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## **SECTION 15086**

### **DUCT INSULATION**

#### **PART 1 GENERAL**

##### **1.1 SECTION INCLUDES**

- A. Duct insulation.
- B. Duct Liner.
- C. Insulation jackets.

##### **1.2 REFERENCE STANDARDS**

- A. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2007.
- B. ASTM B 209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric]; 2007.
- C. ASTM C 518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2004.
- D. ASTM C 553 - Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2008.
- E. ASTM C 612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2009.
- F. ASTM C 1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material); 2005.
- G. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2010.
- H. ASTM E 96/E 96M - Standard Test Methods for Water Vapor Transmission of Materials; 2005.
- I. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association; 2006.
- J. SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible; Sheet Metal and Air Conditioning Contractors' National Association; 2005.
- K. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

##### **1.3 SUBMITTALS**

- A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- B. Manufacturer's Instructions: Indicate installation procedures necessary to ensure acceptable workmanship and that installation standards will be achieved.

##### **1.4 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section with not less than three years of documented experience.

##### **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical

damage, by storing in original wrapping.

## **1.6 FIELD CONDITIONS**

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

## **PART 2 PRODUCTS**

### **2.1 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION**

- A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E 84, NFPA 255, or UL 723.

### **2.2 GLASS FIBER, FLEXIBLE**

- A. Manufacturer:
  - 1. Johns Manville Corporation: [www.jm.com](http://www.jm.com).
  - 2. Owens Corning Corp: [www.owenscorning.com](http://www.owenscorning.com).
  - 3. CertainTeed Corporation: [www.certainteed.com](http://www.certainteed.com).
- B. Insulation: ASTM C 553; flexible, noncombustible blanket.
  - 1. 'K' value: 0.25 at 75 degrees F, when tested in accordance with ASTM C 518.
  - 2. Governing body regulation values or as listed on the drawings as more stringent than 'K' value above, insulation value shall be superceeded with said value
- C. Vapor Barrier Jacket:
  - 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
  - 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E 96/E 96M.

### **2.3 GLASS FIBER, RIGID**

- A. Manufacturer:
  - 1. Johns Manville Corporation: [www.jm.com](http://www.jm.com).
  - 2. Owens Corning Corp: [www.owenscorning.com](http://www.owenscorning.com).
  - 3. CertainTeed Corporation: [www.certainteed.com](http://www.certainteed.com).
- B. Insulation: ASTM C 612; rigid, noncombustible blanket.
  - 1. 'K' value: .16 at 75 degrees F, when tested in accordance with ASTM C 518.
  - 2. Governing body regulation values or as listed on the drawings as more stringent than 'K' value above, insulation value shall be superceeded with said value
- C. Vapor Barrier Jacket:
  - 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
  - 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E 96/E 96M.

### **2.4 JACKETS**

- A. Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
- B. Mineral Fiber (Outdoor) Jacket: Asphalt impregnated and coated sheet, 50 lb/square.
- C. Aluminum Jacket: ASTM B 209 (ASTM B 209M).
  - 1. Thickness: 0.016 inch sheet.

### **2.5 DUCT LINER**

- A. Manufacturers:
  - 1. Johns Manville Corporation: [www.jm.com](http://www.jm.com).

2. Owens Corning Corp: [www.owenscorning.com](http://www.owenscorning.com).
  3. CertainTeed Corporation: [www.certainteed.com](http://www.certainteed.com).
- B. Insulation: Incombustible glass fiber complying with ASTM C 1071; flexible blanket, rigid board, and preformed round liner board; impregnated surface and edges coated with poly vinyl acetate polymer, or acrylic polymer shown to be fungus and bacteria resistant by testing to ASTM G 21.
1. Apparent Thermal Conductivity: Maximum of .24 at 75 degrees F.

### **PART 3 EXECUTION**

#### **3.1 EXAMINATION**

- A. Verify that ducts have been tested before applying insulation materials.
- B. Verify that surfaces are clean, foreign material removed, and dry.

#### **3.2 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards.
- C. Insulated ducts conveying air below ambient temperature:
  1. Finish with tape and vapor barrier jacket.
  2. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
- D. Insulated ducts conveying air above ambient temperature:
- E. Exterior Applications: Provide insulation with vapor barrier jacket. Cover with with calked aluminum jacket with seams located on bottom side of horizontal duct section.
- F. External Duct Insulation Application:
  1. Install without sag on underside of duct. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift duct off trapeze hangers and insert spacers.
  2. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
- G. Duct and Plenum Liner Application:
  1. Secure insulation with mechanical liner fasteners. Refer to SMACNA HVAC Duct Construction Standards - Metal and Flexible for spacing.
  2. Seal and smooth joints. Seal and coat transverse joints.
  3. Duct dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for insulation thickness.

#### **3.3 SCHEDULES - INSULATE DUCTS PER TITLE-24 REQUIREMENTS**

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## **SECTION 15145**

### **PLUMBING PIPING**

#### **PART 1 GENERAL**

##### **1.1 SECTION INCLUDES**

- A. Pipe, pipe fittings, valves, and connections for piping systems.
  - 1. Sanitary sewer and vent.
  - 2. Domestic water.

##### **1.2 REFERENCE STANDARDS**

- A. ASME B16.3 - Malleable Iron Threaded Fittings; The American Society of Mechanical Engineers; 1998 (R2006).
- B. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2001 (R2005) (ANSI B16.18).
- C. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2001 (R2005).
- D. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV; The American Society of Mechanical Engineers; 2002.
- E. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV; The American Society of Mechanical Engineers; 2007.
- F. ASME B31.9 - Building Services Piping; The American Society of Mechanical Engineers; 2008 (ANSI/ASME B31.9).
- G. ASTM B 32 - Standard Specification for Solder Metal; 2008.
- H. ASTM B 88 - Standard Specification for Seamless Copper Water Tube; 2009.
- I. ASTM B 88M - Standard Specification for Seamless Copper Water Tube (Metric); 2005.
- J. ASTM C 564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings; 2009a.
- K. ASTM D 1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2006.
- L. ASTM D 2239 - Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Controlled Inside Diameter; 2003.
- M. ASTM D 2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems; 2004 (Reapproved 2009).
- N. ASTM D 2661 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings; 2008.
- O. ASTM D 2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings; 2009.
- P. AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding; American Welding Society; 2004 and errata.
- Q. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications; Cast Iron Soil Pipe Institute; 2005.

- R. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; Cast Iron Soil Pipe Institute; 2004.
- S. MSS SP-67 - Butterfly Valves; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2002a.

### **1.3 SUBMITTALS**

- A. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
- B. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

### **1.4 QUALITY ASSURANCE**

- A. Perform Work in accordance with State of California, standards.
  - 1. Maintain one copy on project site.
- B. Valves: Manufacturer's name and pressure rating marked on valve body.
- C. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.
- D. Welder Qualifications: Certified in accordance with ASME (BPV IX).
- E. Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.

### **1.5 REGULATORY REQUIREMENTS**

- A. Perform Work in accordance with State of California plumbing code.
- B. Conform to applicable code for installation of backflow prevention devices.
- