and managed from a minimum of four different windows.

    a. Input Status Window: Overlay status icon with a large red blinking icon. Selecting the icon will acknowledge the alarm.
    b. History Log Transaction Window: Display name, time, and date in red text. Selecting red text will acknowledge the alarm.
    c. Alarm Log Transaction Window: Display name, time, and date in red. Selecting red text will acknowledge the alarm.
    d. Graphic Map Display: Display a steady colored icon representing each alarm input location. Change icon to flashing red when the alarm occurs. Change icon from flashing red to steady red when the alarm is acknowledged.

9. Once an alarm is acknowledged, the operator shall be prompted to enter comments about the nature of the alarm and actions taken. Operator's comments may be manually entered or selected from a programmed predefined list, or a combination of both.
10. For locations where there are regular alarm occurrences, provide programmed comments. Selecting that comment shall clear the alarm.
11. The time and name of the operator who acknowledged and resolved the alarm shall be recorded in the database.
12. Identical alarms from the same alarm point shall be acknowledged at the same time the operator acknowledges the first alarm. Identical alarms shall be resolved when the first alarm is resolved.
13. Alarm functions shall have priority over downloading, retrieving, and updating database from workstations and controllers.
14. When a reader-controlled output (relay) is opened, the corresponding alarm point shall be automatically bypassed.

P. Monitor Display: Display text and graphic maps that include zone status integrated into the display. Colors are used for the various components and current data. Colors shall be uniform throughout the system.

1. Color Code:

    a. FLASHING RED: Alerts operator that a zone has gone into an alarm or that primary power has failed.
    b. STEADY RED: Alerts operator that a zone is in alarm and alarm has been acknowledged.

c. YELLOW: Advises operator that a zone is in access.
d. GREEN: Indicates that a zone is secure and that power is on.

2. Graphics:

a. Support 32,000 graphic display maps and allow import of maps from a minimum of 16 standard formats from another drawing or graphics program.
b. Allow I/O to be placed on graphic maps by the drag-and-drop method.
c. Operators shall be able to view the inputs, outputs, and the point's name by moving the mouse cursor over the point on the graphic map.
d. Inputs or outputs may be placed on multiple graphic maps. The operator shall be able to toggle to view graphic maps associated with I/Os.
e. Each graphic map shall have a display-order sequence number associated with it to provide a predetermined order when toggled to different views.
f. Camera icons shall have the ability to be placed on graphic maps that, when selected by an operator, will open a video window, display the camera associated with that icon, and provide pan-tilt-zoom control.
g. Input, output, or camera placed on a map shall allow the ability to arm or bypass an input, open or secure an output, or control the pan-tilt-zoom function of the selected camera.

Q. System test software enables operators to initiate a test of the entire system or of a particular portion of the system.

1. Test Report: The results of each test shall be stored for future display or printout. The report shall document the operational status of system components.

R. Report-Generator Software: Include commands to generate reports for displaying, printing, and storing on disk and tape. Reports shall be stored by type, date, and time. Report printing shall be the lowest-priority activity. Report-generation mode shall be operator selectable but set up initially as periodic, automatic, or on request. Include time and date printed and the name of operator generating the report. Report formats may be configured by operators.

1. Automatic Printing: Setup shall specify, modify, or inhibit the report to be generated; the time the initial report is to be generated; the time interval between reports; the end of the period; and the default printer.
2. Printing on Request: An operator may request a printout of any report.
3. Alarm Reports: Reporting shall be automatic as initially set up. Include alarms recorded by system over the selected time and information about the type of alarm **such as door alarm, intrusion alarm, tamper alarm, etc.**, the type of sensor, the location, the time, and the action taken.
4. Access and Secure Reports: Document zones placed in access, the time placed in access, and the time placed in secure mode.
5. Custom Reports: Reports tailored to exact requirements of who, what, when, and where. As an option, custom report formats may be stored for future printing.
6. Automatic History Reports: Named, saved, and scheduled for automatic generation.
7. Cardholder Reports: Include data, or selected parts of the data, as well as the ability to be sorted by name, card number, imprinted number, or by any of the user-defined fields.
8. Cardholder by Reader Reports: Based on who has access to a specific reader or group of readers by selecting the readers from a list.

9. Cardholder by Access-Level Reports: Display everyone that has been assigned to the specified access level.
10. Who Is "In" (Muster) Report:

    a. Emergency Muster Report: One-click operation on toolbar launches report.
    b. Cardholder Report. Contain a count of persons who are "In" at a selected Location and a detailed listing of name, date, and time of last use, sorted by the last reader used or by the group assignment.

11. Panel Labels Reports: Printout of control-panel field documentation including the actual location of equipment, programming parameters, and wiring identification. Maintain system installation data within system database so that data are available on-site at all times.
12. Activity and Alarm On-Line Printing: Activity printers for use at workstations; prints all events, or alarms only.
13. History Reports: Custom reports that allow the operator to select any date, time, event type, device, output, input, operator, Location, name, or cardholder to be included or excluded from the report.

    a. Initially store history on the hard disk of the host workstation.
    b. Permit viewing of the history on workstations or print history to any system printer.
    c. The report shall be definable by a range of dates and times with the ability to have a daily start and stop time over a given date range.
    d. Each report shall depict the date, time, event type, event description, and device; or I/O name, cardholder group assignment, and cardholder name or code number.
    e. Each line of a printed report shall be numbered to ensure that the integrity of the report has not been compromised.
    f. Total number of lines of the report shall be given at the end of the report. If the report is run for a single event such as "Alarms," the total shall reflect how many alarms occurred during that period.

14. Reports shall have the following four options:

    a. View on screen.
    b. Print to system printer. Include automatic print spooling and "Print To" options if more than one printer is connected to the system.
    c. "Save to File" with full path statement.
    d. System shall have the ability to produce a report indicating status of system inputs and outputs or of inputs and outputs that are abnormal, out of time zone, manually overridden, not reporting, or in alarm.

15. Custom Code List Subroutine: Allow the access codes of system to be sorted and printed according to the following criteria:

    a. Active, inactive, or future activate or deactivate.
    b. Code number, name, or imprinted card number.
    c. Group, Location access levels.
    d. Start and stop code range.
    e. Codes that have not been used since a selectable number of days.
    f. In, out, or either status.

g. Codes with trace designation.

16. The reports of system database shall allow options so that every data field may be printed.
17. The reports of system database shall be constructed so that the actual position of the printed data shall closely match the position of the data on the data-entry windows.

S. Anti-Passback:

1. System shall have global and local anti-passback features, selectable by Location. System shall support hard and soft anti-passback.
2. Hard Anti-Passback: Once a credential holder is granted access through a reader with one type of designation (IN or OUT), the credential holder may not pass through that type of reader designation until the credential holder passes through a reader of opposite designation.
3. Soft Anti-Passback: Should a violation of the proper IN or OUT sequence occur, access shall be granted, but a unique alarm shall be transmitted to the control station, reporting the credential holder and the door involved in the violation. A separate report may be run on this event.
4. Timed Anti-Passback: A controller capability that prevents an access code from being used twice at the same device (door) within a user-defined amount of time.
5. Provide four separate zones per Location that can operate without requiring interaction with the host workstation (done at controller). Each reader shall be assignable to one or all four anti-passback zones. In addition, each anti-passback reader can be further designated as "Hard," "Soft," or "Timed" in each of the four anti-passback zones. The four anti-passback zones shall operate independently.
6. The anti-passback schemes shall be definable for each individual door.
7. The Master Access Level shall override anti-passback.
8. System shall have the ability to forgive (or reset) an individual credential holder or the entire credential-holder population anti-passback status to a neutral status.

T. Visitor Assignment:

1. Provide for and allow an operator to be restricted to only working with visitors. The visitor badging subsystem shall assign credentials and enroll visitors. Allow only those access levels that have been designated as approved for visitors.
2. Provide an automated log of visitor name, time and doors accessed, and name of person contacted.
3. Allow a visitor designation to be assigned to a credential holder.
4. Security access system shall be able to restrict the access levels that may be assigned to credentials issued to visitors.
5. Allow operator to recall visitors' credential-holder file once a visitor is enrolled in the system.
6. The operator may designate any reader as one that deactivates the credential after use at that reader. The history log shall show the return of the credential.
7. System shall have the ability to use the visitor designation in searches and reports. Reports shall be able to print all or any visitor activity.

U. Time and Attendance:

1. Time and attendance reporting shall be provided to match IN and OUT reads and display cumulative time in for each day and cumulative time in for length designated in the report.
2. Shall be provided to match IN and OUT reads and display cumulative time in for each day and cumulative time in for length designated in the report.
3. System software setup shall allow designation of selected access-control readers as time and attendance hardware to gather the clock-in and clock-out times of the users at these readers.

    a. Reports shall show in and out times for each day, total time in for each day, and a total time in for period specified by the user.
    b. Allow the operator to view and print the reports, or save the reports to a file.
    c. Alphabetically sort reports on the person's last name, by Location or location group. Include all credential holders or optionally select individual credential holders for the report.

V. Training Software: Enables operators to practice system operation, including alarm acknowledgment, alarm assessment, response force deployment, and response force communications. System shall continue normal operation during training exercises and shall terminate exercises when an alarm signal is received at the console.

W. Entry-Control Enrollment Software: Database management functions that allow operators to add, delete, and modify access data as needed.

1. The enrollment station shall not have alarm response or acknowledgment functions.
2. Provide multiple, password-protected access levels. Database management and modification functions shall require a higher operator access level than personnel enrollment functions.
3. The program shall provide means to disable the enrollment station when it is unattended, to prevent unauthorized use.
4. The program shall provide a method to enter personnel identifying information into the entry-control database files through enrollment stations. In the case of personnel identity-verification subsystems, this shall include biometric data. Allow entry of personnel identifying information into the system database using menu selections and data fields. The data field names shall be customized during setup to suit user and site needs. Personnel identity-verification subsystems selected for use with the system shall fully support the enrollment function and shall be compatible with the entry-control database files.
5. Cardholder Data: Provide 99 user-defined fields. System shall have the ability to run searches and reports using any combination of these fields. Each user-defined field shall be configurable, using any combination of the following features:

    a. MASK: Determines a specific format with which data must comply.
    b. REQUIRED: Operator is required to enter data into field before saving.
    c. UNIQUE: Data entered must be unique.
    d. DEACTIVATE DATE: Data entered will be evaluated as an additional deactivate date for all cards assigned to this cardholder.
    e. NAME ID: Data entered will be considered a unique ID for the cardholder.

6. Personnel Search Engine: A report generator with capabilities such as search by last name, first name, group, or any predetermined user-defined data field; by codes not used in definable number of days; by skills; or by seven other methods.
7. Multiple Deactivate Dates for Cards: User-defined fields to be configured as additional stop dates to deactivate any cards assigned to the cardholder.
8. Batch card printing.
9. Default card data can be programmed to speed data entry for sites where most card data are similar.
10. Enhanced ASCII File Import Utility: Allows the importing of cardholder data and images.
11. Card Expire Function: Allows readers to be configured to deactivate cards when a card is used at selected devices.

## 2.6 SYSTEM DATABASE

A. Database and database management software shall define and modify each point in database using operator commands. Definition shall include parameters and constraints associated with each system device.

B. Database Operations:

1. System data management shall be in a hierarchical menu-tree format, with navigation through expandable menu branches and manipulated with use of menus and icons in a main menu and system toolbar.
2. Navigational Aids:

    a. Toolbar icons for add, delete, copy, print, capture image, activate, deactivate, and muster report.
    b. Point and click feature to facilitate data manipulation.
    c. Next and previous command buttons visible when editing database fields to facilitate navigation from one record to the next.
    d. Copy command and copy tool in the toolbar to copy data from one record to create a new similar record.

3. Data entry shall be automatically checked for duplicate and illegal data and shall be verified for valid format.
4. System shall generate a memo or note field for each item that is stored in database, allowing the storing of information about any defining characteristics of the item. Memo field is used for noting the purpose for which the item was entered, reasons for changes that were made, and the like.

C. File Management:

1. File management shall include database backup and restoration system, allowing selection of storage media, including 3.5-inch floppy disk, Zip and Jaz drives, and designated network resources.
2. Operations shall be both manual and automatic modes. The number of automatic sequential backups before the oldest backup will be overwritten; FIFO mode shall be operator selectable.

3. Backup program shall provide manual operation from any workstation on the LAN and shall operate while system remains operational.

D. Operator Passwords:

1. Support up to **32,000** individual system operators, each with a unique password.
2. Allow passwords to be case sensitive.
3. Passwords shall not be displayed when entered.
4. Passwords shall have unique and customizable password profile, and allow several operators to share a password profile. Include the following features in the password profile:

    a. Predetermine the highest-level password profile for access to all functions and areas of program.
    b. Allow or disallow operator access to any program operation, including the functions of View, Add, Edit, and Delete.
    c. Restrict doors to which an operator can assign access.

5. Operators shall use a user name and password to log on to system. This user name and password shall be used to access database areas and programs as determined by the associated profile.
6. Make provision to allow the operator to log off without fully exiting program. User may be logged off but program will remain running while displaying the login window for the next operator.

E. Access Card/Code Operation and Management: Access authorization shall be by card, by a manually entered code (PIN), or by a combination of both (card plus PIN).

1. Access authorization shall verify the facility code first, the card or card-and-PIN validation second, and the access level (time of day, day of week, date), anti-passback status, and number of uses last.
2. Use data-entry windows to view, edit, and issue access levels. Access-authorization entry-management system shall maintain and coordinate all access levels to prevent duplication or the incorrect creation of levels.
3. Allow assignment of multiple cards/codes to a cardholder.
4. Allow assignment of up to four access levels for each Location to a cardholder. Each access level may contain any combination of doors.
5. Each door may be assigned four time zones.
6. Access codes may be up to 11 digits in length.
7. Software shall allow the grouping of locations so cardholder data can be shared by all locations in the group.
8. Visitor Access: Issue a visitor badge for data tracking or photo ID purposes without assigning that person a card or code.
9. Cardholder Tracing: Allow for selection of cardholder for tracing. Make a special audible and visible annunciation at control station when a selected card or code is used at a designated code reader. Annunciation shall include an automatic display of the cardholder image.
10. Allow each cardholder to be given either an unlimited number of uses or a number from one to 9999 that regulates the number of times the card can be used before it is automatically deactivated.

11. Provide for cards and codes to be activated and deactivated manually or automatically by date. Provide for multiple deactivate dates to be preprogrammed.

F. Security Access Integration:

1. Photo ID badging and photo verification shall use the same database as the security access and may query data from cardholder, group, and other personal information to build a custom ID badge.
2. Automatic or manual image recall and manual access based on photo verification shall also be a means of access verification and entry.
3. System shall allow sorting of cardholders together by group or other characteristic for a fast and efficient method of reporting on, and enabling or disabling, cards or codes.

G. Key control and tracking shall be an integrated function of cardholder data.

1. Provide the ability to store information about which conventional metal keys are issued and to whom, along with key construction information.
2. Reports shall be designed to list everyone who possesses a specified key.

H. Facility Codes: System shall accommodate up to 2048 facility codes per Location, with the option of allowing facility codes to work at all doors or only at particular doors.

I. Operator Comments:

1. With the press of one appropriate button on the toolbar, the user shall be permitted to enter operator comments into the history at any time.
2. Automatic prompting of operator comment shall occur before the resolution of each alarm.
3. Operator comments shall be recorded by time, date, and operator number.
4. Comments shall be sorted and viewed through reports and history.
5. The operator may enter comments in two ways; either or both may be used:

    a. Manually entered through keyboard data entry (typed), up to 65,000 characters per each alarm.
    b. Predefined and stored in database for retrieval on request.

6. System shall have a minimum of 999 predefined operator comments with up to 30 characters per comment.

J. Group:

1. Group names may be used to sort cardholders into groups that allow the operator to determine the tenant, vendor, contractor, department, division, or any other designation of a group to which the person belongs.
2. System software shall have the capacity to assign one of 32,000 group names to an access authorization.
3. Make provision in software to deactivate and reactivate all access authorizations assigned to a particular group.
4. Allow sorting of history reports and code list printouts by group name.

K. Time Zones:

1. Each zone consists of a start and stop time for seven days of the week and three holiday schedules. A time zone is assigned to inputs, outputs, or access levels to determine when an input shall automatically arm or disarm, when an output automatically opens or secures, or when access authorization assigned to an access level will be denied or granted.
2. Up to four time zones may be assigned to inputs and outputs to allow up to four arm or disarm periods per day or four lock or unlock periods per day; up to three holiday override schedules may be assigned to a time zone.
3. Data-entry window shall display a dynamically linked bar graph showing active and inactive times for each day and holiday, as start and stop times are entered or edited.
4. System shall have the capacity for **2048** time zones for each Location.

L. Holidays:

1. Three different holiday schedules may be assigned to a time zone. Holiday schedule consists of date in format MM/DD/YYYY and a description. When the holiday date matches the current date of the time zone, the holiday schedule replaces the time-zone schedule for that 24-hour period.
2. System shall have the capacity for **32,000** holidays.
3. Three separate holiday schedules may be applied to a time zone.
4. Holidays have an option to be designated as occurring on the designated date each year. These holidays remain in the system and will not be purged.
5. Holidays not designated to occur each year shall be automatically purged from the database after the date expires.

M. Access Levels:

1. System shall allow for the creation of up to **32,000** access levels.
2. One level shall be predefined as the Master Access Level. The Master Access Level shall work at all doors at all times and override any anti-passback.
3. System shall allow for access to be restricted to any area by reader and by time. Access levels shall determine when and where an Identifier is authorized.
4. System shall be able to create multiple door and time-zone combinations under the same access level so that an Identifier may be valid during different time periods at different readers even if the readers are on the same controller.

N. User-Defined Fields:

1. System shall provide a minimum of 99 user-defined fields, each with up to 50 characters, for specific information about each credential holder.
2. System shall accommodate a title for each field; field length shall be 20 characters.
3. A "Required" option may be applied to each user-defined field that, when selected, forces the operator to enter data in the user-defined field before the credential can be saved.
4. A "Unique" option may be applied to each user-defined field that, when selected, will not allow duplicate data from different credential holders to be entered.
5. Data format option may be assigned to each user-defined field that will require the data to be entered with certain character types in specific spots in the field entry window.
6. A user-defined field, if selected, will define the field as a deactivate date. The selection shall automatically cause the data to be formatted with the windows MM/DD/YYYY date format. The credential of the holder will be deactivated on that date.

7. A search function shall allow any one user-defined field or combination of user-defined fields to be searched to find the appropriate cardholder. The search function shall include a search for a character string.
8. System shall have the ability to print cardholders based on and organized by the user-defined fields.

O. Code Tracing:

1. System shall perform code tracing selectable by cardholder and by reader.
2. Any code may be designated as a "traced code" with no limit to how many codes can be traced.
3. Any reader may be designated as a "trace reader" with no limit to which or how many readers can be used for code tracing.
4. When a traced code is used at a trace reader, the access-granted message that usually appears on the monitor window of the central station shall be highlighted with a different color than regular messages. A short singular beep shall occur at the same time the highlighted message is displayed on the window.
5. The traced cardholder image (if image exists) shall appear on workstations when used at a trace reader.

## 2.7 SURGE AND TAMPER PROTECTION

A. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor-entry connection to components.

1. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits" as recommended by manufacturer for type of line being protected.

B. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station control-unit alarm display shall identify tamper alarms and indicate locations.

## 2.8 CENTRAL-STATION HARDWARE

A. Central-Station Computer: Standard workstation of modular design.

B. Redundant Central Computer: One identical redundant central computer, connected in a hot standby, peer configuration. This computer shall automatically maintain its own copies of system software, application software, and data files. System transactions and other activities that alter system data files shall be updated to system files of redundant computer in near real time. If central computer fails, redundant computer shall assume control immediately and automatically.

C. Desktop Workstations:

1. Performance Requirements:

a. Performance requirements may dictate equipment exceeding minimum requirements indicated.
b. Capable of running **Microsoft Windows**
c. Energy Star compliant.
d. Processor:
1) Cores: **Quad**
2) Series: **Core i7**

e. RAM:

1) Capacity: 16 **GB**.
2) Speed and Type: **1333** MHz,

f. Primary Hard Drive:

1) Media: **Solid state**
2) Number of Hard Drives: **One**
3) Capacity: 2TB.
4) Minimum Average Seek Time: 1ms

g. Optical Read and Write Drive:

1) Include with at least 2 MB of data buffer.
2) Minimum Data Buffer Capacity: 10ms
3) Minimum Average Access Time: 20ms.

4) Average access time of 150 ms or less.
5) MTBF of at least 100,000 power-on hours.

h. Expansion slots: Minimum of 4, **64** bit.
i. Video Card:

1) Capable of supporting **two** monitors.
2) Resolution: **1920 by 1080** pixels minimum for each monitor.
3) RAM: 16 GB.

j. Sound Card:

1) At least 128 voice wavetable synthesis.
2) Capable of delivering three-dimensional sound effects.
3) High-resolution 16-bit stereo digital audio recording and playback with user-selectable sample rates up to 48,000 Hz.

k. Network Interface Card: Include card with connection, as applicable.

1) 10-100-1000 base TX Ethernet with RJ45 connector port.

2) 100 base FX Ethernet with SC or ST port.

l. Wireless Ethernet, 802.11 a/b/g/n.
m. Optical Modem: Full duplex link for connection to optical fiber cable provided.
n. I/O Ports:

1) Two USB 3.0 ports on front panel, six on back panel, and three internal on motherboard.
2) One serial port.
3) One parallel port.
4) Two PS/2 ports.
5) One RJ-45.
6) One stereo line-in and line-out on back panel.
7) One microphone and headphone connector on front panel.
8) One IEEE 1394 on front and back panel with workstation I-e card.
9) One ESATA port on back panel.

o. Battery: Life of at least three years to maintain system clock/calendar and ROM, as a minimum.

2. Keyboard:

a. 101 key enhanced keyboard.
b. Full upper- and lowercase ASCII keyset, numeric keypad, dedicated cursor control keypad, and 12 programmable function keys.
c. Wireless operation within up to 72 inches (1800 mm) in front of workstation.

3. Pointing Device:

a. Either a two- or three-button mouse.
b. Wireless operation within up to 72 inches (1800 mm) in front of workstation.

4. Flat Panel Display Monitor:

a. Number of Displays: **Two**.
b. Display Support: **Individual tilt adjustable base.**
c. Color display with 27” diagonal viewable area.
d. Aspect Ratio: **16 to 9**
e. Resolution: **1920 by 1080** pixels at 60 Hz with pixel size of **0.277** mm or smaller.
f. **Digital** input signal.
g. Response Time: 10 ms.
h. Dynamic Contrast Ratio: **50000 to 1**
i. Brightness: **250 cd/sq. m**
j. Energy Star compliant.
k. Antiglare display.

5. Speakers:

a. Two, with individual controls for volume, bass and treble.
b. Signal to Noise Ratio: At least 65 dB.
c. Power: At least 4 W per speaker/channel.

d. Magnetic shielding to prevent distortion on the video monitor.

6. I/O Cabling: Include applicable cabling to connect I/O devices.
7. Software:

a. Factory installed operating system.

## 2.9 FIXED MAP DISPLAY

A. A fixed map display shall show the layout of the protected facilities. Zones corresponding to those monitored by the system shall be highlighted on the display. Status of each zone shall be displayed using digital displays as required within each designated zone. A digital display test switch shall be provided on the map display.

## 2.10 CONTROLLERS

A. Controllers: Intelligent peripheral control unit, complying with UL 294, that stores time, date, valid codes, access levels, and similar data downloaded from the central station or workstation for controlling its operation.

B. Subject to compliance with requirements in this article, manufacturers may use multipurpose controllers.

C. Battery Backup: Sealed, lead acid; sized to provide run time during a power outage of 90 minutes, complying with UL 924.

D. Alarm Annunciation Controller:

1. The controller shall automatically restore communication within 10 seconds after an interruption with the field device network.

a. Inputs: Monitor dry contacts for changes of state that reflect alarm conditions. Provides at least eight alarm inputs, which are suitable for wiring as normally open or normally closed contacts for alarm conditions.
b. Alarm-Line Supervision:
1) Transmit alarm-line-supervision alarm to the central station during the next interrogation cycle after the abnormal current condition.

c. Outputs: Managed by central-station software.

2. Auxiliary Equipment Power: A GFI service outlet inside the controller enclosure.

E. Entry-Control Controller:

1. Function: Provide local entry-control functions including one- and two-way communications with access-control devices such as card readers, keypads, biometric personnel identity-verification devices, door strikes, magnetic latches, gate and door operators, and exit push buttons.

a. Operate as a stand-alone portal controller using the downloaded database during periods of communication loss between the controller and the field-device network.
b. Accept information generated by the entry-control devices; automatically process this information to determine valid identification of the individual present at the portal:

1) On authentication of the credentials or information presented, check privileges of the identified individual, allowing only those actions granted as privileges.
2) Privileges shall include, but are not limited to, time of day control, day of week control, group control, and visitor escort control.

c. Maintain a date-, time-, and Location-stamped record of each transaction. A transaction is defined as any successful or unsuccessful attempt to gain access through a controlled portal by the presentation of credentials or other identifying information.

2. Inputs:

a. Data from entry-control devices; use this input to change modes between access and secure.
b. Database downloads and updates from the central station that include enrollment and privilege information.

3. Outputs:

a. Indicate success or failure of attempts to use entry-control devices and make comparisons of presented information with stored identification information.
b. Grant or deny entry by sending control signals to portal-control devices
c. Maintain a date-, time-, and Location-stamped record of each transaction and transmit transaction records to the central station.
d. Door Prop Alarm: If a portal is held open for longer than **20 seconds** alarm sounds.

4. With power supplies sufficient to power at voltage and frequency required for field devices and portal-control devices.
5. Data Line Problems: For periods of loss of communication with the central station, or when data transmission is degraded and generating continuous checksum errors, the controller shall continue to control entry by accepting identifying information, making authentication decisions, checking privileges, and controlling portal-control devices.

a. Store up to **1000** transactions during periods of communication loss between the controller and access-control devices for subsequent upload to the central station on restoration of communication.

6. Controller Power: NFPA 70, Class II power-supply transformer, with 12- or 24-V ac secondary, backup battery and charger.

a. Backup Battery: **Premium, valve**, recombinant-sealed, lead-calcium battery; spill proof; with a full one-year warranty and a pro rata **19 5**-year warranty. With

single-stage, constant-voltage-current, limited battery charger, comply with battery manufacturer's written instructions for battery terminal voltage and charging current recommendations for maximum battery life.

b. Backup Battery: Valve-regulated, recombinant-sealed, lead-acid battery; spill proof. With single-stage, constant-voltage-current, limited battery charger, comply with battery manufacturer's written instructions for battery terminal voltage and charging current recommendations for maximum battery life.

c. Backup Power-Supply Capacity: **Five** minutes of battery supply. Submit battery and charger calculations.

d. Power Monitoring: Provide manual, dynamic battery-load test, initiated, and monitored at the control center; with automatic disconnection of the controller when battery voltage drops below controller limits. Report by using local controller-mounted digital displays and by communicating status to central station. Indicate normal power on and battery charger on trickle charge. Indicate and report the following:

1) Trouble Alarm: Normal power-off load assumed by battery.
2) Trouble Alarm: Low battery.
3) Alarm: Power off.

## 2.11 SECONDARY ALARM ANNUNCIATOR

A. Secondary Alarm Annunciation Site: A workstation with limited I/O capacity, consisting of a secondary alarm annunciation workstation **to allow the operator to duplicate functions of the main operator interface and to show system status changes**.

## 2.12 ENROLLMENT CENTER

A. Equipment for enrolling personnel into, and removing personnel from, system database, using a dedicated desktop workstation

1. Include equipment to enroll selected biometric credentials.

B. Enrollment equipment shall support encoding of credential cards including cryptographic and other internal security checks as required for system.

1. Allow only authorized entry-control enrollment personnel to access the enrollment equipment using passwords.
2. Include enrollment-subsystem configuration controls and electronic diagnostic aids for subsystem setup and troubleshooting with the central station.
3. Enrollment-station records printer shall meet requirements of the report printer.

C. Entry-Control Enrollment Software:

1. Shall include database management functions for the system, and shall allow an operator to change and modify the data entered in the system as needed.
2. Software shall not have alarm response or acknowledgment functions as a programmable function.
3. Multiple, password-protected access levels shall be provided at the enrollment station.

4. Database management and modification functions shall require a higher operator-access level than personnel enrollment functions.
5. Software shall provide a means for disabling the enrollment station when it is unattended, to prevent unauthorized use.
6. Software shall provide a method to enter personnel identifying information into the entry-control database files through enrollment stations to include a credential unit in use at the installation.
7. In the case of personnel identity-verification subsystems, this data shall include biometric data.
8. Software shall allow entry of this data into the system database files through the use of simple menu selections and data fields. The data field names shall be customized to suit user and site needs.
9. Personnel identity-verification subsystems selected for use with the system shall fully support the enrollment function and shall be compatible with the entry-control database files.

D. Accessories:

1. Steel desk-type console, swivel chair on casters, and equipment racks.
2. Console and Equipment Racks: Comply with EIA/ECA-310-E.
3. Equipment, with the exception of the printers, shall be rack mounted in the console and equipment racks.
4. Storage Cabinet: Locking cabinet approximately 72 inches (1830 mm) high, 36 inches (915 mm) wide, and 24 inches (610 mm) deep, with three adjustable shelves and two storage racks.

E. System Capacity: Number of badges shall be limited only by hard disk space. Badge templates and images shall be in color, supporting the maximum color capability of workstation operating system.

F. Badge Configuration:

1. Software for badge template creation shall include a template consisting of background and predetermined locations of photographs, text objects and data fields for text, and bar-code and biometric information. Include automatic sizing of data fields placed on a badge to compensate for names, which may otherwise be too large to fit in the area designated.
2. Allow different badge templates to be used for each department, tenant, or visitor.
3. As a setup option, templates shall be automatically selected for the badge, based on the group to which the credential holder is assigned. Allow the operator to override the automatic template selection and use a template chosen by the operator for creating a badge.
4. Setup shall determine which graphics and credential-holder information will be displayed and where on the card it will be placed. All data in the security access system, such as name, code, group, access level, and any of the 99 user-defined fields, shall be selectable, with the ability to place them anywhere on the card.
5. System shall include an importing, filing, and recall system of stored images and shapes that can be placed on the badge.
6. Allow multiple images on the same badge, including, but not limited to, bar codes, digital photos, and signatures.
7. Support transparent backgrounds so that image is only surrounded by the intended background and not by its immediate background.

G. Photo Imaging: Integral to security access.

1. Import images from bitmap file formats, digital cameras, TWAIN cameras, or scanners. Allow image cropping and editing, WYSIWYG badge-building application, and badge print-preview and printing capabilities.
2. System shall support multiple images stored for each credential holder, including signatures, portrait views, and profile views.

H. Text Objects: Badge configuration shall provide for creation of custom text as an object, allowing font selection, typing, scaling, and formatting of the text object. Formatting options shall include changing font, font size, text flow, and text alignment; bending or curving the text object into a circle or semicircle; applying 3-D effects; and applying predefined effects such as tilt, extrusion, or beveling. Text shall be placed and optionally automatically centered within any region of the badge layout.

I. Badges and Credential Cards:

1. Badges are credential cards that do not contain data to be read by card readers.
2. Credential cards shall store uniquely coded data used by card readers as an Identifier.

    a. Magnetic-Stripe Cards: Comply with ISO/IEC 7810, ISO/IEC 7811-1, ISO/IEC 7811-2, ISO/IEC 7811-6, and ISO/IEC 7811-7. Use single-layer magnetic tape material that is coated with a plastic, slick protective coat and affixed to the back of the credential card near the top.
    b. Wiegand Wire-Effect Cards: Ferromagnetic wires laminated into the credential card using binary digits specified for Wiegand readers to generate a unique credential card identification code.
    c. Proximity **Cards**: Use proximity detection without physical contact with the reader for proper operation.

3. Allow entry-control card to be modified by lamination or direct print process during the enrollment process for use as a picture and identification badge without reduction of readability. The design shall allow for the addition of at least one slot or hole to accommodate the attachment of a clip for affixing the credential card to the type of badge holder used at the site.

    a. Card Size and Dimensional Stability: Standard size, **2-1/8 by 3-3/8 inches (54 by 86 mm)**; dimensionally stable so that an undamaged card with deformations resulting from normal use shall be readable by the card reader.
    b. Card Material: Abrasion resistant, nonflammable, and nontoxic; and impervious to solar radiation and effects of ultraviolet light.
    c. Card Construction: Core and laminate or monolithic construction. Lettering, logos, and other markings shall be hot stamped into the credential material or direct printed.

        1) Incorporate **holographic images** as a security enhancement.
        2) Furnish equipment for on-site assembly and lamination of credential cards.

    d. Card Durability and Maintainability: Designed and constructed to yield a useful lifetime of at least five years or 5000 insertions or swipes, whichever results in a

longer period of time. Allow credential cards to be cleaned by wiping with a sponge or cloth wetted with soap and water.

J. Card-Making Equipment: Consisting of a workstation, video camera, video-imaging equipment, and a printer.

1. Camera: NTSC color standard, RGB video output, 470 lines minimum horizontal resolution, and automatic white balance with full rated output under illumination of 0.5 fc (5 lx).
2. Video Imaging: Live-image capture software and hardware and a digital signature capture pad.
3. Standard workstation, modified as follows:

    a. Redundant workstation is not required.
    b. Printer is not required.
    c. UPS is not required.
    d. Sound card is not required.

4. Printer: Dye-sublimation resin thermal transfer, **300** dpi resolution, 16.7 million colors, accepting cards ranging in size from 2.1 by 3 inches to 2.6 by 3.7 inches (53 by 76 mm to 66 by 94 mm) and having card thickness ranging from 0.020 to 0.060 inch (0.5 to 1.5 mm). Printer shall have options for encoding magnetic stripe using tracks 1, 2, and 3. Throughput shall be not less than **60** seconds per card.

## 2.13 DOOR AND GATE HARDWARE INTERFACE

A. Exit Device with Alarm: Operation of the exit device shall generate an alarm. Exit device and alarm contacts are specified in Section 087100 "Door Hardware."

B. Exit Alarm: Operation of a monitored door shall generate an alarm. Exit devices and alarm contacts are specified in Section 087100 "Door Hardware."

C. Electric Door Strikes: Use end-of-line resistors to provide power-line supervision. Signal switches shall transmit data to controller to indicate when the bolt is not engaged and the strike mechanism is unlocked, and they shall report a forced entry. Power and signal shall be from the controller. Electric strikes are specified in Section 087100 "Door Hardware."

D. Electromagnetic Locks: End-of-line resistors shall provide power-line supervision. Lock status sensing signal shall positively indicate door is secure. Power and signal shall be from the controller. Electromagnetic locks are specified in Section 087100 "Door Hardware."

E. Vehicle Gate Operator: Interface electrical operation of gate with controls in this Section. Vehicle gate operators shall be connected, monitored, and controlled by the security access controllers. Vehicle gate and accessories are specified in Section 323113 "Chain Link Fences and Gates."

## 2.14 FIELD-PROCESSING SOFTWARE

A. Operating System:

1. Local processors shall contain an operating system that controls and schedules that local processor's activities in real time.
2. Local processor shall maintain a point database in its memory that includes parameters, constraints, and the latest value or status of all points connected to that local processor.
3. Execution of local processor application programs shall utilize the data in memory resident files.
4. Operating system shall include a real-time clock function that maintains the seconds, minutes, hours, date, and month, including day of the week.
5. Local processor real-time clock shall be automatically synchronized with the central station at least once per day to plus or minus 10 seconds (the time synchronization shall be accomplished automatically, without operator action and without requiring system shutdown).

B. Startup Software:

1. Causes automatic commencement of operation without human intervention, including startup of all connected I/O functions.
2. Local processor restart program based on detection of power failure at the local processor shall be included in the local processor software.
3. Initiates operation of self-test diagnostic routines.
4. Upon failure of the local processor, if the database and application software are no longer resident, the local processor shall not restart and systems shall remain in the failure mode indicated until the necessary repairs are made.
5. If the database and application programs are resident, the local processor shall immediately resume operation.

C. Operating Mode:

1. Local processors shall control and monitor inputs and outputs as specified, independent of communications with the central station or designated workstations.
2. Alarms, status changes, and other data shall be transmitted to the central station or designated workstations when communications circuits are operable.
3. If communications are not available, each local processor shall function in a stand-alone mode and operational data, including the status and alarm data normally transmitted to the central station or designated workstations, shall be stored for later transmission to the central station or designated workstations.
4. Storage for the latest 4000 events shall be provided at local processors, as a minimum.
5. Local processors shall accept software downloaded from the central station.
6. Panel shall support flash ROM technology to accomplish firmware downloads from a central location.

D. Failure Mode: Upon failure for any reason, each local processor shall perform an orderly shutdown and force all local processor outputs to a predetermined (failure-mode) state, consistent with the failure modes shown and the associated control device.

E. Functions:

1. Monitoring of inputs.
2. Control of outputs.
3. Reporting of alarms automatically to the central station.
4. Reporting of sensor and output status to central station upon request.

5. Maintenance of real time, automatically updated by the central station at least once a day.
6. Communication with the central station.
7. Execution of local processor resident programs.
8. Diagnostics.
9. Download and upload data to and from the central station.

## 2.15 FIELD-PROCESSING HARDWARE

A. Alarm Annunciation Local Processor:

1. Respond to interrogations from the field device network, recognize and store alarm status inputs until they are transmitted to the central station, and change outputs based on commands received from the central station.
2. Local processor shall also automatically restore communication within 10 seconds after an interruption with the field device network and provide dc line supervision on each of its alarm inputs.
3. Local processor inputs shall monitor dry contacts for changes of state that reflect alarm conditions.
4. Local processor shall have at least eight alarm inputs which allow wiring contacts as normally open or normally closed for alarm conditions; and shall provide line supervision for each input by monitoring each input for abnormal open, grounded, or shorted conditions using dc current change measurements.
5. Local processor shall report line supervision alarms to the central station.
6. Alarms shall be reported for any condition that remains abnormal at an input for longer than 500 milliseconds.
7. Alarm condition shall be transmitted to the central computer during the next interrogation cycle.
8. Local processor outputs shall reflect the state of commands issued by the central station.
9. Outputs shall be a form C contact and shall include normally open and normally closed contacts.
10. Local processor shall have at least four command outputs.
11. Local processor shall be able to communicate with the central station via RS-485 or TCP/IP as a minimum.

B. Processor Power Supply:

1. Local processor and sensors shall be powered from an uninterruptible power source.
2. Uninterruptible power source shall provide eight hours of battery back-up power in the event of primary power failure and shall automatically fully recharge the batteries within 12 hours after primary power is restored.
3. If the facility is without an emergency generator, the uninterruptible power source shall provide 24 hours of battery backup power.
4. There shall be no equipment malfunctions or perturbations or loss of data during the switch from primary to battery power and vice versa.
5. Batteries shall be sealed, non-outgassing type.
6. Power supply shall be equipped with an indicator for ac input power and an indicator for dc output power.
7. Loss of primary power shall be reported to the central station as an alarm.

C. Auxiliary Equipment Power: A GFI service outlet shall be furnished inside the local processor's enclosure.

D. Entry-Control Local Processor:

1. Entry-control local processor shall respond to interrogations from the field device network, recognize and store alarm status inputs until they are transmitted to the central station, and change outputs based on commands received from the central station.
2. Local processor shall also automatically restore communication within 10 seconds after an interruption with the field device network and provide dc line supervision on each of its alarm inputs.
3. Entry-control local processor shall provide local entry-control functions including communicating with field devices such as card readers, keypads, biometric personnel identity-verification devices, door strikes, magnetic latches, gate and door operators, and exit push buttons.
4. Processor shall also accept data from entry-control field devices as well as database downloads and updates from the central station that include enrollment and privilege information.
5. Processor shall send indications of successful or failed attempts to use entry-control field devices and shall make comparisons of presented information with stored identification information.
6. Processor shall grant or deny entry by sending control signals to portal-control devices and mask intrusion-alarm annunciation from sensors stimulated by authorized entries.
7. Entry-control local processor shall use inputs from entry-control devices to change modes between access and secure.
8. Local processor shall maintain a date-time- and location-stamped record of each transaction and transmit transaction records to the central station.
9. Processor shall operate as a stand-alone portal controller using the downloaded database during periods of communication loss between the local processor and the central station.
10. Processor shall store a minimum of 4000 transactions during periods of communication loss between the local processor and the central station for subsequent upload to the central station upon restoration of communication.
11. Local processor inputs shall monitor dry contacts for changes of state that reflect alarm conditions.
12. Local processor shall have at least eight alarm inputs which allow wiring contacts as normally open or normally closed for alarm conditions; and shall also provide line supervision for each input by monitoring each input for abnormal open, grounded, or shorted conditions using dc current change measurements.
13. Local processor shall report line supervision alarms to the central station.
14. Alarms shall be reported for any condition that remains abnormal at an input for longer than 500 ms.
15. Alarm condition shall be transmitted to the central station during the next interrogation cycle.
16. Entry-control local processor shall include the necessary software drivers to communicate with entry-control field devices. Information generated by the entry-control field devices shall be accepted by the local processor and automatically processed to determine valid identification of the individual present at the portal.
17. Upon authentication of the credentials or information presented, the local processor shall automatically check privileges of the identified individual, allowing only those actions granted as privileges.

18. Privileges shall include, but are not limited to, time of day control, day of week control, group control, and visitor escort control. The local processor shall maintain a date-time- and location-stamped record of each transaction.
19. Transaction is defined as any successful or unsuccessful attempt to gain access through a controlled portal by the presentation of credentials or other identifying information.
20. Local processor outputs shall reflect the state of commands issued by the central station.
21. Outputs shall be a form C contact and shall include normally open and normally closed contacts.
22. Local processor shall have at least four addressable outputs.
23. The entry-control local processor shall also provide control outputs to portal-control devices.
24. Local processor shall be able to communicate with the central station via RS-485 or TCP/IP as a minimum.
25. The system manufacturer shall provide strategies for downloading database information for panel configurations and cardholder data to minimize the required download time when using IP connectivity.

## 2.16 TIA 232-F ASCII INTERFACE SPECIFICATIONS

A. ASCII interface shall allow TIA 232-F connections to be made between the control station operating as the host workstation and any equipment that will accept TIA 232-F ASCII command strings, such as CCTV switches, intercoms, and paging systems.

1. Alarm inputs in system shall allow for individual programming to output up to four unique ASCII character strings through two different COM ports on the host workstation.
2. Inputs shall have the ability to be defined to transmit a unique ASCII string for alarm and one for restore through one COM port, and a unique ASCII string for a nonalarm, abnormal condition and one for a normal condition through the same or different COM port.
3. Predefined ASCII character strings shall have the ability to be up to 420 characters long with full use of all the ASCII control characters, such as return or line feed. Character strings shall be defined in the system database and then assigned to the appropriate inputs.
4. COM ports of the host workstation used to interface with external equipment shall be defined in the setup portion of the software. COM port's baud rate, word length, stop bits, and parity shall be definable in the software to match that of the external equipment.

B. Pager-System Interface: Alarms shall be able to activate a pager system with customized message for each input alarm.

1. TIA 232-F output shall be capable of connection to a pager interface that can be used to call a paging system or service and send a signal to a portable pager. System shall allow an individual alphanumeric message per alarm input to be sent to the paging system. This interface shall support both numeric and alphanumeric pagers.

C. Alarm-System Interface:

1. TIA 232-F output shall be capable of transmitting alarms from other monitoring and alarm systems to central-station automation software.

2. Alternatively, alarms that are received by this access-control system are to be transferred to the alarm automation system as if they were sent through a digital alarm receiver.

    a. System shall be able to transmit an individual message from any alarm input to a burglar-alarm automation monitoring system.
    b. System shall be able to append to each message a predefined set of character strings as a prefix and a suffix.

## 2.17 FLOOR-SELECT ELEVATOR CONTROL

A. Elevator access control shall be integral to security access.

1. System shall be capable of providing full elevator security and control through dedicated controllers without relying on the control-station host workstation for elevator control decisions.
2. Access-control system shall enable and disable car calls on each floor and floor-select buttons in each elevator car, restricting passengers' access to the floors where they have been given access.
3. System setup shall, through programming, automatically and individually secure and unsecure each floor-select button of a car by time and day. Each floor-select button within a car shall be separately controlled so that some floors may be secure while others remain unsecure.
4. When a floor-select button is secure, it shall require the passenger to use his or her access code and gain access to that floor before the floor-select button will operate. The passenger's credential shall determine which car call and floor-select buttons are to be enabled, restricting access to floors unless authorized by the system's access code database. Floor-select button shall be enabled only in the car where the credential holder is the passenger.

B. Security access system shall record which call button is pressed, along with credential and time information.

1. System controller shall record elevator access data.
2. The controller shall reset all additional call buttons that may have been enabled by the user's credential.
3. The floor-select elevator control shall allow for manual override from a workstation workstation either by individual floor or by cab.

## 2.18 REAL-TIME GUARD TOUR

A. Guard tour module shall provide the ability to plan, track, and route tours. Module shall input an alarm during tour if guard fails to make a station. Tours can be programmed for sequential or random tour-station order.

1. Guard tour setup shall define specific routes or tours for the guard to take, with time restrictions in which to reach every predefined tour station.
2. Guard tour activity shall be automatically logged to the central-station workstation's hard drive.

3. If the guard is early or late to a tour station, a unique alarm per station shall appear at the central station to indicate the time and station.
4. Guard tour setup shall allow the tours to be executed sequentially or in a random order with an overall time limit set for the entire tour instead of individual times for each tour station.
5. Setup shall allow recording of predefined responses that will display for the operator at the control station should a "Failed to Check In" alarm occur.

B. Guard tour module shall allow proprietary direct-connected systems to use security access-control hardware to perform guard tour management in real time.

C. A tour station is a physical location where a guard shall go and perform an action indicating that he or she has arrived. This action, performed at the tour station, shall be one of 13 different events with any combination of station types within the same tour. An event at a tour station shall be one of the following types:

1. Access Granted.
2. Access Denied Code.
3. Access Denied Card plus PIN.
4. Access Denied Time Zone.
5. Access Denied Level.
6. Access Denied Facility.
7. Access Denied Code Timer.
8. Access Denied Anti-Passback.
9. Access Granted Passback Violation.
10. Alarm.
11. Restored.
12. Input Normal.
13. Input Abnormal.

D. Guard tour and other system features shall operate simultaneously with no interference.

E. Guard Tour Module Capacity: 999 possible guard tour definitions with each tour having up to 99 tour stations. System shall allow all 999 tours to be running at the same time.

## 2.19 VIDEO AND CAMERA CONTROL

A. Control station or designated workstation displays live video from a CCTV source.

1. Control Buttons: On the display window, with separate control buttons to represent Left, Right, Up, Down, Zoom In, Zoom Out, Scan, and a minimum of two custom-command auxiliary controls.
2. Provide at least seven icons to represent different types of cameras, with ability to import custom icons. Provide option for display of icons on graphic maps to represent their physical location.
3. Provide the alarm-handling window with a command button that will display the camera associated with the alarm point.

B. Display mouse-selectable icons representing each camera source, to select source to be displayed. For CCTV sources that are connected to a video switcher, control station shall

automatically send control commands through a COM port to display the requested camera when the camera icon is selected.

C. Allow cameras with preset positioning to be defined by displaying a different icon for each of the presets. Provide control with Next and Previous buttons to allow operator to cycle quickly through the preset positions.

## 2.20 TRANSFORMERS

A. NFPA 70, Class II control transformers, NRTL listed. Transformers for security access-control system shall not be shared with any other system.

## 2.21 CABLE AND ASSET MANAGEMENT SOFTWARE

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Computer-based cable and asset management system, with fully integrated database and graphic capabilities, complying with requirements in TIA 606-B.

1. Document physical characteristics by recording the network, asset, user, TIA details, device configurations, and exact connections between equipment and cabling.

    a. Manage the physical layer of security system.
    b. List device configurations.
    c. List and display circuit connections.
    d. Record firestopping data.
    e. Record grounding and bonding connections and test data.

2. Information shall be presented in database view, schematic plans, or technical drawings.

    a. Microsoft Visio Technical Drawing shall be used as drawing and schematic plans software. Drawing symbols, system layout, and design shall comply with SIA/IAPSC AG-01.

3. System shall interface with the following testing and recording devices:

    a. Direct-upload tests from circuit testing instrument into the workstation.
    b. Direct-download circuit labeling into labeling printer.

C. Software shall be designed for <**Insert type of software and version**> of the same version as security access system's central station and workstations and shall be installed on the designated workstation, using a hard drive dedicated only to this management function.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine roughing-in for LAN and control cable conduit systems to workstations, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

A. Comply with recommendations in SIA CP-01.

B. Comply with TIA 606-B, "Administration Standard for Commercial Telecommunications Infrastructure."

C. Product Schedules: Obtain detailed product schedules from manufacturer of access-control system or develop product schedules to suit Project. Fill in all data available from Project plans and specifications and publish as Product Schedules for review and approval.

1. Record setup data for control station and workstations.
2. For each Location, record setup of controller features and access requirements.
3. Propose start and stop times for time zones and holidays, and match up access levels for doors.
4. Set up groups, facility codes, linking, and list inputs and outputs for each controller.
5. Assign action message names and compose messages.
6. Set up alarms. Establish interlocks between alarms, intruder detection, and video surveillance features.
7. Prepare and install alarm graphic maps.
8. Develop user-defined fields.
9. Develop screen layout formats.
10. Propose setups for guard tours and key control.
11. Discuss badge layout options; design badges.
12. Complete system diagnostics and operation verification.
13. Prepare a specific plan for system testing, startup, and demonstration.
14. Develop acceptance test concept and, on approval, develop specifics of the test.
15. Develop cable and asset-management system details; input data from construction documents. Include system schematics and Visio Technical Drawings in electronic format <**Insert software**>.

D. In meetings with Architect and Owner, present Product Schedules and review, adjust, and prepare final setup documents. Use approved, final Product Schedules to set up system software.

## 3.3 IDENTIFICATION

A. In addition to requirements in this article, comply with applicable requirements in Section 270553 "Identification for Communications Systems" and with TIA 606-B.

B. Using software specified in "Cable and Asset Management Software" Article, develop cable administration drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with the same designation. Use logical and systematic designations for facility's architectural arrangement.

C. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.

D. At completion, cable and asset management software shall reflect as-built conditions.

## 3.4 SYSTEM SOFTWARE AND HARDWARE

A. Develop, install, and test software and hardware, and perform database tests for the complete and proper operation of systems involved. Assign software license to Owner.

## 3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to supervise and assist with startup service.

1. Complete installation and startup checks according to approved procedures that were developed in "Preparation" Article and with manufacturer's written instructions.
2. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.

## 3.6 PROTECTION

A. Maintain strict security during the installation of equipment and software. Rooms housing the control station, and workstations that have been powered up shall be locked and secured with an activated burglar alarm and access-control system reporting to a central station complying with UL 1610, "Central-Station Burglar-Alarm Units," during periods when a qualified operator in the employ of Contractor is not present.

## 3.7 DEMONSTRATION

A. **Train** Owner's maintenance personnel to adjust, operate, and maintain security access system. See Section 017900 "Demonstration and Training."

B. Develop separate training modules for the following:

1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.
2. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel.
3. Security personnel.
4. Hardware maintenance personnel.
5. Corporate management.

END OF SECTION 281300

# SECTION 281500 - ACCESS CONTROL HARDWARE DEVICES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Card readers, credential cards, and keypads
2. Biometric identity-verification equipment
3. Cables
4. Transformers

B. Related Requirements:

1. Section 281300 "Access Control System Software and Database Management" for control and monitoring applications, workstations, and interfaces.

### 1.3 DEFINITIONS

A. Credential: Data assigned to an entity and used to identify that entity.

B. DTS: Digital Termination Service. A microwave-based, line-of-sight communication provided directly to the end user.

C. Identifier: A credential card; keypad personal identification number; or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.

D. Location: A Location on the network having a PC-to-controller communications link, with additional controllers at the Location connected to the PC-to-controller link with a TIA 485-A communications loop. Where this term is presented with an initial capital letter, this definition applies.

E. PC: Personal computer. Applies to the central station, workstations, and file servers.

F. RAS: Remote access services.

G. RF: Radio frequency.

H. ROM: Read-only memory. ROM data is maintained through losses of power.

I. TCP/IP: Transport control protocol/Internet protocol.

J. TWAIN: Technology without an Interesting Name. A programming interface that lets a graphics application, such as an image editing program or desktop publishing program, activate a scanner, frame grabber, or other image-capturing device.

K. WMP: Windows media player.

L. Wiegand: Patented magnetic principle that uses specially treated wires embedded in the credential card.

M. WYSIWYG: What You See Is What You Get. Text and graphics appear on the screen the same as they will in print.

## 1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Reference each product to a location on Drawings. Test and evaluation data presented in Product Data shall comply with SIA BIO-01.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Diagrams for cable management system.
2. System labeling schedules, including electronic copy of labeling schedules that are part of the cable and asset identification system of the software specified in Parts 2 and 3.
3. Wiring Diagrams. For power, signal, and control wiring. Show typical wiring schematics including the following:

    a. Workstation outlets, jacks, and jack assemblies.
    b. Patch cords.
    c. Patch panels.

4. Cable Administration Drawings: As specified in "Identification" Article.
5. Battery and charger calculations for central station, workstations, and controllers.

C. Product Schedules.

D. Samples: For workstation outlets, jacks, jack assemblies, and faceplates. For each exposed product and for each color and texture specified.

## 1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

## 1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For security system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on **USB** media of the hard-copy submittal.
2. System installation and setup guides with data forms to plan and record options and setup decisions.

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Credential card blanks, ready for printing. Include enough credential cards for all personnel to be enrolled at the site plus an extra **50** percent for future use.
2. Fuses of all kinds, power and electronic, equal to 1**0** percent of amount installed for each size used, but no fewer than three units.
3.

## 1.8 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

1. Cable installer must have on staff an RCDD certified by Building Industry Consulting Service International.

B. Source Limitations: Obtain central station, workstations, controllers, Identifier readers, and all software through one source from single manufacturer.

## 1.9 DELIVERY, STORAGE, AND HANDLING

A. Store in temperature- and humidity-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 50 and 85 deg F (10 and 30 deg C), and not more than 80 percent relative humidity, noncondensing.

B. Open each container; verify contents against packing list; and file copy of packing list, complete with container identification, for inclusion in operation and maintenance data.

C. Mark packing list with the same designations assigned to materials and equipment for recording in the system labeling schedules that are generated by software specified in "Cable and Asset Management Software" Article.

D. Save original manufacturer's containers and packing materials and deliver as directed under provisions covering extra materials.

1.10 PROJECT CONDITIONS

A. Environmental Conditions: System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Control Station: Rated for continuous operation in ambient conditions of 60 to 85 deg F (16 to 30 deg C) and a relative humidity of 20 to 80 percent, noncondensing.
2. Indoor, Controlled Environment: NEMA 250, Type 1 enclosure. System components, except the central-station control unit, installed in **temperature-controlled** indoor environments shall be rated for continuous operation in ambient conditions of **36 to 122 deg F (2 to 50 deg C)** dry bulb and 20 to 90 percent relative humidity, noncondensing.
3. Indoor, Uncontrolled Environment: NEMA 250, **Type 3R** enclosures. System components installed in **non-temperature-controlled** indoor environments shall be rated for continuous operation in ambient conditions of **0 to 122 deg F (minus 18 to plus 50 deg C)** dry bulb and 20 to 90 percent relative humidity, noncondensing.
4. Outdoor Environment: NEMA 250, NEMA 250, **Type 4X** enclosures. System components installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of **minus 30 to plus 122 deg F (minus 34 to plus 50 deg C)**] dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation where exposed to rain as specified in NEMA 250, winds up to 85 mph (137 km/h)
5. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.
6. Corrosive Environment: For system components subjected to corrosive fumes, vapors, and wind-driven salt spray in coastal zones, provide NEMA 250, **Type 4X** enclosures.

PART 2 - PRODUCTS

2.1 OPERATION

A. Security access system hardware shall use a single database for access-control and credential-creation functions.

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. Comply with NFPA 70, "National Electrical Code."

C. Comply with **SIA DC-01 and** SIA DC-03.

2.3 CARD READERS, CREDENTIAL CARDS, AND KEYPADS

A. Basis of design is HID or approved equal.

B. Contractor to provide 100 access control cards for the end user.

C. Card-Reader Power: Powered from its associated controller, including its standby power source, and shall not dissipate more than 5 W.

D. Response Time: Card reader shall respond to passage requests by generating a signal that is sent to the controller. Response time shall be 800 ms or less, from the time the card reader finishes reading the credential card until a response signal is generated.

E. Enclosure: Suitable for surface, semi-flush, pedestal, or weatherproof mounting. Mounting types shall additionally be suitable for installation in the following locations:

1. Indoors, controlled environment.
2. Indoors, uncontrolled environment.
3. Outdoors, with built-in heaters or other cold-weather equipment to extend the operating temperature range as needed for operation at the site.

F. Display: Digital visual indicator shall provide visible and audible status indications and user prompts. Indicate power on or off, whether user passage requests have been accepted or rejected, and whether the door is locked or unlocked.

G. Wiegand Swipe Reader: Set up for **26**-bit data cards. Comply with SIA AC-01.

H. Insert Readers: Requiring the card to be inserted from the **side**, powered by the controller.

I. Touch-Plate and Proximity Readers:

1. Active-detection proximity card readers shall provide power to compatible credential cards through magnetic induction, and shall receive and decode a unique identification code number transmitted from the credential card.
2. Passive-detection proximity card readers shall use a swept-frequency, RF field generator to read the resonant frequencies of tuned circuits laminated into compatible credential cards. The resonant frequencies read shall constitute a unique identification code number.
3. The card reader shall read proximity cards in a range from direct contact to at least 6 inches (150 mm) from the reader.

J. Keypads:

1. Entry-control keypads shall use a unique combination of alphanumeric and other symbols as an Identifier.
2. Keypads shall contain an integral alphanumeric/special symbols keyboard with symbols arranged in **ascending ASCII-code ordinal sequence**.
3. Communication protocol shall be compatible with the local processor.

K. Keypad Display:

1. Keypads shall include a digital visual indicator and shall provide **visible and audible** status indications and user prompts.
2. Display shall indicate power on or off and whether user passage requests have been accepted or rejected.

3. Design of the keypad display or keypad enclosure shall limit viewing angles of the keypad as follows:

    a. Maximum Horizontal Viewing Angle: Plus or minus 5 degrees or less off a vertical plane perpendicular to the plane of the face of the keypad display.
    b. Maximum Vertical Viewing Angle: Plus or minus 15 degrees or less off a horizontal plane perpendicular to the plane of the face of the keypad display.

L. Keypad Response Time:

1. The keypad shall respond to passage requests by generating a signal to the local processor. The response time shall be 800 ms or less from the time the last alphanumeric symbol is entered until a response signal is generated.

M. Keypad Power:

1. The keypad shall be powered from the source as shown and shall not dissipate more than 150 W.

N. Keypad Mounting Method:

1. Keypads shall be suitable for surface, semi-flush, pedestal, or weatherproof mounting as required.

O. Keypad Duress Codes:

1. Keypads shall provide a means for users to indicate a duress situation by entering a special code.

P. Keypad and Wiegand-Swipe-Reader Combination: Designed to require an entry on the keypad before presenting the credential card.

1. Keypad: Allow the entry of four **numeric digits** that are associated with a specific credential. Keypads shall contain an integral alphanumeric/special symbol keyboard with symbols arranged in **ascending ASCII-code ordinal sequence**. Keypad display or enclosure shall limit viewing angles of the keypad as follows:

    a. Maximum Horizontal Viewing Angle: Plus or minus 5 degrees or less off a vertical plane perpendicular to the plane of the face of the keypad display.
    b. Maximum Vertical Viewing Angle: Plus or minus 15 degrees or less off a horizontal plane perpendicular to the plane of the face of the keypad display.

2. Wiegand Swipe Reader: Set up for **26**-bit data cards to generate a unique card identification code. Comply with SIA AC-01.

Q. Communication Protocol: Compatible with local processor.

R. Touch-Plate and Contactless Card Reader: The reader shall have "flash" download capability to accommodate card format changes. The card reader shall have capability of transmitting data to security control panel and shall comply with ISO/IEC 7816.

S. Credential Card Modification: Entry-control cards shall be able to be modified by lamination direct print process during the enrollment process without reduction of readability. The design of the credential cards shall allow for the addition of at least one slot or hole to accommodate the attachment of a clip for affixing the credential card to the badge holder used at the site.

T. Card Size and Dimensional Stability: Credential cards shall be **2-1/8 by 3-3/8 inches (54 by 86 mm)**. The credential card material shall be dimensionally stable so that an undamaged card with deformations resulting from normal use shall be readable by the card reader.

U. Card Material: Abrasion resistant, nonflammable, nontoxic, and impervious to solar radiation and effects of ultraviolet light.

V. Card Construction:

1. Core and laminate or monolithic construction.
2. Lettering, logos, and other markings shall be hot stamped into the credential material or direct printed.
3. Incorporate **holographic images** as a security enhancement.
4. Furnish equipment for on-site assembly and lamination of credential cards.

## 2.4 PUSH-BUTTON SWITCHES

A. Push-Button Switches: Momentary-contact back-lighted push buttons with stainless steel switch enclosures.

B. Electrical Ratings:

1. Minimum continuous current rating of **10** A at 120-V ac or 5 A at 240-V ac.
2. Contacts that will make 720 VA at **60** A and that will break at 720 VA at **10** A.

C. Enclosures: Flush or surface mounting. Push buttons shall be suitable for flush mounting in the switch enclosures.

D. Enclosures shall additionally be suitable for installation in the following locations:

1. Indoors, controlled environment.
2. Indoors, uncontrolled environment.
3. Outdoors.

E. Power: Push-button switches shall be powered from their associated controller, using dc control.

## 2.5 CABLES

A. General Cable Requirements: Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and as recommended by system manufacturer for integration requirement.

B. PVC-Jacketed, TIA 232-F.

1. **Three** No. 22 AWG, stranded (7x30) tinned copper conductors.

2. Polypropylene insulation.
3. Aluminum foil-polyester tape shield with 100 percent shield coverage.
4. PVC jacket.
5. Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
6. Flame Resistance: Comply with UL 1581.

C. Plenum-Rated TIA 232-F Cables:

1. **Three** No. 22 AWG, stranded (7x30) tinned copper conductors.
2. PE insulation.
3. Aluminum foil-polyester tape shield with 100 percent shield coverage.
4. Fluorinated ethylene propylene jacket.
5. Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
6. Flame Resistance: Comply with NFPA 262.

D. PVC-Jacketed, TIA 485-A Cables:

1. Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. NFPA 70 Type: Type CM.
6. Flame Resistance: Comply with UL 1581.

E. Plenum-Rated TIA 485-A Cables:

1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. NFPA 70 Type: Type CMP
6. Flame Resistance: NFPA 262, Flame Test.

F. Multiconductor, PVC, Reader and Wiegand Keypad Cables:

1. No. 22 AWG, paired and twisted multiple conductors, stranded (7x30) tinned copper conductors, semirigid PVC insulation, overall aluminum-foil/polyester-tape shield with 100 percent shield coverage, plus tinned copper braid shield with 65 percent shield coverage, and PVC jacket.
2. NFPA 70, Type CMG.
3. Flame Resistance: UL 1581 vertical tray.
4. For TIA 232-F applications.

G. Paired, PVC, Reader and Wiegand Keypad Cables:

1. Three pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, individual aluminum-foil/polyester-tape shielded pairs each with No. 22 AWG, stranded tinned copper drain wire, 100 percent shield coverage, and PVC jacket.

2. NFPA 70, Type CM.
3. Flame Resistance: UL 1581 vertical tray.

H. Paired, PVC, Reader and Wiegand Keypad Cables:

1. Three pairs, twisted, No. 20 AWG, stranded (7x28) tinned copper conductors, polyethylene (polyolefin) insulation, individual aluminum-foil/polyester-tape shielded pairs each with No. 22 AWG, stranded (19x34) tinned copper drain wire, 100 percent shield coverage, and PVC jacket.
2. NFPA 70, Type CM.
3. Flame Resistance: UL 1581 vertical tray.

I. Paired, Plenum-Type, Reader and Wiegand Keypad Cables:

1. Three pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, individual aluminum-foil/polypropylene-tape shielded pairs each with No. 22 AWG, stranded tinned copper drain wire, 100 percent shield coverage, and fluorinated-ethylene-propylene jacket.
2. NFPA 70, Type CMP.
3. Flame Resistance: NFPA 262 flame test.

J. Multiconductor, Plenum-Type, Reader and Wiegand Keypad Cables:

1. Six conductors, No. 20 AWG, stranded (7x28) tinned copper conductors, fluorinated-ethylene-propylene insulation, overall aluminum-foil/polyester-tape shield with 100 percent shield coverage plus tinned copper braid shield with 85 percent shield coverage, and fluorinated-ethylene-propylene jacket.
2. NFPA 70, Type CMP.
3. Flame Resistance: NFPA 262 flame test.

K. LAN Cabling:

1. Comply with requirements in Section 271513 "Communications Copper Horizontal Cabling."

## 2.6 TRANSFORMERS

A. NFPA 70, Class II control transformers, NRTL listed. Transformers for security access-control system shall not be shared with any other system.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine roughing-in for LAN and control cable conduit systems to PCs, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

A. Comply with recommendations in SIA CP-01.

B. Comply with TIA 606-B, "Administration Standard for Commercial Telecommunications Infrastructure."

C. Product Schedules: Obtain detailed product schedules from manufacturer of access-control system or develop product schedules to suit Project. Fill in all data available from Project plans and specifications and publish as Product Schedules for review and approval.

D. In meetings with Architect and Owner, present Product Schedules and review, adjust, and prepare final setup documents. Use approved, final Product Schedules to set up system software.

## 3.3 CABLING

A. Comply with NECA 1, "Good Workmanship in Electrical Construction."

B. Install cables and wiring according to requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.

D. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use NRTL-listed plenum cable in environmental airspaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.

E. Install LAN cables using techniques, practices, and methods that are consistent with Category 5e rating of components and optical fiber rating of components, and that ensure Category 6 and optical fiber performance of completed and linked signal paths, end to end.

F. Boxes and enclosures containing security-system components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.

G. Install end-of-line resistors at the field device location and not at the controller or panel location.

## 3.4 CABLE APPLICATION

A. Comply with TIA 569-D, "Commercial Building Standard for Telecommunications Pathways and Spaces."

B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.

C. TIA 232-F Cabling: Install at a maximum distance of 50 ft. (15 m) between terminations.

D. TIA 485-A Cabling: Install at a maximum distance of 4000 ft. (1220 m) between terminations.

E. Card Readers and Keypads:

1. Install number of conductor pairs recommended by manufacturer for the functions specified.
2. Unless manufacturer recommends larger conductors, install No. 22 AWG wire if maximum distance from controller to the reader is 250 ft. (75 m), and install No. 20 AWG wire if maximum distance is 500 ft. (150 m).
3. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the controller.
4. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.

F. Install minimum No. 16 AWG cable from controller to electrically powered locks. Do not exceed **500 ft. (150 m)** between terminations.

G. Install minimum No. 18 AWG ac power wire from transformer to controller, with a maximum distance of **150 ft.** between terminations.

## 3.5 GROUNDING

A. Comply with Section 270526 "Grounding and Bonding for Communications Systems."

B. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."

C. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

D. Bond shields and drain conductors to ground at only one point in each circuit.

E. Signal Ground:

1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
2. Bus: Mount on wall of main equipment room with standoff insulators.
3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

## 3.6 INSTALLATION

A. Install card readers, keypads, push buttons, and biometric readers.

## 3.7 IDENTIFICATION

A. In addition to requirements in this article, comply with applicable requirements in Section 270553 "Identification for Communications Systems" and with TIA 606-B.

B. Using software specified in "Cable and Asset Management Software" Article, develop cable administration drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with the same designation. Use logical and systematic designations for facility's architectural arrangement.

C. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.

D. At completion, cable and asset management software shall reflect as-built conditions.

## 3.8 SYSTEM SOFTWARE AND HARDWARE

A. Develop, install, and test software and hardware, and perform database tests for the complete and proper operation of systems involved. Assign software license to Owner.

## 3.9 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. LAN Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts. Use tester approved for type and kind of installed cable. Test for faulty connectors, splices, and terminations. Test according to TIA 568-C.1, "Commercial Building Telecommunications Cabling Standards - Part 1: General Requirements." Link performance for balanced twisted-pair cables must comply with minimum criteria in TIA 568-C.1.
2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power-supply output under maximum load, signal loop resistance,

and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.

3. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.

C. Devices and circuits will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

## 3.10 STARTUP SERVICE

A. Engage a factory-authorized service representative to supervise and assist with startup service.

1. Complete installation and startup checks according to approved procedures that were developed in "Preparation" Article and with manufacturer's written instructions.
2. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.

## 3.11 DEMONSTRATION

A. **Train** Owner's maintenance personnel to adjust, operate, and maintain security access system. See Section 017900 "Demonstration and Training."

B. Develop separate training modules for the following:

1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.
2. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel.
3. Security personnel.
4. Hardware maintenance personnel.
5. Corporate management.

END OF SECTION 281500

SECTION 281600 - INTRUSION DETECTION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 00 and Division 01 Specifications Sections, apply to this Section.

B. Door Hardware

1.2 SUMMARY

A. Section includes intrusion detection with communication links to perform monitoring, alarm, and control functions.

B. System must fully integrate with section Video Management System and CCTV System.

C. The security system shall be an electronically operated, supervised system of modular design utilizing addressable technology for remote devices. System includes control panel, door contacts, break glass sensors, keypads, power supplies and batteries, phone line dialer, supervised wiring, etc. as required for a complete and operational system.

D. The scope includes all hardware, software, training and services required to provide a fully operational system, programmed to the Owner’s requirements and containing all software and licenses required to perform the specified functions.

1.3 SCOPE OF WORK

A. Furnish and install a complete Intrusion Detection/Access Control system with the performance criteria detailed in this specification. The system shall be inclusive of all necessary functions, monitoring, and control capability as detailed herein and on accompanying Shop drawings.
   1. On-site or remote video monitoring
   2. Power loss detection and monitoring, generator switching

B. This specification document provides the requirements for the installation, programming, and configuration of a complete DMP panel. This system shall include, but not be limited to:
   1. Control panel
   2. System cabinet
   3. Power supply
   4. Digital Signaling Line Circuits (SLC)
   5. Notification Appliance Circuits (NAC)
   6. Annunciator/keypad bus
   7. Batteries
   8. Wiring

9. Conduit
10. Associated peripheral devices
11. Other relevant components and accessories required to furnish and install a complete and operational addressable reporting Life Safety System.

## 1.4 DEFINITIONS

A. Control Unit: System component that monitors inputs and controls outputs through various circuits.

B. Master Control Unit: System component that accepts inputs from other control units and may also perform control-unit functions. The unit has limited capacity for the number of protected zones and is installed at an unattended location or at a location where it is not the attendant's primary function to monitor the security system.

C. Monitoring Station: Facility that receives signals and has personnel in attendance at all times to respond to signals. A central station is a monitoring station that is listed.

D. Standard Intruder: A person who weighs 100 lb (45 kg) or less and whose height is 60 inches (1525 mm) or less; dressed in a long-sleeved shirt, slacks, and shoes.

E. Standard-Intruder Movement: Any movement, such as walking, running, crawling, rolling, or jumping, of a "standard intruder" in a protected zone.

## 1.5 SECTION DESCRIPTION

A. Intrusion Detection System.

B. Operation of any addressable perimeter protection device shall initiate the following:

1. Display alarm condition on LCD keypad display.
2. Provide audible annunciation via indoor/outdoor master siren.
3. Arm/disarm specific zones/partitions from any system keypad.
4. Transmit a signal over supervised telephone lines to a central station or security monitor service as coordinated with Owner via a digital dialer.

C. Uninterruptible Power Supply (UPS).

## 1.6 QUALITY ASSURANCE

A. National Fire Protection Association.

B. National Electric Code. NFPA 70

C. NFPA 72 Local Protective Signaling

D. NFPA 72 Remote Station Protective Signaling

E. American with Disabilities Act.

F. Underwriter's Laboratory.

G. Latest ANSI TIA/EIA-568, 569, 606, 607 Standards and Tenth Edition (or later). BICSI Telecommunications Distribution Methods Manual (TDMM).

H. UL 1610 -- Central-Station Burglar-Alarm Units.

I. UL 1023 -- Standard for Safety Household Burglar-Alarm System Units.

J. UL 609 -- Standard for Safety Local Burglar Alarm Units and Systems.

K. UL 365 -- Standard for Safety Police Station Connected Burglar Alarm Units and Systems.

L. UL 1023 -- Household Fire Warning System Units.

M. UL 1635 -- Digital Burglar Alarm Communicator System Units

N. UL 294 -- Access Control System Units

O. AES Algorithm Certificate #2350 128

P. AES Algorithm Certificate #2595 256

Q. All equipment described herein shall be the product of a manufacturer of established reputation and experience, who shall have produced similar equipment for a period of at least 2 years and who shall be able to refer to similar installations within a 75 mile radius now rendering satisfactory service.

R. The manufacturer and their local agent shall show satisfactory evidence upon request that they maintain a fully equipped service center capable of furnishing adequate inspection and service to the equipment including standard replacement parts. The manufacturer and /or agent shall be prepared to offer a service contract for the maintenance of the system after the warranty period.

S. To establish continuity in the manufacturer, systems components shall be the standard product of one manufacturer. Further, an effort shall be made to establish common sources for equipment of all systems. The manufacturer will have a minimum of five (5) years' experience in the manufacture of progressive products specified.

T. All materials furnished under this contract shall be new, of highest quality and shall be of a regularly manufactured line, currently in production at the time of installation.

## 1.7 CONTRACTOR QUALIFICATIONS

A. The Security Management System shall be furnished, installed and programmed by a contractor who meets all the requirements listed herein. It shall not be acceptable for the SMS contractor to utilize a sub contractor for any portion of the work, unless the sub contractor has been approved in writing by the Engineer based upon adherence to the qualifications listed herein.

B. The Contractor shall maintain a fully equipped, factory certified service organization capable of providing full maintenance and service of the installed system within 24 hours. This facility shall be available for inspection by the Engineer.

C. The Contractor shall employ factory trained service personnel for the service and maintenance of the system.

D. The Contractor shall have had a minimum of 1 year experience with the specified SMS.

E. This experience shall include having completed a minimum of 2 installations in the past 12 months of similar size and scope. The Contractor shall provide references and contact information for the project sites in which the qualifying installations occurred.

## 1.8 SUBMITTALS

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

B. Shop Drawings: Detail assemblies of standard components that are custom assembled for specific application on this Project.

1. Raceway Riser Diagrams: Detail raceway runs required for intrusion detection. Include designation of devices connected by raceway, raceway type and size, and type and size of wire and cable fill for each raceway run.
2. Site and Floor Plans: Indicate final outlet and device locations, routing of raceways, and cables inside and outside the building.
3. Master Control-Unit Console Layout: Show required artwork and device identification.
4. Device Address List: Coordinate with final system programming.
5. System Wiring Diagrams: Include system diagrams unique to Project. Show connections for all devices, components, and auxiliary equipment. Include diagrams for equipment and for system with all terminals and interconnections identified.
6. Details of surge-protection devices and their installation.
7. Sensor detection patterns and adjustment ranges.

C. Equipment and System Operation Description: Include method of operation and supervision of each component and each type of circuit. Show sequence of operations for manually and automatically initiated system or equipment inputs. Description must cover this specific Project; manufacturer's standard descriptions for generic systems are unacceptable.

D. Samples: For units with factory-applied color finishes.

E. Submittals that do not contain all the above information will be rejected.

1.9 CLOSEOUT SUBMITTAL

A. Operation and maintenance data.

1.10 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. Intrusion Detection Devices: Furnish quantity equal to ten percent of the number of units of each type installed, but no fewer than one of each type.
2. Fuses: Three of each kind and size.
3. Tool Kit: Provide three sets of tools for use with security fasteners, each packaged in a compartmented kit configured for easy handling and storage.
4. Security Fasteners: Furnish no fewer than 1 box for every 50 boxes or fraction thereof, of each type and size of security fastener installed.

1.11 PROJECT CONDITIONS

A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

B. Altitude: Sea level to 4000 feet (1220 m).

C. Master Control Unit: Rated for continuous operation in an ambient of 60 to 85 deg F (16 to 29 deg C) and a relative humidity of 20 to 80 percent, noncondensing.

D. Interior, Controlled Environment: System components, except master control unit, installed in temperature-controlled interior environments shall be rated for continuous operation in ambients of 36 to 122 deg F (2 to 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.

E. Interior, Uncontrolled Environment: System components installed in non-temperature- controlled interior environments shall be rated for continuous operation in ambients of 0 to 122 deg F (minus 18 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.

F. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambients of minus 30 to plus 122 deg F (minus 34 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, condensing. Comply with UL 294 and UL 639 for outdoor-use equipment. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph (137 km/h) and snow cover up to 24 inches (610 mm) thick.

1.12 SYSTEM WARRANTY

A. The Intrusion Detection System shall be warranted by the contractor for a period of one (1) year from date of substantial completion.

## 1.13 OPERATION AND MAINTENANCE MANUALS

A. Submit in accordance with Section 270010 a complete End User Manual including the following:

1. Component Operating Manual including technical data sheets.
2. Information for reordering replacement parts.
3. Provide a replacement parts list.
4. Provide a list of recommended parts, tools, and instruments for testing and maintenance purposes.
5. Wiring diagrams/details:
6. System functional block diagrams.
7. System schematic diagrams.
8. System wiring list.
9. Identify terminals to facilitate installation, operating and maintenance.

B. System Operating Instructions: Provide a clear and concise description of operation which gives, in detail, the information required to properly operate the equipment and system.

C. Component Service Manual: Include information for testing, repair, troubleshooting, assembly, disassembly, and required/recommended maintenance intervals.

## 1.14 MANUFACTURERS' QUALIFICATIONS

A. Qualification of the Manufacturer:

1. All equipment described herein shall be the product of a manufacturer of established reputation and experience, who shall have produced similar equipment for a period of at least 5 years and who shall be able to refer to similar installations now rendering satisfactory service.
2. Perform all work under the on site supervision of a factory authorized, trained technician. It shall be the responsibility of the technician to check, inspect and adjust this installation to the engineer's and owner approval. A CSR of the installing contractor or manufacturer shall train the owner's personnel on the proper operation and maintenance of the equipment. Perform all work in conjunction with this installation in accordance with good engineering practices as established by NEC.
3. The manufacturer and their local agent shall show satisfactory evidence upon request that they maintain a fully equipped service center capable of furnishing adequate inspection and service to the equipment including standard replacement parts. The manufacturer and/or agent shall be prepared to offer a service contract for the maintenance of the system after the warranty period.
4. To establish continuity in the manufacturer, systems components shall be the standard product of one manufacturer. Further, an effort shall be made to establish common sources for equipment of all systems. The manufacturer will have a minimum of five (5) years' experience in the manufacture of progressive products specified.
5. Shall be same manufacturer as section 282300

B. Qualifications of the Contractor/Subcontractor:

1. The contractor/subcontractor is required to answer all warranty and Service calls within 4 hours of the initial customer contact and provide an authorized technician onsite within 24 hours.
    a. Proper identification is required and must be visible while onsite for warranty/service calls. Notification of completion must be provided to authorized personnel onsite before departing facility.
    b. Consult and coordinate with all trades providing adjoining work and make an Adjustment or relocation necessary to accommodate other equipment or to maintain proper function of existing equipment without claims for additional payment.
2. These Specifications contained herein describe specific functional requirements of the Intrusion Detection System as required by the owner. It is the intent of these specifications to detail and describe the exact performance of the system. The system features outlined in the Specifications are deemed mandatory for the project. References to model numbers are intended only for descriptive purposes. Systems that deviate from these Performance Specifications shall be considered alternate systems.

## 1.15 SYSTEM OPERATION

A. Upon entering a valid access code via a system control keypad, the system shall disarm the applicable zones, disarm the alarm system, and log the transaction pertaining to time, date, and user.

B. The Intrusion Detection System shall provide the following functions:

1. A system control panel, control keypads, magnetic door contacts, motion sensors, and alert sirens.
2. Provide interconnection to the Owner provided dedicated telephone connection for monitored response to after-hours alarms.
3. Provide interconnection to the central control panel for monitoring all applicable doors with door contacts.
4. System shall be fully integrated with the building's Access Control System.
5. The System shall be integrated with the building lighting system and shall activate the corridor lights and other selected areas in the event of alarm activation.
6. The System shall be supervised, i.e. power failure, line cuts and communication failures shall signal the monitoring station(s) of the problem.
7. The fire system flow and tamper points shall be attached to the system.
8. The System shall provide monthly reports, detailing as a minimum:
    a. Alarm System usage.
    b. Door Openings.
    c. Door Closings.
    d. Alarm Conditions.
9. The System shall be programmed to accept individual access codes from authorized employees. Codes shall not be shared.
10. The System shall be compatible with the Owner's monitoring service.

PART 2 - PRODUCTS

2.1 PRODUCT EQUIVALENCY

A. Where products are listed with multiple manufacturers, these manufacturers will be approved as equals if all specified features are provided. Any equipment not specifically approved in writing prior to the bid date will not be considered regardless of qualifications. Failure to provide the "precise functional equivalent" shall result in the removal of the alternate equipment at the Contractor's expense.

B. Different manufacturers may require various options, accessories, converters, patch cables, etc. to perform the specified features and functions. Therefore, all material and/or equipment necessary for proper operation of the system shall be deemed part of these specifications.

2.2 FUNCTIONAL DESCRIPTION OF SYSTEM

A. DSC

B. DMP

C. Honywell

D. Description: Hard-wired, modular, microprocessor-based controls, intrusion sensors and detection devices, and communication links to perform monitoring, alarm, and control functions.

E. Supervision: System components shall be continuously monitored for normal, alarm, supervisory, and trouble conditions. Indicate deviations from normal conditions at any location in system. Indication includes identification of device or circuit in which deviation has occurred and whether deviation is an alarm or malfunction.

1. Alarm Signal: Display at master control unit and actuate audible and visual alarm devices.
2. Trouble Condition Signal: Distinct from other signals, indicating that system is not fully functional. Trouble signal shall indicate system problems such as battery failure, open or shorted transmission line conductors, or control-unit failure.
3. Supervisory Condition Signal: Distinct from other signals, indicating an abnormal condition as specified for the particular device or control unit.

F. System Control: Master control unit shall directly monitor intrusion detection units and connecting wiring.

G. System shall automatically reboot program without error or loss of status or alarm data after any system disturbance.

H. Operator Commands:

1. Help with System Operation: Display all commands available to operator. Help command, followed by a specific command, shall produce a short explanation of the purpose, use, and system reaction to that command.
2. Acknowledge Alarm: To indicate that alarm message has been observed by operator.
3. Place Protected Zone in Access: Disable all intrusion-alarm circuits of a specific protected zone. Tamper circuits may not be disabled by operator.
4. Place Protected Zone in Secure: Activate all intrusion-alarm circuits of a protected zone.
5. Protected Zone Test: Initiate operational test of a specific protected zone.
6. System Test: Initiate system-wide operational test.
7. Print reports.

I. Timed Control at Master Control Unit: Allow automatically timed "secure" and "access" functions of selected protected zones.

J. Automatic Control of Related Systems: Alarm or supervisory signals from certain intrusion detection devices control the following functions in related systems:

1. Switch signal to selected monitor from CCTV camera in vicinity of sensor signaling an alarm.

K. Printed Record of Events: Print a record of alarm, supervisory, and trouble events on system printer. Sort and report by protected zone, device, and function. When master control unit receives a signal, print a report of alarm, supervisory, or trouble condition. Report type of signal (alarm, supervisory, or trouble), protected zone description, date, and time of occurrence. Differentiate alarm signals from other indications. When system is reset, report reset event with the same information concerning device, location, date, and time. Commands shall initiate the reporting of a list of current alarm, supervisory, and trouble conditions in system or a log of past events.

L. Response Time: Two seconds between actuation of any alarm and its indication at master control unit.

M. Circuit Supervision: Supervise all signal and data transmission lines, links with other systems, and sensors from master control unit. Indicate circuit and detection device faults with both protected zone and trouble signals, sound a distinctive audible tone, and illuminate an LED. Maximum permissible elapsed time between occurrence of a trouble condition and indication at master control unit is 20 seconds. Initiate an alarm in response to opening, closing, shorting, or grounding of a signal or data transmission line.

N. Programmed Secure-Access Control: System shall be programmable to automatically change status of various combinations of protected zones between secure and access conditions at scheduled times. Status changes may be preset for repetitive, daily, and weekly; specially scheduled operations may be preset up to a year in advance. Manual secure-access control stations shall override programmed settings.

O. Manual Secure-Access Control: Coded entries at manual stations shall change status of associated protected zone between secure and access conditions.

## 2.3 SYSTEM COMPONENT REQUIREMENTS

A. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor entry connection to components.

B. Intrusion Detection Units: Listed and labeled by a qualified testing agency for compliance with UL 639.

C. Interference Protection: Components shall be unaffected by radiated RFI and electrical induction of 15 V/m over a frequency range of 10 to 10,000 MHz and conducted interference signals up to 0.25-V rms injected into power supply lines at 10 to 10,000 MHz.

D. Tamper Protection: Tamper switches on detection devices, control units, annunciators, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled and when entering conductors are cut or disconnected. Master control-unit alarm display shall identify tamper alarms and indicate locations.

E. Self-Testing Devices: Automatically test themselves periodically, but not less than once per hour, to verify normal device functioning and alarm initiation capability. Devices transmit test failure to master control unit.

F. Antimasking Devices: Automatically check operation continuously or at intervals of a minute or less, and use signal-processing logic to detect blocking, masking, jamming, tampering, or other operational dysfunction. Devices transmit detection of operational dysfunction to master control unit as an alarm signal.

G. Addressable Devices: Transmitter and receivers shall communicate unique device identification and status reports to master control unit.

H. Remote-Controlled Devices: Individually and remotely adjustable for sensitivity and individually monitored at master control unit for calibration, sensitivity, and alarm condition.

## 2.4 ENCLOSURES

A. Interior Sensors: Enclosures that protect against dust, falling dirt, and dripping noncorrosive liquids.

B. Interior Electronics: NEMA 250, Type 12.

C. Exterior Electronics: NEMA 250, Type 4X, stainless steel.

D. Corrosion Resistant: NEMA 250, Type 4X, stainless steel.

E. Screw Covers: Where enclosures are readily accessible, secure with security fasteners of type appropriate for enclosure.

## 2.5 REMOTE ANNUNCIATORS

A. The system shall support a maximum of sixteen (16) supervised remote annunciators with the identical capabilities, functions and display layout. Operation of the remote annunciators shall be limited to authorized users by the use of a code or key.

B. The remote annunciators shall be capable of operating at a maximum wiring distance of 15,000 feet from the control unit on unshielded, non-twisted cable.

## 2.6 SECURE AND ACCESS DEVICES

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. Digital Security Controls Ltd.; a business unit of Tyco Safety Products.
2. Edwards Signaling & Security Systems; part of GE Security.
3. Honeywell International Inc.; Honeywell Security.
4. Tyco Electronics.

## 2.7 TEST FUNCTION

A. The system shall include a provision that permits testing from any alphanumeric keypad. The test shall include standby battery, alarm bell or siren, and communication to the central station.

B. The system shall include a provision for an automatic, hourly, daily, weekly, thirty (30) day, or up to sixty (60) day communication link test from the control panel installation site to the central station.

C. The system shall include a provision for displaying the internal system power and wiring conditions. Internal monitors shall include the bell circuit, AC power, battery voltage level, charging voltage, panel box tamper, phone trouble line 1, phone trouble line 2, transmit trouble, and network trouble.

## 2.8 POWER SUPPLIES

A. Power supplies for the control unit shall operate from 120 Vac, supplied at the respective protected areas. Standby batteries shall be supplied to power the system in the event of a utility power failure. Batteries shall be sized to provide 105% capacity for eight hours. Standby batteries shall be sealed lead-acid. Power supplies shall be all Solid State.

B. Controls shall be designed to maintain full battery charge when alternating current is available. Batteries shall be recharged to 85% capacity within 24 hours from battery use. The system shall be automatically transferred to battery power upon loss of alternating current power and return to alternating current power upon restoration. Intrusion alarms shall not be initiated during switch over; a signal shall be initiated upon failure of battery or alternating current power.

## 2.9 DOOR SWITCHES

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

1. General Electric Company; GE Security, Inc.
2. Honeywell International Inc.; Honeywell Security.
3. Honeywell International Inc.; Honeywell Video Systems.

B. Description: Balanced-magnetic switch, complying with UL 634, installed on frame with integral overcurrent device to limit current to 80 percent of switch capacity. Bias magnet and minimum of three encapsulated reed switches shall resist compromise from introduction of foreign magnetic fields.

C. Flush-Mounted Switches: Unobtrusive and flush with surface of door and window frame.

D. Overhead Door Switch: Balanced-magnetic type, listed for outdoor locations, and having door-mounted magnet and floor-mounted switch unit.

## 2.10 PIR SENSORS

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

1. Digital Security Controls Ltd.; a business unit of Tyco Safety Products.
2. General Electric Company; GE Security, Inc.
3. Honeywell International Inc.; Honeywell Security.
4. Tyco Electronics.

B. Listed and labeled by a qualified testing agency for compliance with SIA PIR-01.

C. Description: Sensors detect intrusion by monitoring infrared wavelengths emitted from a human body within their protected zone and by being insensitive to general thermal variations.

1. Wall-Mounted Unit Maximum Detection Range: 125 percent of indicated distance for individual units and not less than 50 feet (15 m).

D. Device Performance:

1. Sensitivity: Adjustable pattern coverage to detect a change in temperature of 2 deg F (1 deg C) or less, and standard-intruder movement within sensor's detection patterns at any speed between 0.3 to 7.5 fps (0.09 to 2.3 m/s) across two adjacent segments of detector's field of view.
2. Test Indicator: LED test indicator that is not visible during normal operation. When visible, indicator shall light when sensor detects an intruder. Locate test enabling switch under sensor housing cover.

## 2.11 MASTER CONTROL UNIT

A. Manufacturers: available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. DMP
2. DSC
3. Honeywell
4. General Electric Company; GE Security, Inc.
5. Visonic Inc.
6. Tyco Electronics.

B. Description: Supervise sensors and detection subsystems and their connecting communication links, status control (secure or access) of sensors and detector subsystems, activation of alarms and supervisory and trouble signals, and other indicated functions.

1. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
2. Include a real-time clock for time annotation of events on the event recorder and printer.
3. Addressable initiation devices that communicate device identity and status.
4. Control circuits for operation of mechanical equipment in response to an alarm.

C. Construction: Wall-mounted cabinet, modular, with separate and independent alarm and supervisory system modules. Arrangements that require removal of field wiring for module replacement are unacceptable.

D. Comply with UL 609.

E. Protected Zones: Quantity of alarm and supervisory zones as indicated, with capacity for expanding number of protected zones by a minimum of 25 percent.

F. Power Supply Circuits: Master control units shall provide power for remote power-consuming detection devices. Circuit capacity shall be adequate for at least a 25 percent increase in load.

G. Cabinet: Lockable, steel enclosure arranged so operations required for testing, normal operation, and maintenance are performed from front of enclosure. If more than a single cabinet is required to form a complete control unit, provide exactly matching modular enclosures. Accommodate all components and allow ample gutter space for field wiring. Identify each enclosure by an engraved, laminated, phenolic-resin nameplate. Lettering on enclosure nameplate shall not be less than 1 inch (25 mm) high. Identify, with permanent labels, individual components and modules within cabinets.

H. Transmission to Monitoring Station: A communications device to automatically transmit alarm, supervisory, and trouble signals to the monitoring station, operating over a standard voice grade telephone leased line. Comply with UL 1635.

I. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

## 2.12 INPUT/OUTPUT CAPACITY

A. This system shall be capable of monitoring a maximum of 574 individual zones and controlling a maximum of 506 output relays.

B. The control panel shall have, as an integral part of the assembly, 2 SPDT Form C relays rated at 1 Amp at 30 Vdc and four open collector 12 Vdc outputs rated at 50mA each. It shall also have the capacity of a maximum of 125 output expander modules with 500 switched ground, open collector outputs, 50mA maximum and 506 auxiliary relays (Form C rated at 1.0 Amp at 30 Vdc).

C. The panel shall also provide 99 programmable output profiles for schedules, and include an integral bell alarm circuit providing at least 1.5 Amps of steady, pulsed, or temporal bell output. Output type shall be programmable by zone type. Relays and voltage outputs shall be capable of being independently programmed to turn on and/or off at selected times each day.

## 2.13 KEYPADS

A. The system shall support a maximum of sixteen (16) keypads on XR550/XR350 Series or eight (8) keypads on XR150 Series with alphanumeric display. Each keypad shall be capable of arming and disarming any system area based on a pass code or Proximity key authorization. The keypad alphanumeric display shall provide complete prompt messages during all stages of operation and system programming and display all relevant operating and test data.

B. Communication between the control panel and all keypads and zone expanders shall be multiplexed over a non-shielded multi-conductor cable, as recommended by the manufacturer. This cable shall also provide the power to all keypads, zone expanders, output expanders, and other power consuming detection devices.

C. If at any time a keypad does not detect polling; the alphanumeric display shall indicate “SYSTEM TROUBLE”. If at any time two devices are programmed for the same address, the alphanumeric keypad shall display “4 WIRE BUS TROUBLE”. If at any time a keypad detects polling but not for its particular address, the alphanumeric display shall indicate “NON POLLED ADDR”. The system shall display all system troubles at selected keypads with distinct alphanumeric messages.

D. The keypad shall include self-test diagnostics enabling the installer to test all keypad functions: display test, key test, zone test, LED test, relay test, tone test, and address test.

E. The keypad shall provide an easy-to-read English text display. The text shall exactly match the text seen in all software reports, keypad displays, and central station reports.

F. The keypad user interface shall be a simple-to-use, menu-driven help system that is completely user friendly.

G. The control panel shall support a keypad interface accessible in a browser window. The web-accessible keypad interface shall provide at least five (5) programmable hyperlinks for camera access or other use.

## 2.14 ZONE CONFIGURATION

A. A minimum of 4 Class B ungrounded zones shall be available at each keypad or zone expander on the system.

B. The system shall have the capacity for a maximum of eight (8) keypads and a maximum of 25 four (4) zone expanders It shall also have the capacity of a maximum of 25 supervised relay output expanders. All Class B zones shall be 2-wire, 22 AWG minimum, supervised by an end-of-line (EOL) device and shall be able to detect open and short conditions in excess of 500ms duration.

C. Each zone shall function in any of the following configurations: Night, Day, Exit, Fire, Supervisory, Emergency, Panic, Auxiliary 1, Auxiliary 2, Fire Verification, Cross Zone, Priority, and Key Switch Arming.

D. The digital SLCs and the annunciator/keypad bus shall be able to operate at a maximum wiring distance of 2500 feet from the control panel on unshielded, non-twisted cable. This distance may be extended to a total of 15,000 feet when bus repeater modules are installed.

## 2.15 COMMUNICATION

A. The system shall be capable of signaling to as many as 8 remote monitoring station receivers. Seven (7) of the eight (8) paths shall be capable of being assigned as either a “primary” or “backup” path. In such a manner the system shall have multiple primary paths to multiple remote monitoring stations as well as multiple backup paths to multiple monitoring stations.

B. The system shall employ Adaptive Technology that allows a Backup communication path programmed for Network or Cellular to automatically ADAPT to the faster check-in rate of the Primary path should the Primary path become unavailable. This creates a seamless transition for communication.

C. The system shall be capable of dialing up to (2) remote monitoring station receivers, four telephone numbers of 32 digits each using two separate switched telephone network lines such that if two unsuccessful attempts are made on the first line to the first number, the system shall make two attempts on first line to the second number. If these two attempts are unsuccessful, the system shall make two further attempts on the first line of the first number. After the tenth unsuccessful attempt, dialing shall stop and the alphanumeric keypad shall display trouble. Should another event occur that requires a report to be transmitted, the dialing sequence shall be repeated. The system shall have a programmable option to dial a second set of telephone numbers after the first ten attempts using the same sequence.

D. The system shall be capable of supporting Network communication with digital dialer backup, existing Ethernet data networks, satellite communication, fiber optic networks, local area networks, wide area networks, cellular communication, and retail data networks.

## 2.16 FALSE ALARM REDUCTION FEATURES

A. The system shall can provide false alarm reduction features, functions, capabilities, or processes that either require alarms be verified or potential alarms be corrected before a system or zone can be placed into an armed state.

B. Exit Error Alert and Reporting--The panel shall be able to provide an automatic function to prevent a false alarm from occurring if an exit door does not properly close after the system is armed.

C. Entry and Exit Delay Annunciation--When arming, the system shall provide clear annunciation indicators to the user about the need to exit the premises prior to the exit delay time expiring.

D. When disarming, the system shall notify the user the need to disarm the system prior to the entry delay time expiring.

E. Remote Annunciation--The system shall be able to provide entry and exit delay time period notification. This notification can be from keypads, remote annunciators, or bell tests.

F. Abort Reporting--The system shall be capable of sending an Abort report to the central station if the system is disarmed while the alarm is still sounding. The Abort report shall be sent after the alarm report to notify the central station that an authorized user has cancelled the alarm.

G. System Testing--The system shall offer testing features that are simple, quick, and complete and provide the highest measure of safety by ensuring that alarm conditions are detected and communicated to the proper authorities in a timely manner and on a regularly scheduled basis.

H. Ambush Code--The system shall offer ambush codes for those dangerous encounters where the user is instructed to either arm or disarm the system under threat of harm. The duress code shall disarm the system without giving local indication of an alarm that might put the user well-being in jeopardy.

I. Two-Button Panic Feature--The system shall support keypads that provide the option to use only two-button panic codes. The user shall be required to press and hold two designated keys for approximately two seconds before the system generates a panic alarm.

J. Fire Verify Zones--The system shall support Fire Verify zones to help the panel verify the existence of an actual fire condition before it sends an alarm report to the central station. The Fire Verify zone shall require the panel to perform a Sensor Reset whenever a device connected to a Fire Verify zone initiates an alarm. This shall begin a verification period during which the panel waits for a second alarm initiation. If the original zone or any other Fire Verify zone on the panel initiates an alarm within the next 120 seconds, the panel shall recognize this as an actual alarm and send an alarm report to the central station.

K. Cross-Zoning Protection--The system shall support cross-zoning as a means of requiring two device trips to occur within a short period of time before sounding an alarm and sending an alarm report to the central station. Supported device trips shall be from one device that trips two times, or from two devices that each trip once.

L. Swinger Zone Bypassing--The system shall be capable of automatically bypassing a zone if it goes into an alarm or trouble condition a specified number of times within a one-hour period. The panel shall be able to track the number of times the zone trips while armed and compare that against a programmed number. When that number is reached, the panel shall be able to automatically bypass the zone. The panel shall be capable of resetting the zone when the area to which it is assigned disarms, is manually reset from the keypad or remotely, or remains normal for one hour.

M. Recently Armed Report--The system shall be capable sending a System Recently Armed report, along with a zone alarm report, to the central station any time an alarm occurs within five minutes of the system arming. The System Recently Armed report allows the central station operator to follow a “call the subscriber first” procedure instead of immediately dispatching the police to what could be a false alarm.

N. Transmit Delay--The system shall be capable of programming the panel to wait up to 60 seconds before sending burglary alarm reports to the central station. If an alarm is accidental, the user shall be able to disarm the system within the programmed Transmit Delay time. An Abort report shall be sent in place of an alarm report after the system disarms. During the alarm, sirens and panel relay outputs shall not be delayed and shall still provide local condition annunciation.

O. Call Waiting Cancel--The system shall be capable of being programmed to cancel call waiting any time the panel dials the receiver number to send a report.

P. Cancel/Verify--The system shall be capable of sending either a Cancel Report or Verify Report to the Central Station to signify that the end user has Canceled an Alarm or Verified an Alarm condition. Also the system shall be programmable to instead of Cancel/Verify show “IS THIS A FALSE ALARM? NO YES”. If YES send validation of alarm to Central Station, if NO send alarm cancel.

## 2.17 AREA SYSTEM MODE

A. The system user shall be capable of selectively arming and disarming any one or more of 32 areas within the intrusion detection system based on the user PIN code and/or keypad used. Each of the 574 zones shall be able to be assigned to any of the 32 available areas. The system shall be capable of having up to a thirty-two (32) character length name programmed for each area.

B. The system user shall be capable of assigning an opening and closing schedule to all areas or to each of the 32 areas separately. Each area shall be able to arm or disarm automatically by a schedule. The system shall have the capacity for common areas that automatically disarm when any other area disarms and that automatically arm when all others areas arm.

C. The networked system shall have the ability to comply with Bank Safe & Vault application. The networked system shall also have the ability to use a two-man rule for disarming or allowing door access to an area. The system shall have the ability to operate a Common Area application.

D. The Encrypted system shall have the feature of Card Plus Pin by area High security card access is provided by the Card Plus Pin feature that requires both a card read and a PIN (4-6 digit user ID) entry for arming/disarming and access by area. This Card Plus Pin operation complies with the ICPG 705 requirement for dual id authentication.

## 2.18 ZONES

A. The system shall have a minimum of eight (8) grounded burglary zones available from the control panel, and two floating ground powered zones for two wire type compatible smoke detectors. The system shall have the ability to expand using the panel's keypad bus for up to sixty-four additional zones. The system shall have the ability to integrate up to 500 wireless zones for a total of 574 zones overall.

## 2.19 SECURITY FASTENERS

A. Operable only by tools produced for use on specific type of fastener by fastener manufacturer or other licensed fabricator. Drive system type, head style, material, and protective coating as required for assembly, installation, and strength.

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

1. Acument Global Technologies North America.
2. Safety Socket LLC.
3. Tamper-Pruf Screws.

C. Drive System Types: Pinned Torx.

D. Socket Flat Countersunk Head Fasteners:

1. Heat-treated alloy steel, ASTM F 835 (ASTM F 835M).
2. Stainless steel, ASTM F 879 (ASTM F 879M), Group 1 CW.

E. Socket Button Head Fasteners:

1. Heat-treated alloy steel, ASTM F 835 (ASTM F 835M).
2. Stainless steel, ASTM F 879 (ASTM F 879M), Group 1 CW.

F. Socket Head Cap Fasteners:

1. Heat-treated alloy steel, ASTM A 574 (ASTM A 574M).
2. Stainless steel, ASTM F 837 (ASTM F 837M), Group 1 CW.

G. Protective Coatings for Heat-Treated Alloy Steel:

1. Zinc chromate, ASTM F 1135, Grade 3 or Grade 4, for exterior applications and interior applications where indicated.
2. Zinc phosphate with oil, ASTM F 1137, Grade I, or black oxide unless otherwise indicated.

## PART 3 - EXECUTION

### 3.1 CONTRACTOR/OWNER COMMUNICATION

A. Contractor shall obtain the following programming information from the Owner:

1. Phone numbers for the Security/Burglary Panels shall be gathered from the Owner.

a. Is the receiver Contact ID or SIA?

2. Whether or not there is a monitoring company that is used, and if an account exists/needs to be created.

3. Alarm codes shall be provided.

### 3.2 INSTALLATION

A. Install systems in accordance with UL, NEC and all other applicable codes. Install system to comply with drawings and final shop drawings in compliance with manufacturer instructions. Provide all required hardware and labor for rack mounting of head-end system components.

B. 120V power for control panels, remote power panels, remote input/output panels, etc shall be provided under this specification section as coordinated with the Electrical Contractor.

C. Refer to plans for locations and quantities of equipment. Equipment locations shown on plans will be required to be field coordinated to ensure proper system operation.

D. No items of equipment shall be installed in such a manner as to void or reduce the proper operating characteristics of individual components or of the system. Devices such as motion detectors, audio detectors, glass break sensors, etc. shall be installed following the manufacturer's recommendations.

E. Perform all work under the on site supervision of a factory authorized trained technician. It shall be the responsibility of the technician to check, inspect and adjust this installation to the engineer's and Owner approval. A CSR of the installing contractor or manufacturer shall train the Owner's personnel on the proper operation and maintenance of the equipment. Perform all work in conjunction with this installation in accordance with good engineering practices as established by NEC.

## 3.3 WIRING INSTALLATION

A. All wiring between devices shall be run open wired above accessible ceilings. Where existing cable management systems are in place and there is adequate capacity to install the wiring, the contractor may utilize these pathways providing they have coordinated with all other wiring contractor on site.

B. Where pathways do not exist for wiring, this contract shall be responsible for providing all required cable management systems such as J-hooks to support communications cabling to meet building codes and manufacturer's recommendations.

C. All cabling installed in ceiling spaces that are used for air distribution plenums shall be UL plenum rated.

D. This contract shall be responsible for furnishing and installing all required cabling between components to form a complete and operational system meeting all the requirements of this specifications.

## 3.4 GROUNDING

A. The installing contractor shall be responsible for ensuring the grounding integrity of all installed equipment to eliminate the potential for equipment or personnel hazards due to improperly or inadequately grounded systems.

B. All grounding and bonding shall be in conformance with the National Electric Code, article 250 and as recommended by EIA/TIA-607.

C. The Division 16 Contractor has provided 120V branch circuitry for use by the SMS system contractor. The branch circuitry is run with a dedicated equipment grounding conductor which shall be utilized by the SMS system equipment. In no case shall the SMS system installation compromise the integrity of the Building Electrical Grounding System.

## 3.5 PROGRAMMING

A. It is the Contractor's responsibility to program the system in this section according to the Owner's wishes. This involves day and night restrictions, time schedules, building zoning, sequence of operation, etc. The Contractor shall meet with the Owner and/or Engineer and reach agreement on the programming. This programming agreement shall then be written out in detail and forwarded to the Engineer for approval. After approval is granted, proceed with final programming.

## 3.6 IDENTIFICATION/LABELING

A. Contractor shall identify all major items of equipment and tag all cables with permanent type markers to denote equipment served. Cables shall be tagged at both ends and at each point where the cable is administered.

B. The contractor shall be responsible for generating and programming the labeling for camera information within the recorder software.

C. All labeling and recording shall be approved by the Owner and the Engineer prior to application.

## 3.7 TESTING

A. The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all site testing. The Owner will witness all performance verification. Original copies of all data produced during performance verification shall be turned over to the Owner at the conclusion of testing prior to final approval.

B. The field testing shall as a minimum include:

1. Verification that alarm points are received, annunciated properly and transmitted through the central monitoring station.
2. Verification that all motion detectors have the proper coverage patterns and that false alarms are not being generated due to motion coverage patterns into adjacent areas.
3. Verification that all user input and control features are accessible at each keypad and operators control station.
4. Verification that the final system programming including schedules and sequence of operation are performing as expected.

C. The Contractor shall deliver a report describing results of functional tests, diagnostics, and calibrations including written certification to the Owner that the installed complete system has been calibrated, tested, and is ready to begin performance verification testing. The report shall also include a copy of the approved performance verification test procedure.

D. Performance Verification Test: The Contractor shall demonstrate that the completed SMS complies with the contract requirements. Using approved test procedures, all physical and functional requirements of the project shall be demonstrated and shown. The performance verification test, as specified, shall not be started until receipt by the Contractor of written permission from the Owner, based on the Contractor's written report. This shall include certification of successful completion of Contractor Field Testing as specified in paragraph "Contractor's Field Testing," and upon successful completion of training as specified. The Owner may terminate testing at any time when the system fails to perform as specified.

## 3.8 TRAINING REQUIREMENTS

A. Provide the Owner with a minimum of 24 hours of training designed to make all users familiar with the operation of the system.

B. Provide all training and utilize specified manuals and record documentation. All training shall be provided at the project site and coordinated with the Owner.

C. Training shall include multiple four-hour sessions encompassing all instructions required for system operation. Provide operators manuals and user guides with training. Provide follow up training after initial training.

D. Training shall utilize the equipment provided at the project site. Coordinate use, time and availability of equipment with the Owner.

E. Demonstrate adjustment, operation and maintenance of the system including each component and control.

## 3.9 SYSTEM ACCEPTANCE REQUIREMENTS

A. The contractor shall demonstrate proper operation of all aspects of the system to the Owner's representative.

## 3.10 AS-BUILT DOCUMENTATION

A. Operation and Maintenance Manuals: Submit in accordance with Section 17010 a complete End User Manual including the following:

1. Component Operating Manual including technical data sheets.
2. Information for reordering replacement parts.
3. Provide a replacement parts list.
4. Provide a list of recommended parts, tools, and instruments for testing and maintenance purposes.
5. Wiring diagrams/details:
6. System functional block diagrams.
7. System schematic diagrams.
8. System wiring list.
9. Identify terminals to facilitate installation, operating and maintenance.

B. System Operating Instructions: Provide a clear and concise description of operation which gives, in detail, the information required to properly operate the equipment and system.

C. Component Service Manual: Include information for testing, repair, troubleshooting, assembly, disassembly, and required/recommended maintenance intervals.

## 3.11 WARRANTY

A. Warranty all equipment and materials for a period of 3 years from the date of Final acceptance from the specifying authority /Owner. If any defects in materials, workmanship or operational failures under "NORMAL" conditions are experienced within the warranty period, promptly correct at no expense to the Owner.

B. The system wiring and installation shall comply with all applicable codes and drawings, and shall be installed in accordance with the manufacturer's recommendations.

END OF SECTION 281600

SECTION 282100 - VIDEO SURVEILLANCE CAMERAS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The drawings and general provisions of the Contract, General and Special Conditions and Division 1 Sections apply to this Section.

1.2 SCOPE OF WORK

A. These Specifications contained herein describe specific functional requirements of the Video Surveillance Cameras, Video Management System, Servers/Storage and system programming. It is not the intent of these specifications to detail and describe the exact performance of the cameras. The system features outlined in the Specifications are deemed mandatory for the project. References to model numbers are intended only for descriptive purposes. Systems that deviate from these Performance Specifications shall be considered alternate systems.

B. Contractor shall have total “turn-key” responsibility (except where noted) for ensuring the system is installed complete and functional, consistent with the manufacturer's specifications and that all applicable fire, electrical, and building codes and standards are met. Where required by the various codes, the vendor is responsible to obtain the necessary approval(s) of the Authority Having Jurisdiction (AHJ).

C. Section includes a complete video surveillance system consisting of cameras, network video servers, storage, software, monitors, and workstations.

D. Interior Camera System - System consists of multiple IP based cameras with specified housings, mounting, lenses, features, etc. throughout the building interior as indicated on the drawings and as specified herein.

E. Exterior Camera System - System consists of multiple IP based cameras with specified housings, mounting, lenses, local power supplies, features, etc. around the perimeter of the building and throughout the project site as indicated on the drawings and as specified herein.

F. Any aspect of these specifications, or future addendum, which appears to the Contractor to fall outside applicable codes or standards, shall immediately be brought to the attention of the Owner.

1.3 QUALITY ASSURANCE

A. National Fire Protection Association.

B. National Electric Code.

C. American with Disabilities Act.

D. Underwriter’s Laboratory.

E. FCC Part 15 – Subpart B Class A.

F. NEMA Type 4AX.

G. NEMA Type 1.

H. NTSC/EIA.

I. ISO 14001

J. ISO/IEC 14496-2 MPEG-4, MPEG-H Part 2.

K. H.264, H.265.

L. FCC CFR 47 Part 15 Class A – Telecommunications – Radio Frequency Devices – Digital Device Emission

M. UL 60950-1 Information Technology Equipment – Safety.

N. Latest ANSI TIA/EIA-568, 569, 606, 607 Standards and 11th Edition (or later).

O. BICSI Telecommunications Distribution Methods Manual (TDMM) 13$^{tVerh}$ Edition or later.

P. All equipment described herein shall be the product of a manufacturer of established reputation and experience, who shall have produced similar equipment for a period of at least 2 years and who shall be able to refer to similar installations within a 75-mile radius now rendering satisfactory service.

Q. The manufacturer and their local agent shall show satisfactory evidence upon request that they maintain a fully equipped service center capable of furnishing adequate inspection and service to the equipment including standard replacement parts. The manufacturer and /or agent shall be prepared to offer a service contract for the maintenance of the system after the warranty period.

1. Installer working on this project must possess a valid certificate from the equipment manufacturer verifying completion of Installation and Service Training.

R. To establish continuity in the manufacturer, systems components shall be the standard product of one manufacturer. Further, an effort shall be made to establish common sources for equipment of all systems. The manufacturer will have a minimum of five (5) years' experience in the manufacture of progressive products specified.

S. All materials furnished under this contract shall be new, of highest quality and shall be of a regularly manufactured line, currently in production at the time of installation.

## 1.4 DEFINITIONS

A. Industry standard words and phrases are used throughout the Drawings and Specifications, except:

1. Words which have well-known technical or trade meanings are used in accordance with such recognized meanings.

2. Whenever the following listed words and phrases are used, they shall be mutually understood to have the following respective meanings:

B. The words “as indicated.” means: as shown on the Drawings, and in accordance with the Specifications.

C. The words “as required.” means: as required to provide a complete and satisfactory Work in full conformance with the Drawings and Specifications.

D. The word “New” means: new Work to be provided by Contractor.

E. The word “Provide” means: furnish, install, connect, test and make ready for use.

F. The words “Relocate existing” means: remove existing item from present location. Reinstall, re-connect, and test existing item and make ready for use at new location as shown on the Drawings.

G. The words “Remove existing “means: remove existing item and return item to Owner.

H. The word “Replace” means: remove existing item and return item to Owner. Provide new item as indicated.

I. The word “Work”: The Work is the completed construction required by the Drawings and Specifications, and includes all labor necessary to produce such construction, and all materials and equipment incorporated or to be incorporated in such construction.

J. The word “Furnish” means: supply item as specified. Item to be installed by others.

## 1.5 CONTRACTOR QUALIFICATIONS

A. Qualifications of Contractor

1. Contractor shall be an installation and service contractor regularly engaged in the sale, installation, maintenance and service of electronic security systems to include access control, video, security intercom/communications, intrusion detection, etc.
2. Contractor shall have three years’ experience with the installation, start-up and programming of systems of a similar size and complexity to the one proposed.
3. Contractor shall be a factory authorized dealer of the system proposed for at least two years.
4. Contractor shall provide factory certified technicians to perform the installation of all components in this project. Evidence of the certification shall be in writing from the manufacturer and shall be on the technician’s person at all times while on site.

B. Installing contractor shall provide at least 3 examples of projects of similar size and scope to include:

1. Project name
2. Project locations
3. Project description
4. Contact name, email address and phone number

C. Supervision of Work

1. Contractor shall employ a competent Foreman to be in responsible charge of the Work. Foreman shall be on the project site daily during the execution of the Work.
2. Contractor's Foreman shall be a regular employee, principle, or officer of Contractor, who is thoroughly experienced in projects of a similar size and type. Contractor shall not use contract employees or Subcontractors as Foremen.

D. Qualifications of Technicians

1. All electronic systems Work shall be performed by electronic technicians thoroughly trained in the installation and service of specialty low-voltage electronic systems.
2. Electrician electrical workers may be used to install conduit, raceways, wiring, and the like, provided that final termination, hook-up, programming, and testing is performed by a qualified electronic technician, and that all such Work is supervised by the Contractor's Foreman.
3. All incidental Work, such as cutting and patching, lock hardware installation, painting, carpentry, and the like, shall be accomplished by skilled craftsperson regularly engaged in such type of work. All such Work shall comply with the highest standards applicable to that respective industry or craft.
4. All 120 VAC power wiring and connections are to be performed by a qualified Electrician, licensed to perform such Work in the Owner.

E. Subcontractors

1. Definition: A Subcontractor is a person or entity who has a direct contract with the Contractor to perform any of the Work at the site.
2. Use of any Subcontractor is subject to the approval of Owner. The Contractor shall identify all Subcontractors on the Bid Form. The Contractor shall make no substitution for any Subcontractor previously selected without approval from Owner.
3. Contractor's Foreman shall be on the project site daily during all periods when Subcontractors are performing any of the Work. Contractor's Foreman shall be in responsible charge of all Work, including any Work being performed by Subcontractors.
4. By an appropriate written agreement, the Contractor shall require each Subcontractor, to the extent of the Work to be performed by the Subcontractor, to be bound to the Contractor by the terms of the Drawings and Specifications, and to assume toward the Contractor all the obligations and responsibilities which the Contractor, by these documents, assumes toward Owner.

F. Supervision and Construction Procedures

1. The Contractor shall supervise and direct the Work, using his best skill and attention. Contractor is solely responsible for all construction means, methods, and techniques.
2. The Contractor shall employ a competent foreman who shall be in attendance at the project site during the progress of the Work. The foreman shall represent the Contractor and all communications given to the foreman shall be as binding as if given to the Contractor.

G. Regulatory Requirements

1. All Work is to conform to all building, fire, and electrical codes and ordinances applicable in the Owner. In case of conflict between the Drawings/Specifications and codes, the codes shall govern. Notify Owner Project Manager of any such conflicts.
2. Contractor shall secure and pay for all licenses, permits, plan reviews, engineering certifications, and inspections required by regulatory agencies. Contractor shall prepare,

at Contractor's expense, any documents, including drawings that may be required by regulatory agencies.

H. Permits

1. The Contractor shall make application for and obtain any and all permits required by federal, state, county, city, or other authority having jurisdiction over the work.

I. The Project Drawings represent the level of system design to be provided by Owner. Contractor shall provide all additional system design work required, including:

1. Conduit layout and sizing.
2. Wire and cable layout and sizing.
3. Point-to-point wiring and equipment hook-up information.
4. Equipment mounting details.
5. Design of equipment cabinets.
6. Other detailed design work required.

B. Contractor’s design shall conform to all applicable codes and ordinances. All electrical design, including the sizing and placement of conduit, raceways and conductors, shall be in accordance with NFPA 70: National Electrical Code, current version, unless local codes establish more stringent requirements.

J. Contractor’s design work is subject to review and approval by Owner’s Project Manager.

K. Contractor’s design shall also include:

1. The addition of all wire, cable, conduit, connectors and junction boxes required for system operation.
2. The installation of conduit between the control components and all equipment at each door, as necessary.
3. Completed “as-built” documentation of all security systems, including documentation of existing equipment, wiring, conduits, and raceways.
4. Other Work as defined within the Project Drawings and Specifications.

L. The contractor/subcontractor is required to answer all warranty and Service calls within 4 hours of the initial customer contact and provide an authorized technician onsite within 24 hours.

1. Proper identification is required and must be visible while onsite for warranty/service calls. Notification of completion must be provided to authorized personnel onsite before departing facility.
2. Consult and coordinate with all trades providing adjoining work and make an Adjustment or relocation necessary to accommodate other equipment or to maintain proper function of existing equipment without claims for additional payment.

M. These Specifications contained herein describe specific functional requirements of the SMS as required by the owner. It is the intent of these specifications to detail and describe the exact performance of the system. The system features outlined in the Specifications are deemed mandatory for the project. References to model numbers are intended only for descriptive purposes. Systems that deviate from these Performance Specifications shall be considered alternate systems.

1.6 WARRANTY

A. Provide a three (3) year full warranty of the system, including equipment, wiring and software against defects in material and workmanship from the date of system completion and acceptance. If any defects are found within the warranty period, the defective system component shall be replaced at no extra cost to the Owner for parts or labor.

B. Manufacturer shall provide a limited 5-year warranty for the product to be free of defects in material and workmanship on all cameras, servers, storage devices, encoders, and media-convertors.

C. During the first year's warranted operation, the Contractor shall perform two inspections at 6-month intervals or less. This work shall be performed during regular working hours, Monday through Friday, excluding legal holidays. These inspections shall include:

1. Visual checks and operational test of the peripheral equipment, cameras, interface panels, recording devices, monitors, video equipment electrical and mechanical controls, and a check of the picture quality from each camera both day and night.
   a.) Assure Wide-Dynamic Range and day/night settings are optimized.

2. Check recording parameters to include frames-per-second, quality, and retention length.
3. Correct all diagnosed problems.
4. Resolve any previous outstanding problems.

D. Contractor warrants that all Work furnished (material and labor) under this Contract will be of good quality, free from faults and defects, and in conformance with the Project Drawings and Specifications.

E. Contractor shall provide a parts and labor guarantee on all Work. Contractor's guarantee shall cover all costs associated with troubleshooting, repair, and replacement of defective Work, including costs of labor, transportation, lodging, materials, and equipment.

F. Guarantee shall not cover any damage to material or equipment caused by accident, misuse, unauthorized modification or repair by Owner, or acts of god.

G. Contractor shall promptly respond to Owner's requests for service during the guarantee period. Contractor shall provide repair service as soon as reasonably possible upon request from Owner, but in no case shall service response exceed 8 hours from time of request.

H. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period.

I. The Contractor shall be responsible to provide service during normal working hours within (4) hours after notification by the Owner for normal service or within (2) hours for emergency service. Emergency service is defined as the loss of 25% or more of system component operation, or the loss of the video switcher or other head-end equipment. Provide an on-site authorized factory technician within 24 hours if required.

J. If equipment cannot be repaired within 24 hours of service visit, Contractor shall provide "loaner" equipment to the Owner at no charge.

1.7 SUBMITTALS

A. Product Data: Product Data submittal shall only be required if the Contractor requests a substitution or a particular brand product is not specified or recommended.

1. Manufacturer’s printed or electronic data sheets.
2. Manufacturer’s installation and operations manuals.
3. Manufacturer’s warranty information.

B. Include individual device counts by model number, mounts, and other required appurtenances required for a fully functional video management system.

A. Include details of construction, interface of equipment, and relationship with adjacent construction (if applicable).

1. Provide server and storage specifications and storage calculations with estimated video retention time per server based on the requirements as outlined within these specifications.
2. Provide installation diagrams and pertinent information for all devices, i.e. rack space for recorders, power requirements, rough-ins, etc.
3. Provide a spreadsheet detailing each camera, model, IP and MAC address, firmware, included mounts and other hardware as needed.

C. Procedures

1. Provide submittals to Owner’s Project Manager.
2. Submit electronic copy of each submittal.

D. Shop Drawings

1. General Shop Drawings for the project as described elsewhere.
2. Provide other Shop Drawings only if specifically requested by Owner’s Project Manager.

E. Manufacturers Installation and Programming Instructions

1. Provide Manufacturers Installation and Programming Instructions as requested in the various Specification Sections.

F. Project Record Drawings

1. Definition: Project Record Drawings are drawings that completely record and document all aspects and features of the Work. (Also known as “as-built” drawings.)
2. The purpose of Project Record Drawings is to provide factual information regarding all aspects of the Work, to enable future service, modifications, and additions to the Work.
3. Project Record Drawings are an important element of this Work. Contractor shall accurately maintain Project Record Drawings throughout the course of this project. Project Record Drawings shall include documentation of all Work, including the documentation of existing equipment, wiring, conduits, and raceways that are to be reused in the Work.
4. Owner Project Manager shall furnish Contractor with two (2) sets of site plans for Contractor's use in preparing Project Record Drawings. One set shall be used as a working set, the other shall be used to prepare the final record set.

5. Contractor shall maintain the working set of Project Record Drawings at the project site throughout the course of the Work. The working set shall be updated on a daily basis as the Work progresses.
6. Project Record Drawings shall accurately show the physical placement of the following:

    a.) Equipment and devices.
    b.) Conduit and raceways.
    c.) Junction and pull box locations.
    d.) End-of-line resistor locations.
    e.) Interfaces to external equipment.
    f.) Connections to power and telephone circuits.

G. Project Record Drawings shall show the physical placement of each device and conduit or aerial center line, to be accurate to within one foot (1') of the nearest landmark. Where the site plan furnished by Owner's Project Manager conflicts with actual conditions, Contractor shall amend site plan as required. Indicate exact description of conduit runs (above ground, two-foot trench, along outside wall of building, etc.).

H. Project Record Drawings shall show wire and cable runs, zone numbers, tamper circuit configuration, panel/circuit breaker numbers from which equipment is powered, and splice points. Such information may be shown on the site plans.

I. Project Record Drawings shall be available for inspection by Owner's Project Manager on a daily basis. Incomplete or inaccurate Project Record Drawings may be cause for delay of Contractor's payment.

J. Upon completion of Work, and prior to Final Acceptance, Contractor shall prepare and submit to Owner's Project Manager a final record set of Project Record Drawings. This set shall consist of all data transferred from the working set, supplemented by Riser Diagrams and other information. The final record set of Project Record Drawings shall be drafted by a skilled draftsperson, under the supervision of Contractor. All final Project Record Drawings shall be provided to Owner.

K. System Documentation

1. Definition: System Documentation is a complete collection of all installation, programming, operation, and maintenance manuals and work sheets relating to the equipment provided as part of the Work.
2. Contractor shall maintain a file of System Documentation at the project site throughout the course of the Work. Such file shall be updated with new information as equipment is received and installed. System Documentation shall be available for inspection by Owner Project Manager on a daily basis.
3. Upon completion of Work, and prior to final Acceptance, Contractor shall prepare and submit to Owner's Project Manager electronic sets of System Documentation.

L. Closeout Submittals

1. Provide a set of as-built drawings and manuals to the Owner's Project Manager
    a.) As-Built Drawings
    b.) Mounting Details
    c.) Product Data
    d.) Installation Manuals
    e.) Operating Manuals

f.) Maintenance/Service Manuals

2. Provide the Owner’s Project Manager- with all programming sheets, keys to the equipment cabinets, as-built drawings, operating manuals, maintenance/repair manuals, spare fuses, all programming sheets and keys to the equipment cabinets, tools for tamper-resistant enclosures and tools for manual resetting devices.
3. Complete hardcopy printout and electronic copy from the system Device Manager which outlined system and camera configuration, which includes camera model number, IP address, and MAC address, image and other system settings.

## 1.8 DISCLOSURE OF NON-CONFORMING EQUIPMENT

A. Project owner desires to make an informed decision regarding the Contractor's proposed project approach, mobilization, staging and overall implementation schedule of tasks.

B. Contractor is required to disclose, separate from any cut or advertising sheets, any functional, operational or electrical requirements of these specifications that they are not able to perform, and/or which fall outside the scope of their quotation.

C. The form of this disclosure shall be by letter clearly identifying these noncompliant items and describing how the Contractor intends to address these issues.

D. Absent such disclosure, Contractors shall be responsible for ensuring that their systems will fully operate as outlined in these specifications without additional cost to the owner or other parties.

E. Contractor may elect to provide an alternate design approach if cost savings could be realized. This approach shall be clearly outlined within their submittal and should not consider any sacrifice of system functionality or capacity.

## 1.9 DELIVERY, STORAGE, AND HANDLING

A. Security of Contractor’s Tools and Equipment: Owner is not responsible for the care, storage or security of any of the Contractor's tools or equipment.

## 1.10 PROJECT/SITE CONDITIONS

A. Environmental Conditions

1. Power: Electrical power will be supplied by Owner to the extent that the usage is compatible with available facilities in the vicinity of the work.
2. Telephone: Contractor may use a telephone designated by Owner for local and toll-free calls. The costs of long distance calls are the responsibility of the Contractor and shall not be charged to Owner.
3. Rest room Facilities: Contractor may use existing Rest room facilities designated by Owner.
4. Parking: Owner reserves the right to limit or restrict Contractor parking based upon the daily requirements of the other contractors on site.
5. Dust Control: Make provisions to control all dust, dirt, and foreign material caused by the performance of the Work.

6. Use of explosive type fastening equipment is prohibited.
7. Notify Owner immediately of any damage or possible damage to any other equipment.

B. Clean-Up

1. Contractor shall clean-up, on a daily basis as the Work progresses, all dirt, dust and debris caused by Contractor’s operations. Clean-up shall be completed by the end of each workday to the satisfaction of Owner's on-site representative.
2. In the event that Contractor fails to clean-up, Owner may elect to have clean-up performed by others, with the costs of such clean-up being charged to the Contractor.

C. Construction Aids

1. Definition: Construction Aids are facilities and equipment required by personnel to facilitate the execution of the Work. Construction Aids include scaffolds, staging, ladders, platforms, hoists, cranes, lifts, trenchers, core drillers, protective equipment, and other such facilities and equipment.
2. Contractor shall provide all Construction Aids required in the execution of the Work. Construction Aids that are the property of Owner or other contractors shall not be used without permission.
3. Storage of Construction Aids shall be coordinated with Owner's on-site representative.

D. Safety

1. The Contractor shall be responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the Work.
2. Contractor shall comply with all local, state, and federal regulations and laws for the safety of the work place.

E. Accident Reports

1. Serious or fatal accidents shall be reported immediately by telephone or radio to the Owner's Project Manager.

F. Existing Conditions

1. Owner does not warrant the condition of any portion of the existing wiring, conduit or raceway systems. Prior to submitting his proposal, Contractor shall examine all existing conditions and determine to what extent the existing wiring, conduit, and raceway systems may be reused.
2. Contractor's proposal price shall include the cost of replacing existing wiring, conduit, and raceways as required.

## 1.11 SEQUENCING

A. Description

1. This implementation plan describes the general approach that shall be followed in order to minimize the time for the security video systems to be operational.

B. Approach

1. Contractor shall plan and schedule all work in such a sequence as to minimize the time before the system is operational. The following is a suggested work sequence:

   a.) Order all equipment needed and notify any subcontractors to schedule their participation.
   b.) Perform all system layout work.
   c.) Insure there are an adequate number of power receptacles available to operate all security equipment and coordinate with Owner as to where power is available.
   d.) Provide shop drawings to verify location of all equipment, conduit runs, power connections, etc. Submit shop drawings to Owner Project Manager.
   e.) Coordinate with Owner to provide space in each building's Communications Room for mounting of processors.
   f.) Prepare and pre-test all equipment to the greatest extent possible.
   g.) Meet with owner to define programming requirements.
   h.) Install all equipment.
   i.) Confirm all field-of-views are correct with the owner.
   j.) Provide training on the programming other various options.
   k.) Test and inspect all systems.
   l.) Perform all other Work as required.
   m.) Perform the Acceptance Test.
   n.) Provide training.
   o.) Provide as-built drawings, O&M Manuals and other required deliverables.

## 1.12 SCHEDULING

A. The Contractor, within five (5) days after being awarded the contract, shall prepare and submit for Owner's information, an estimated progress schedule for the Work. The progress schedule shall be related to the entire project, and shall indicate start and completion dates.

## 1.13 SYSTEM STARTUP

A. Power shall only be applied to the system after re-checking for proper grounding of the system and measuring all loops for lack of shorts, grounds, and open circuits.

## 1.14 OWNER'S INSTRUCTIONS

A. Coordination with Owner

1. Contractor shall closely schedule and coordinate his activities with designated Owner representatives.
2. Contractor shall provide Owner's Project Manager with a work plan on a weekly basis. Such work plan will describe locations of intended activities, types of activities, and potential conflicts to facility operations.

B. Owner's Right to Carry Out The Work

1. If the Contractor defaults or neglects to carry out the Work in accordance with the Project Drawings and Specifications and fails within seven days after receipt of written notice from Owner to commence and continue correction of such default or neglect with

diligence and promptness, Owner may, after seven days following receipt of an additional written notice and without prejudice to any other remedy Owner may have, make good such deficiencies. In such case, an appropriate Change Order shall be issued deducting from the payments then or thereafter due the Contractor the cost of correcting such deficiencies.

C. Minor Changes in The Work

1. Owner shall have the authority to order minor changes in the Work not involving an adjustment in the Contract Sum or an extension of the Contract Time and not inconsistent with the intent of the Project Drawing and Specifications. Such changes shall be provided by written order.

1.15 COMMISSIONING

A. Manufacturer shall provide the opportunity to assist Contractor with commissioning.

B. After all Work is completed, and prior to requesting the Acceptance test, Contractor shall conduct a final inspection, and pre-test all equipment and system features. Contractor shall correct any deficiencies discovered as the result of the inspection and pre-test.

C. Contractor shall submit a request for the Acceptance test in writing to the Owner Project Manager, no less than fourteen days prior to the requested test date. The request for Acceptance test shall be accompanied by a certification from Contractor that all Work is complete and has been pre-tested, and that all corrections have been made.

D. During Acceptance test, Contractor shall demonstrate all equipment and system features to Owner. Contractor shall remove covers, open wiring connections, operate equipment, and perform other reasonable work as requested by Owner.

1. Verify proper fields of view, operation of auto-iris lenses, maximize WDR and day/night settings for the environment.
2. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.
3. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object 50 to 75 feet away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place. Adjust IR illumination as required.
4. Demonstrate that system recording requirements are met with frames-per-second, image quality and retention.
5. Set and name all preset positions at the direction of Owner's personnel.
6. Set sensitivity of motion detection zones, configure system alarms from motion detection zones, virtual trip lines, PTZ hand-over and all other analytics that may be required of this project.
7. Configure camera names, sequencing, salvos, and other "virtual matrix and/or video-wall" configurations that may be required of this project.

E. Any portions of the Work found to be deficient or not in compliance with the Project Drawing and Specifications will be rejected. Owner Project Manager will prepare a list of any such

deficiencies observed during the Acceptance test. Contractor shall promptly correct all deficiencies. Upon correction of deficiencies, Contractor shall submit a request in writing to Owner Project Manager for another Acceptance Test.

F. If, at the conclusion of the Acceptance Test, all Work is found to be acceptable and in compliance with the Project Drawings and Specifications, Owner Project Manager will issue a letter of Acceptance to Contractor and Owner.

## 1.16 MAINTENANCE

A. Provide full procedures for all database back-ups and system restores.

B. Provide full procedures for server/workstation hard drive maintenance, such as defrag, etc.

1. Provide full procedures for maintaining physical and software firewalls.
2. Provide full procedures for upgrading software.

C. Provide full procedures for testing battery condition on all field panels for adequate back-up time.

D. Provide full procedures for any other tasks that must be performed to ensure the warranty remains intact.

## 1.17 MANUFACTURERS

A. Qualification of the Manufacturer:

1. All equipment described herein shall be the product of a manufacturer of established reputation and experience, who shall have produced similar equipment for a period of at least 5 years and who shall be able to refer to similar installations now rendering satisfactory service.
2. Perform all work under the onsite supervision of a factory authorized, trained technician. It shall be the responsibility of the technician to check, inspect and adjust this installation to the engineer's and owner approval. A CSR of the installing contractor or manufacturer shall train the owner's personnel on the proper operation and maintenance of the equipment. Perform all work in conjunction with this installation in accordance with good engineering practices as established by NEC.
3. The manufacturer and their local agent shall show satisfactory evidence upon request that they maintain a fully equipped service center capable of furnishing adequate inspection and service to the equipment including standard replacement parts. The manufacturer and/or agent shall be prepared to offer a service contract for the maintenance of the system after the warranty period.
4. To establish continuity in the manufacturer, systems components shall be the standard product of one manufacturer. Further, an effort shall be made to establish common sources for equipment of all systems. The manufacturer will have a minimum of five (5) years' experience in the manufacture of progressive products specified.
5. Manufacturer shall have local sales and technical support available. During the installation process, manufacturer shall be actively involved to assist with the installation.

Upon completion of the installation, manufacturer shall provide an on-site review of the installation and provide the end-user training on an “as needed” basis.

## PART 2 - PRODUCTS

### 2.1 PRODUCT EQUIVALENCY

A. Where products are listed with multiple manufacturers, these manufacturers will be approved as equals if all specified features are provided. Any equipment not specifically approved in writing prior to the bid date will not be considered regardless of qualifications. Failure to provide the "precise functional equivalent" shall result in the removal of the alternate equipment at the Contractor’s expense.

B. Different manufacturers may require various options, accessories, converters, patch cables, etc. to perform the specified features and functions. Therefore, all material and/or equipment necessary for proper operation of the system shall be deemed part of these specifications.

C. This specification is intended to establish a carefully planned minimum level of quality and performance for all components and will be rigorously enforced by Owner. Acceptable manufacturers of components described herein.

D. Products not listed as equals shall be submitted to BCL through the appropriate channels prior to the final RFI submission date.

### 2.2 MANUFACTURERS

A. Basis of Design is Axis and Hanwha Techwin America with considered equals by Verkada or Bosch.

B. For substitutions to be considered; the contractor shall submit supporting documentation clearly describing functionality and features to meet or exceed the products named. Substitutions shall be pre-approved by the A&E, system designer or owner before contractor submission.

C. All products provided shall meet the National Defense Authorization Act (NDAA) compliancy requirements which addresses the prohibited use of certain video surveillance telecommunications services, equipment and components manufactured by specific vendors.

D. Must be compatible with Access Control Management System and Intrusion Detection system (if applicable). Equipment supplier shall have a service organization that can respond to emergency service calls within 8 hours.

E. All system cameras and supporting devices such as servers, storage, encoders, media-convertors, etc. must have a manufacturers limited 5-year warranty to be free from defects.

F. All material and/or equipment necessary for proper operation of the system, not specified or described herein, shall be deemed part of these specifications.

## 2.3 GENERAL

A. All equipment and materials used shall be standard components that are regularly manufactured and used in the manufacturer's system.

B. All systems and components shall have been thoroughly tested and proven in actual use.

C. All systems and components shall be provided with the availability of a toll-free (U.S. and Canada), 24-hour technical assistance program (TAP) from the manufacturer. The TAP shall allow for immediate technical assistance for either the dealer/installer or the end user at no charge for as long as the product is installed.

D. Cameras shall be IP-based and comply with established network and video standards.

E. Cameras shall be powered by the switch utilizing the network cable.

F. Cameras shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third party applications.

G. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor's entry connection to components.

H. Onboard camera analytics shall be edge-based and at no additional cost to the owner.

I. Cameras shall be ONVIF compliant.

J. Cameras shall support secure boot.

## 2.4 CAMERA MANAGEMENT SOFTWARE

A. Provide and install the selected manufacturer's device manager software to manage the video surveillance devices in network including IP cameras, NVRs and Cloud-Based video surveillance by enabling users to remotely configure multiple devices simultaneously.

B. The software shall support backing up and restoring configuration data from multiple cameras as well as pushing firmware upgrades. Backup file name shall include model number, IP address, and MAC address, and shall be user editable. Backup and restore shall be performed in parallel or sequential mode, and at a user desired relative or absolute time. The software shall support restoring a single configuration to multiple devices.

C. The software shall support setting camera image menu adjustments including SSDR, WDR, white balance, backlight compensation, exposure, day/night, special, & OSD. Image adjustments shall be performed and displayed on a selected camera immediately, and to other selected cameras per model upon selection.

D. Software shall be free of charge with no annual licensing or renewals.

E. Provide all required licenses for the specified system components.

## 2.5 VIDEO SURVEILLANCE SCHEDULE

A. Camera types listed below describing various resolutions, form-factor and features shall be supplied by a single camera manufacturer video surveillance system.

## 2.6 4K OUTDOOR RUGGIDIZED CAMERA (EXTERIOR OF BUILDING)

A. The camera shall be used to capture clear security video images at exterior locations using an IR-sensitive 4K sensor with integrated IR illumination in a IK10/IP66 minimally rated dome enclosure with motorized vari-focal, auto-iris lens.

B. The camera shall minimally meet the operating characteristics of the Axis Q3518-LVE, Hanwha XNV-9082R or pre-accepted submitted equal.

C. Minimum Illumination:
   1. 0.19 lux F1.7 (color)
   2. 0.04 lux F1.7 (B/W)
   3. 0 lux with IR illumination on

D. Resolution
   1. The camera shall be designed to provide video streams in (3840x2160) at up to 30 frames per second (60Hz mode) or 25 frames per second (50Hz mode) using H.265, H.264 or Motion JPEG.
   2. The camera shall provide up to 8 individually cropped out view areas.
   3. The camera shall support video resolutions including:
      a.) 3840x2160
      b.) 1920x1080 (HDTV 1080p)
      c.) 1280x720 (HDTV 720p)
   4. The camera shall provide both landscape format (4:3 and 16:9 aspect ratio) as well as corridor format (3:4 and 9:16 aspect ratio).

E. Encoding
   1. The camera shall support the following video encoding algorithms:
      a.) Motion JPEG encoding in a selectable range from 1 up to 25/30 frames per second in all resolutions.
      b.) Baseline Profile H.264/H.264 encoding with motion estimation in up to 25/30 frames per second.
      c.) Main Profile H.265/H.264 encoding with motion estimation and context-adaptive binary arithmetic coding (CABAC) in up to 25/30 frames per second.
      d.) Support High Profile H.265/H.264 encoding with motion estimation up to 25/30 frames per second.
      e.) Support H.265/H.264 with automatic scene adaptive bitrate control in up to 25/30 frames per second.

F. IR Illumination
   1. The camera shall be equipped with built-in IR LEDs
   2. The IR LEDs shall minimally have a range of up to 30 m (100 ft.)
   3. The IR LEDs shall emit light with a wavelength of 850 nm

G. Event and Intelligent Analytics functionality

1. The camera shall be equipped with an integrated event functionality, which can be trigged by:
    a.) Video Motion Detection
    b.) Directional Detection
    c.) Loitering
    d.) Virtual Trip Line
    e.) Live Stream Accessed
    f.) Camera tampering
    g.) Manual Trigger/Virtual Inputs
    h.) PTZ functionality
    i.) Embedded third party applications capable
    j.) Edge storage disruption detection

H. Edge storage
1. The camera shall support continuous and event controlled recording to:
    a.) Local memory added to the cameras SD-card slot(s)
    b.) Network attached storage, located on the local network
2. The camera shall be able to detect and notify Edge storage disruptions.

I. Security
1. The camera shall support the use of HTTPS and SSL/TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
2. The camera shall provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services.
3. The camera shall support IEEE 802.1X authentication.
4. The camera shall provide support for restricting access to pre-defined IP addresses only, so-called IP address filtering.
5. The camera shall restrict access to the built-in web server by usernames and passwords at three different levels.

J. API support
1. The camera shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third party applications.
2. The camera shall conform to ONVIF profile G as defined by the ONVIF Organization.
3. The camera shall conform to ONVIF profile S as defined by the ONVIF Organization.
4. The camera shall conform to ONVIF profile T as defined by the ONVIF Organization.
5. For ONVIF profile specifications, see www.onvif.org/

K. Embedded applications
1. The camera shall provide a platform allowing the upload of third party applications into the camera.

2.7 5/6 MP VANDAL-RESISTANT MINI DOME FULL HIGH DEFINITION (FHD) NETWORK CAMERA (HALLWAYS AND CORRIDORS)

A. The camera shall be used to capture clear security video images at interior locations using an IR-sensitive 5 or 6 MP sensor with integrated IR illumination in a IK10/IP52 minimally rated dome enclosure with motorized vari-focal, auto-iris lens.

B. Camera shall minimally meet the operating characteristics of the Axis Q3517-LVE, Hanwha XND-8082RV or pre-accepted submitted equal.

C. Minimum Illumination
1. 5/6MP 25/30 fps with WDR:
a.) Color: 0.12 lux at 50 IRE, F1.5
b.) B/W: 0.02 lux at 50 IRE, F1.5
c.) 0 lux with IR illumination on

D. Resolution
1. The camera shall be designed to provide at least two video streams in 5/6 MP (3072x1728) at up to 30 frames per second (60 Hz mode) or 25 frames per second (50 Hz mode) using H.265/H.264 or Motion JPEG.
2. The camera shall support video resolutions including:
a.) 3072x1728
b.) 2240x1680
c.) 1920x1080 (HDTV 1080p)
d.) 1280x720 (HDTV 720p)

E. The camera shall provide both landscape format (4:3 and 16:9 aspect ratio) as well as corridor format (3:4 and 9:16 aspect ratio).

F. Encoding

1. The camera shall support the following video encoding algorithms:
2. Motion JPEG encoding in a selectable range from 1 up to 25/30 frames per second (3072x1728).
3. Baseline Profile H.265/H.264 encoding with motion estimation in up to 25/30 frames per second (3072x1728).
4. Main Profile H.265/H.264 encoding with motion estimation and context-adaptive binary arithmetic coding (CABAC) in up to 25/30 frames per second (3072x1728).
5. Support High Profile H.265/H.264 encoding with motion estimation up to 25/30 frames per second (3072x1728).
6. Support H.265/H.264 with automatic scene adaptive bitrate control.
7. The camera shall provide independently configured simultaneous H.265/H.264 and Motion JPEG streams.
8. The camera shall in H.265/H.264 support Variable Bit Rate (VBR) for video quality adapted to scene content. To protect the network from unexpected bit rate speaks the camera shall support Constant Bit Rate (CBR) or Maximum Bit Rate (MBR).
9. The camera shall provide configurable compression levels.
10. The camera shall support standard baseline profile H.265/H.264 with motion estimation.
11. The camera shall support motion estimation in H.265/H.264/MPEG-4 Part 10/AVC.
12. The camera shall for its H.265/H.264 implementation support scene adaptive bitrate control with automatic dynamic ROI to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements.

G. IR Illumination
   1. The camera shall be equipped with built-in IR LEDs.
   2. The IR LEDs shall have a range of up to 40 m (130 ft.)
   3. The IR LEDs shall emit light with a wavelength of 850 nm.

H. Event and Intelligent Analytics functionality
   1. The camera shall be equipped with an integrated event functionality, which can be trigged by:
      a.) Video Motion Detection
      b.) Directional Detection
      c.) Loitering
      d.) Virtual Trip Line
      e.) Live Stream Accessed
      f.) Camera tampering
      g.) Manual Trigger/Virtual Inputs
      h.) PTZ functionality
      i.) Embedded third party applications capable
      j.) Edge storage disruption detection

I. Edge storage
   1. The camera shall support continuous and event controlled recording to:
      a.) Local memory added to the cameras microSD-card slot
      b.) Network attached storage, located on the local network
   2. The camera shall incorporate encryption functionality for the SD card.
   3. The camera shall be able to detect and notify Edge storage disruptions.

J. Security
   1. The camera shall support the use of HTTPS and SSL/TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
   2. The camera shall provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services.
   3. The camera shall support IEEE 802.1X authentication.
   4. The camera shall provide support for restricting access to pre-defined IP addresses only, so-called IP address filtering.
   5. The camera shall restrict access to the built-in web server by usernames and passwords at three different levels.

K. API support
   1. The camera shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third party applications.
   2. The camera shall conform to ONVIF profile G as defined by the ONVIF Organization.
   3. The camera shall conform to ONVIF profile S as defined by the ONVIF Organization.
   4. The camera shall conform to ONVIF profile T as defined by the ONVIF Organization.
   5. For ONVIF profile specifications, see www.onvif.org/

L. Embedded applications
   1. The camera shall provide a platform allowing the upload of third party applications into the camera.

2.8 12 MP FIXED DOME FISHEYE WITH 180°/270°/360° PANORAMIC VIEW

A. The camera shall be used to capture clear security video images at interior or exterior locations using an IR-sensitive 12 MP fisheye sensor with integrated IR illumination in a IK10/IP66/NEMA4X minimally rated dome enclosure.

B. Camera shall minimally meet the operating characteristics of the Axis M3058-PLVE, Hanwha XNF-9010RV or pre-accepted submitted equal.

C. Illumination
1. Color: 0.39 lux at 50 IRE F2.2
2. B/W: 0.04 lux at 50 IRE F2.2
3. 0 lux with IR illumination on

D. Resolution
1. The camera shall be designed to provide at multiple, individually configurable streams in H.265/H.264 and Motion JPEG.
2. The camera shall support 360° overview, corridor and quad views. Up to four individually cropped out and de-warped view areas. The 360° overview can be streamed simultaneously with four view areas or one other de-warped view.
3. The camera shall support video resolutions including:
   a.) Overview: 2992x2992 to 160x160
   b.) Double Panorama: 3584x1792
   c.) Quad view: 3584x2688 to 256x144
   d.) View area 1-4, 16:9: 2304x1296 to 256x144, 4:3: 2048x1536 to 320x240
   e.) Corridor: 2560x1920 to 256x144
4. The camera shall provide both landscape format (4:3 and 16:9 aspect ratio) as well as corridor format (3:4 and 9:16 aspect ratio).

E. Encoding
1. The camera shall support the following video encoding algorithms:
   a.) Motion JPEG encoding with WDR in a selectable range from 1 up to 12.5/15 frames per second in 360° overview and de-warped views.
   b.) Motion JPEG encoding without WDR in a selectable range from 1 up to 25/30 frames per second in 360° overview.
   c.) Baseline Profile H.265/H.264 encoding with motion estimation.
   d.) Main Profile H.265/H.264 encoding with motion estimation and context-adaptive binary arithmetic coding (CABAC).
   e.) High Profile H.265/H.264 encoding with motion estimation.
2. The camera shall provide independently configured simultaneous H.265/H.264 and Motion JPEG streams.
3. The camera shall in H.265/H.264 support Variable Bit Rate (VBR) for video quality adapted to scene content. To protect the network from unexpected bit rate speaks the camera shall support Maximum Bit Rate (MBR).
4. The camera shall provide configurable compression levels.
5. The camera shall support standard baseline profile H.265/H.264 with motion estimation.
6. The camera shall support motion estimation in H.265/H.264/MPEG-4 Part 10/AVC.
7. The camera shall for its H.265/H.264 implementation support scene adaptive bitrate control with automatic dynamic ROI to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements.

F. IR Illumination
   1. The camera shall be equipped with built-in IR LEDs.
   2. The IR LEDs shall have a range of up to minimally 10m (32 ft.)
   3. The IR LEDs shall emit light with a wavelength of 850 nm.

G. Event and Intelligent Analytics functionality
   1. The camera shall be equipped with an integrated event functionality, which can be trigged by:
      a.) Video Motion Detection
      b.) Directional Detection
      c.) Loitering
      d.) Virtual Trip Line
      e.) Live Stream Accessed
      f.) Camera tampering
      g.) Manual Trigger/Virtual Inputs
      h.) PTZ functionality
      i.) Embedded third party applications capable
      j.) Edge storage disruption detection

H. Edge storage
   1. The camera shall support continuous and event controlled recording to:
      a.) Local memory added to the cameras microSD-card slot
      b.) Network attached storage, located on the local network
   2. The camera shall incorporate encryption functionality for the SD card.
   3. The camera shall be able to detect and notify edge storage disruptions.

I. Security
   1. The camera shall support the use of HTTPS and SSL/TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
   2. The camera shall provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services.
   3. The camera shall support IEEE 802.1X authentication.
   4. The camera shall provide support for restricting access to pre-defined IP addresses only, so-called IP address filtering.
   5. The camera shall restrict access to the built-in web server by usernames and passwords at three different levels.

J. API support
   1. The camera shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third party applications.
   2. The camera shall conform to ONVIF profile G as defined by the ONVIF Organization.
   3. The camera shall conform to ONVIF profile S as defined by the ONVIF Organization.
   4. The camera shall conform to ONVIF profile T as defined by the ONVIF Organization.
   5. For ONVIF profile specifications, see www.onvif.org/

## 2.9 15-20 MP 4-CHANNEL MULTI-SENSOR CAMERA

A. The camera shall be used to capture clear security video images at interior or exterior locations using a 4 individual IR-sensitive 5MP sensors with integrated IR illumination in a IK10/IP66/NEMA4X minimally rated dome enclosure. Each individual sensor shall be remotely adjustable with Pan Tilt Rotate and Zoom capability.

B. Camera shall minimally meet the operating characteristics of the Axis P3719-PLE, Hanwha PNM-9085RQZ or pre-accepted submitted equal.

C. Illumination
   1. Color: 0.20 lux at 50 IRE F1.8
   2. B/W: 0.04 lux at 50 IRE F1.8
   3. 0 lux with IR illumination on

D. Resolution
   1. The camera shall be designed to provide at least two video streams in 5 MP (3072x1728) at up to 30 frames per second (60 Hz mode) or 25 frames per second (50 Hz mode) using H.265/H.264 or Motion JPEG.
   2. The camera shall support video resolutions including:
      a.) 3072x1728
      b.) 2240x1680
      c.) 1920x1080 (HDTV 1080p)
      d.) 1280x720 (HDTV 720p)

E. The camera shall provide both landscape format (4:3 and 16:9 aspect ratio) as well as corridor format (3:4 and 9:16 aspect ratio).

F. Encoding

   1. The camera shall support the following video encoding algorithms:
   2. Motion JPEG encoding in a selectable range from 1 up to 25/30 frames per second (3072x1728).
   3. Baseline Profile H.265/H.264 encoding with motion estimation in up to 25/30 frames per second (3072x1728).
   4. Main Profile H.265/H.264 encoding with motion estimation and context-adaptive binary arithmetic coding (CABAC) in up to 25/30 frames per second (3072x1728).
   5. Support High Profile H.265/H.264 encoding with motion estimation up to 25/30 frames per second (3072x1728).
   6. Support H.265/H.264 with automatic scene adaptive bitrate control.
   7. The camera shall provide independently configured simultaneous H.265/H.264 and Motion JPEG streams.
   8. The camera shall in H.265/H.264 support Variable Bit Rate (VBR) for video quality adapted to scene content. To protect the network from unexpected bit rate speaks the camera shall support Constant Bit Rate (CBR) or Maximum Bit Rate (MBR).
   9. The camera shall provide configurable compression levels.
   10. The camera shall support standard baseline profile H.265/H.264 with motion estimation.
   11. The camera shall support motion estimation in H.265/H.264/MPEG-4 Part 10/AVC.
   12. The camera shall for its H.265/H.264 implementation support scene adaptive bitrate control with automatic dynamic ROI to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements.

G. IR Illumination
   1. The camera shall be equipped with built-in IR LEDs.
   2. The IR LEDs shall have a range of up to 30 m (98 ft.)
   3. The IR LEDs shall emit light with a wavelength of 850 nm.

H. Event and Intelligent Analytics functionality
   1. The camera shall be equipped with an integrated event functionality, which can be trigged by:
      a.) Video Motion Detection
      b.) Directional Detection
      c.) Loitering
      d.) Virtual Trip Line
      e.) Live Stream Accessed
      f.) Camera tampering
      g.) Manual Trigger/Virtual Inputs
      h.) PTZ functionality
      i.) Embedded third party applications capable
      j.) Edge storage disruption detection

I. Edge storage
   1. The camera shall support continuous and event controlled recording to:
      a.) Local memory added to the cameras microSD-card slot for each sensor
      b.) Network attached storage, located on the local network
   2. The camera shall incorporate encryption functionality for the SD card.
   3. The camera shall be able to detect and notify Edge storage disruptions.

J. Security
   1. The camera shall support the use of HTTPS and SSL/TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
   2. The camera shall provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services.
   3. The camera shall support IEEE 802.1X authentication.
   4. The camera shall provide support for restricting access to pre-defined IP addresses only, so-called IP address filtering.
   5. The camera shall restrict access to the built-in web server by usernames and passwords at three different levels.

K. API support
   1. The camera shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third party applications.
   2. The camera shall conform to ONVIF profile G as defined by the ONVIF Organization.
   3. The camera shall conform to ONVIF profile S as defined by the ONVIF Organization.
   4. The camera shall conform to ONVIF profile T as defined by the ONVIF Organization.
   5. For ONVIF profile specifications, see www.onvif.org/

L. Embedded applications
   1. The camera shall provide a platform allowing the upload of third party applications into the camera.

## 2.10 15 MP MULTI-SENSOR 180° PANORAMIC CAMERA

A. The camera shall be used to capture clear security video images at interior or exterior locations using a 3-4 individual IR-sensitive 5MP sensors in a IK10/IP66 minimally rated dome enclosure.

B. Camera shall minimally meet the operating characteristics of the Axis Q3708-PVE, Hanwha PNM-9031V or pre-accepted submitted equal.

C. Illumination
   1. Color: 0.30 lux at 50 IRE F2.8
   2. B/W: 0.06 lux at 50 IRE F2.8

D. Resolution
   1. The camera shall be designed to provide at least two video streams in 5 MP (3072x1728) at up to 30 frames per second (60 Hz mode) or 25 frames per second (50 Hz mode) using H.265/H.264 or Motion JPEG.
   2. The camera shall support video resolutions including:
      a.) 3072x1728
      b.) 2240x1680
      c.) 1920x1080 (HDTV 1080p)
      d.) 1280x720 (HDTV 720p)

E. The camera shall provide both landscape format (4:3 and 16:9 aspect ratio) as well as corridor format (3:4 and 9:16 aspect ratio).

F. Encoding

   1. The camera shall support the following video encoding algorithms:
   2. Motion JPEG encoding in a selectable range from 1 up to 25/30 frames per second (3072x1728).
   3. Baseline Profile H.265/H.264 encoding with motion estimation in up to 25/30 frames per second (3072x1728).
   4. Main Profile H.265/H.264 encoding with motion estimation and context-adaptive binary arithmetic coding (CABAC) in up to 25/30 frames per second (3072x1728).
   5. Support High Profile H.265/H.264 encoding with motion estimation up to 25/30 frames per second (3072x1728).
   6. Support H.265/H.264 with automatic scene adaptive bitrate control.
   7. The camera shall provide independently configured simultaneous H.265/H.264 and Motion JPEG streams.
   8. The camera shall in H.265/H.264 support Variable Bit Rate (VBR) for video quality adapted to scene content. To protect the network from unexpected bit rate speaks the camera shall support Constant Bit Rate (CBR) or Maximum Bit Rate (MBR).
   9. The camera shall provide configurable compression levels.
   10. The camera shall support standard baseline profile H.265/H.264 with motion estimation.
   11. The camera shall support motion estimation in H.265/H.264/MPEG-4 Part 10/AVC.
   12. The camera shall for its H.265/H.264 implementation support scene adaptive bitrate control with automatic dynamic ROI to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements.

G. Event and Intelligent Analytics functionality
   1. The camera shall be equipped with an integrated event functionality, which can be trigged by:

a.) Video Motion Detection
b.) Directional Detection
c.) Loitering
d.) Virtual Trip Line
e.) Live Stream Accessed
f.) Camera tampering
g.) Manual Trigger/Virtual Inputs
h.) PTZ functionality
i.) Embedded third party applications capable
j.) Edge storage disruption detection

H. Edge storage
1. The camera shall support continuous and event controlled recording to:
a.) Local memory added to the cameras microSD-card slot
b.) Network attached storage, located on the local network
2. The camera shall incorporate encryption functionality for the SD card.
3. The camera shall be able to detect and notify Edge storage disruptions.

I. Security
1. The camera shall support the use of HTTPS and SSL/TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
2. The camera shall provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services.
3. The camera shall support IEEE 802.1X authentication.
4. The camera shall provide support for restricting access to pre-defined IP addresses only, so-called IP address filtering.
5. The camera shall restrict access to the built-in web server by usernames and passwords at three different levels.

J. API support
1. The camera shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third party applications.
2. The camera shall conform to ONVIF profile G as defined by the ONVIF Organization.
3. The camera shall conform to ONVIF profile S as defined by the ONVIF Organization.
4. The camera shall conform to ONVIF profile T as defined by the ONVIF Organization.
5. For ONVIF profile specifications, see www.onvif.org/

K. Embedded applications
1. The camera shall provide a platform allowing the upload of third party applications into the camera.

## 2.11 INTELLIGENT VIDEO ANALYTICS

A. The camera shall have a unique conventional intelligent video analytics to trigger an alarm based on user-defined rules.

B. The camera shall incorporate a built-in unique Intelligent Motion Detection (IMD) capability. To minimize false triggers, this Intelligent Motion Detection shall compare the current image with prior 15 frames within the camera. This algorithm shall allow the camera to discriminate against some environmental noise such as shaking leaves or Auto Gain Control maximum rate noise.

C. The camera shall have a camera tampering detection function that alerts the operator if the camera is tampered with. Tampering can include spraying of the camera lens, covering it with a cloth, or changing of the mounting direction.

D. The camera shall have the following scene analytics, all of which can be set from the camera setup menu:
   1. Intrusion: When a moving object enters the designated area, an alarm is triggered.
   2. Passing: A passage or virtual line is determined, and when a moving object passes the set line, an alarm is triggered.

## 2.12 MOUNTING

A. Contractor shall review the project drawings and specifications to provide the necessary mounting for each individual camera to include all surface and back-box adapters, pendant and wall mounts, caps and other appurtenances required for a professional installation taking into consideration aesthetics, vandal proof (IK rating) and weather resistance (IP rating). At no time shall camera wiring be exposed unless expressly approved by the architect, engineer or owner.

   1. Surface – Wall. Unit shall mount on surface of wall to either a recessed electrical outlet box or directly on the wall surface as indicated on the drawings. In some cases, a pendant arm mount may be required.
   2. Surface - Ceiling. Unit shall mount on surface of ceiling to either an electrical outlet box or directly on the ceiling surface as indicated on the drawings.
   3. Recessed – Ceiling. Unit shall mount recessed in an accessible ceiling via the use of ceiling grid support hardware or shall be recessed directly into a fixed ceiling system with appropriate hardware.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerance, hazards to camera installation, and other conditions affecting installation.

B. Examine roughing-in for LAN, WAN, and IP network before device installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 CONTRACTOR/OWNER COMMUNICATIONS

A. Contractor shall obtain the following programming information from the Owner:

1. The labeling scheme for the cameras
   a.) Ex: (Building Name-CC-Camera #-Brief Location) Sunbeam-CC-001-RM150EXT
2. The IP address range to be used for cameras
3. Specific users/passwords to be used when setting up the system for administration/administrators.
4. Schedules to be created/maintained for required analytics (motion detection, virtual trip-line, etc.) and/or camera recording parameters.
5. Exterior cameras shall be surge protected at the camera in the interior building, or in a rack mounted surge protection device for multiple cameras in each TR tied to the grounding bar.

## 3.3 GENERAL INSTALLATION

A. Install systems in accordance with UL, NEC and all other applicable codes. Install system to comply with drawings and final shop drawings in compliance with manufacturer instructions. Provide all required hardware and labor for rack mounting of head-end system components.

B. Refer to plans for locations and quantities of equipment. Equipment locations shown on plans will be required to be field coordinated to ensure proper system operation. The contractor shall provide adequate costs in the bid to locate interior cameras within 10’ in any direction of the location indicated on the bid drawings. Exact location of each camera shall be coordinated with the owner in the field prior to installation. This coordination shall include a site survey with the owner in which the use of a field of view comparator is employed.

C. No items of equipment shall be installed in such a manner as to void or reduce the proper operating characteristics of individual components or of the system. Camera placement shall be coordinated with glass and exterior exposures to reduce or eliminate the requirement for sever back light compensation.

D. Perform all work under the on-site supervision of a factory authorized trained technician. It shall be the responsibility of the technician to check, inspect and adjust this installation to the engineer’s and owner approval. A CSR of the installing contractor or manufacturer shall train the owner’s personnel on the proper operation and maintenance of the equipment. Perform all work in conjunction with this installation in accordance with good engineering practices as established by NEC.

E. Camera Mounts: The Contractor shall install the camera mounts as specified by the manufacturer and as shown; provide mounting hardware sized appropriately to secure the mount, camera and housing, provide electrical and signal transmission cabling to the mount location as specified.

F. Cameras: The Contractor shall install the cameras with power and signal lines to the camera; aim camera to give field of view, configure/optimize WDR and Day/Night setting as needed so to cover the alarm zone and synchronize all cameras.

   1. Provide a change of all camera lenses up/down/size and/or adjust motorized vari-focal lens and re-aiming of each camera as directed by the Owner.

G. Delivery of all loose equipment which is to be turned over to owner shall be carefully coordinated and scheduled with owner prior to shipment

3.4 CYBER SECURITY PROTECTION

A. All cameras shall have the latest firmware installed.

B. Reset to factory default settings.

C. Set the root password
   1. Make sure to use a strong password and keep it protected. On a multi-camera installation, the cameras can have the same password or unique passwords. Using the same password simplifies management but increases the risk if one camera's security is compromised.
   2. When setting the initial password, the password is sent in clear text over the network. If there is a risk of network sniffing, first set up a secure an encrypted HTTPS connection before resetting the passwords.
   3. Use a password with at least 8 characters, preferably using a password generator.

D. Set user permissions

E. Configure basic network settings Set time and date

F. Disable audio

G. Enable encryption
   1. Access the camera using HTTPS, which encrypts the traffic between the client and the camera. All camera administrative tasks should go through HTTPS. Video streamed over RTP/RTSP is still unencrypted. If the video stream contains sensitive data, tunnel RTP/RTSP over HTTPS. This is controlled by (and depends on) the video client/VMS capabilities.
   2. A self-signed certificate is adequate for providing encryption, but the web browser will warn that the certificate cannot be validated. A CA-signed certificate is needed for the client to authenticate that it is accessing the correct camera.
   3. Enable HTTPS users with administration rights should encrypt traffic between the clients and the camera. This requires that the client supports HTTPS.

H. Create a backup admin account
   1. Create a backup administrator account with a different password than the primary administrator account.

I. Create video client account
   1. A client or a Video Management System (VMS) should normally use the operator group with restricted administrator privileges. Video systems and clients should not use the administrator account. In most cases the operator group is sufficient. However, the VMS may use services that require administrator rights.

J. Disable AVHS
   1. If the camera is not connected to a hosted video service, disable AVHS.

K. Disable discovery services
   1. Discovery protocols are support services that make it easier to find the cameras on the network. After deployment, you should stop the cameras from announcing their presence on the network by disabling the discovery protocol.

L. Configure advanced network settings
   1. Select Use the following DNS server address and specify the following:
   2. Enter the domain(s) to search for the host name used by the product. Multiple domains can be separated by semicolons. The host name is always the first part of a fully qualified domain name, for example, myserver is the host name in the fully qualified domain name myserver.mycompany.com where mycompany.com is the domain name.
   3. Enter the IP addresses of the primary and secondary DNS servers. The secondary DNS server is optional and is used if the primary is unavailable.

M. Disable SOCKS
   1. If the network is not using SOCKS, disable it in the network camera as well.

N. Disable QoS
   1. If Quality of Services is not being used, QoS should be disabled.

O. Disable always multicast video
   1. To prevent the camera from multicasting video by default, disable multicast video streaming. The camera can still multicast video upon request.

P. Disable SSH

Q. Set IP address filter
   1. video clients access live and recorded video only through the VMS, they should not be allowed to access any video directly through the cameras.
   2. Enabling IP filtering for authorized clients will prevent the camera from responding to network traffic from any other clients. Make sure to add all authorized clients (VMS server and administrative clients) to the white list.

R. Access to IEEE 802.1x network
   1. To be accepted in a network protected by IEEE 802.1x, the cameras need to have appropriate certificates and settings.

S. Configure SNMP monitoring.

T. Remote system log.

## 3.5 WIRING INSTALLATION

A. CCTV wiring shall be furnished and installed in accordance with manufacturer's recommendations in compliance with all Local, State and National codes. For LAN connection and fiber-optic and copper communication wiring, comply with TAA requirements for Telecommunications Systems Infrastructure. This contract shall be responsible for furnishing and installing all required cabling between components to form a complete and operational system meeting all the requirements of this specifications.

B. Provide firestop material and seal all cable penetrations in the building.

C. All wiring between devices shall be run open wired above accessible ceilings unless otherwise noted. Where existing cable management systems are in place and there is adequate capacity to install the CCTV wiring, the contractor may utilize these pathways providing they have

coordinated with all other wiring contractor on site. Where multiple runs are required all cables shall be bundled with approved cable ties on four foot centers.

D. Where pathways do not exist for SMS wiring, this contract shall be responsible for providing all required cable management systems such as J-hooks to support communications cabling to meet building codes and manufacturer's recommendations.

E. Cables shall not be laid upon ceilings or supported in a manner that would violate any codes or standards.

F. All cabling installed in ceiling spaces that are used for air distribution plenums shall be UL plenum rated.

G. All control and signal cable shall be installed continuous and without splices. Provide appropriate connectors or pre-manufactured cables for each application.

## 3.6 TELECOMMUNICATIONS ROOMS

A. The lay-out of the telecommunications rooms as depicted on the drawings shall be utilized as a general guide for bidding purposes. The final room layout shall be carefully coordinated with input from the owner and from other trades with equipment and/or cabinets to be placed in the room. Final configuration of telecom rooms shall be submitted to Engineer as a coordination drawing with information from all other trades occupying the same room for review prior to permanent mounting of equipment or termination of cabling.

B. Coordinate lay-out of telecom rooms to avoid placing telecommunications equipment and cabinets under water piping (other than sprinkler heads) or HVAC units.

C. Coordinate lay-out of telecom rooms with electrical plans and locations of electrical outlets.

D. Lay-out of telecommunications equipment cabinets and racks shall provide a minimum of 36" aisle in front and behind equipment racks and cabinets which is clear of obstructions or equipment protrusions.

E. Coordinate rack locations and orientation to maintain required clearances including any equipment depths that may have to be accounted for. Some equipment, such as UPS units may have special mounting requirements that need additional coordination.

## 3.7 GROUNDING

A. The installing contractor shall be responsible for ensuring the grounding integrity of all installed equipment to eliminate the potential for equipment or personnel hazards due to improperly or inadequately grounded systems.

B. All grounding and bonding shall be in conformance with the National Electric Code, article 250 and as recommended by EIA/TIA-607.

C. The Division 16 Contractor has provided 120V branch circuitry for use by the CCTV system contractor. The branch circuitry is run with a dedicated equipment grounding conductor which

shall be utilized by the CCTV system equipment. In no case shall the CCTV system installation compromise the integrity of the Building Electrical Grounding System.

## 3.8 PROGRAMMING

A. It is the Contractor's responsibility to program the system in this section according to the Owner's wishes. This involves camera labeling, camera operation sequences, camera and recorder schedules, etc. The Contractor shall meet with the Owner and/or Engineer and reach agreement on the programming. This programming agreement shall then be written out in detail and forwarded to the Engineer for approval. After approval is granted, proceed with final programming.

B. Each building shall have the following minimum programming:

1. Camera labels programmed in NVR/DVR/Server.

2. Camera record rates based upon TOD schedules, alarm events, motion events.

3. Camera motion detection recording based upon TOD schedules. Motion detection scene masking.

4. PTZ cameras – Home position, tours, alarm pre-sets.

5. Configuration of any required analytics such as motion detection, virtual trip lines, loitering, object left behind, etc. Analytics are subject the project requirements and on-board camera analytics of the selected camera and/or server-side capabilities.

C. Additional programming at each building shall include set-up of graphical floor plans with interactive camera icons for all cameras local to that building. Owner NOC shall include set-up of graphical floor plans with interactive camera icons for all sites.

D. Set-up of passwords and a minimum of four (4) user access levels including assignment of specific privileges for each user access level.

## 3.9 IDENTIFICATION/LABELING

A. Contractor shall identify all major items of equipment and tag all cables with permanent type markers to denote equipment served. Cables shall be tagged at both ends and at each point where the cable is administered.

B. The contractor shall be responsible for generating and programming the labeling for camera information within the recorder software.

C. All labeling and recording shall be approved by the Owner and the Engineer prior to application.

## 3.10 TESTS

A. System Startup

1. The Contractor shall not apply power to the CCTV system until the following items have been completed:

   a.) CCTV system equipment items and circuitry have been set up in accordance with manufacturer's instructions.
   b.) A visual inspection of the CCTV system has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections.
   c.) System wiring has been tested and verified as correctly connected as indicated.
   d.) All system grounding and transient protection systems have been verified as properly installed and connected as indicated.
   e.) Power supplies to be connected to the CCTV system have been verified as the correct voltage, phasing, and frequency as indicated.

2. Satisfaction of the above requirements shall not relieve the Contractor of responsibility for incorrect installation, defective equipment items, or collateral damage as a result of Contractor work/equipment.

## 3.11 SITE TESTING

A. General: The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all site testing. The Owner will witness all performance verification. Original copies of all data produced during performance verification shall be turned over to the Owner at the conclusion of testing prior to final approval.

1. Contractor's Field Testing: The Contractor shall calibrate and test all equipment, verify operation, place the integrated system in service, and test the integrated system. The Contractor shall deliver a report describing results of functional tests, diagnostics, and calibrations including written certification to the Owner that the installed complete system has been calibrated, tested, and is ready to begin performance verification testing. The report shall also include a copy of the approved performance verification test procedure. In addition, the Contractor shall make a master video recording showing typical day and night views of each camera in the system and shall deliver the recording with the report. Note any objects in the field of view that might produce highlights that could cause camera blinding. Note any objects in the field of view or anomalies which may cause blind spots. Note if a camera cannot be aimed to cover the zone. Note night assessment capabilities and whether lights or vehicle headlights cause blooming or picture degradation. If any of the above conditions or other conditions exist that cause picture degradation or interfere with the camera field of view, the Contractor shall inform the Architect. The tape shall be recorded using the video recorder installed as part of the CCTV system. The Contractor shall provide the Owner with the original tape as part of the documentation of the system and shall submit a letter certifying that the CCTV system is ready for performance verification testing. The field testing shall as a minimum include:

2. The Contractor shall deliver a report describing results of functional tests, diagnostics, and calibrations including written certification to the Owner that the installed complete system has been calibrated, tested, and is ready to begin performance verification testing. The report shall also include a copy of the approved performance verification test procedure.

3. Performance Verification Test: The Contractor shall demonstrate that the completed CCTV system complies with the contract requirements. Using approved test procedures, all physical and functional requirements of the project shall be demonstrated and shown. The performance verification test as specified, shall not be started until receipt by the Contractor of written permission from the Owner, based on the Contractor's written report. This shall include certification of successful completion of Contractor Field Testing as specified in paragraph "Contractor's Field Testing," and upon successful completion of training as specified. The Owner may terminate testing at any time when the system fails to perform as specified.

## 3.12 TRAINING REQUIREMENTS

A. Provide the owner with a minimum of 24 hours of training designed to make all users familiar with the operation of the system.

1. The Contractor shall conduct training courses for designated personnel in the maintenance and operation of the CCTV system as specified. The training shall be oriented to the specific system being installed under this contract. Training manuals shall be delivered for each trainee with two additional manuals delivered for archiving at the project site. The Contractor is responsible for furnishing all audio-visual equipment and all other training materials and supplies. A training day is 8 hours of instruction, including two 15 minute breaks and excluding lunchtime, Monday through Friday, during the daytime shift in effect at the facility. Approval of the planned training schedule shall be obtained from the Owner at least 14 days prior to the training.

2. The course shall be taught at the project site for one full day during or after the Contractor's field testing. No part of the training given during this course will be counted toward completion of the performance verification test. The course shall consist of classroom instruction, hands-on training, instruction on the specific hardware configuration of the installed system, and specific instructions for operating the installed system. The course shall demonstrate system start up, system operation, system shutdown, system recovery after a failure, the specific hardware configuration, and operation of the system and its software. The students should have no unanswered questions regarding operation of the installed CCTV system. The Contractor shall prepare and insert additional training material in the training manuals when the need for additional material becomes apparent during instruction. The course shall include:

   a.) General: CCTV hardware, installed system architecture and configuration.
   b.) Functional operation of the installed system and software.
   c.) Operator commands.
   d.) Archiving and/or saving recorded video clips for evidentiary purposes.
   e.) Fault diagnostics and correction.
   f.) General system maintenance.
   g.) Replacement of failed components and integration of replacement components into the operating CCTV system.

3. Provide all training and utilize specified manuals and record documentation. All training shall be provided at the project site and coordinated with the Owner.

B. Training shall utilize the equipment provided at the project site. Coordinate use, time and availability of equipment with the Owner.

C. Demonstrate adjustment, operation and maintenance of the system including each component and control.

D. This training period shall be scheduled with the Owner after the successful completion of the system.

## 3.13 AS BUILT DOCUMENTATION

A. Copies of all approved shop drawings with the Engineer's stamp.

B. Owner's manuals for every item of equipment when available from the manufacturer. These shall be the technical manuals provided by the manufacturer and shall not consist of generic sales brochures. Technical manuals shall provide complete specifications for the equipment as well as complete operating, maintenance, troubleshooting and product repair/replacement information. Where available only in electronic format, the contractor may provide a CD with electronic versions of Owner's manuals. CDs containing electronic versions of owner's manuals must contain the proper software viewers for each document type.

a.) Interior Camera assembly including housing and lens
b.) Exterior Camera Assembly including housing and lens.
c.) Each type of camera power supply
d.) Camera recorder
e.) Racks/Cabinets
f.) System Software.

C. Technology drawings updated with final As-Built information. This shall be in the form of a complete set of Technology drawings with as-built information indicated in colored pen based upon actual field conditions.

D. System schematic and block diagrams for every system updated with final as-built information. These drawings shall define the exact arrangement of each system including wiring configuration, device locations and cable types.

E. Rack elevations for all systems with rack mounted equipment.

F. System Operating Instructions: Provide a clear and concise description of preparation which gives, in detail, the information required to properly operate the equipment and system.

G. Provide statement of warranty.

## 3.14 WARRANTY

A. This Contractor shall warrant all workmanship, equipment and material provided under this contract for a period of three (3) years from the date of approval of certificate of contract completion by the Owner.

B. Manufacturer equipment warranty shall be five (5) years. If any defects are found within the warranty period, the defective system component shall be replaced at no extra cost to the Owner for parts or labor. Provide statement of warranty with the O&M manuals.

C. During the first year's warranted operation, the Contractor shall perform two inspections at 6-month intervals or less. This work shall be performed during regular working hours, Monday through Friday, excluding legal holidays. These inspections shall include:

a.) Visual checks and operational test of the multiplexer, peripheral equipment, interface panels, recording devices, monitors, video equipment electrical and mechanical controls, and a check of the picture quality from each camera.
b.) Correct all diagnosed problems.
c.) Resolve any previous outstanding problems.

D. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period.

E. The Contractor shall be responsible to provide service during normal working hours within (4) hours after notification by the Owner for normal service or within (2) hours for emergency service. Emergency service is defined as the loss of 25% or more of system component operation, or the loss of the video switcher or other head-end equipment. Provide an on-site authorized factory technician within 24 hours if required.

F. If equipment cannot be repaired within 24 hours of service visit, Contractor shall provide "loaner" equipment to the Owner at no charge.

## 3.15 CERTIFICATION

A. Upon completion of the testing, the manufacturer or representative shall issue to the Owner a letter of certification attesting to the fact that he has tested and adjusted the system, that all components are properly installed and free of defects, and that the system is in compliance with this specification

END OF SECTION 282100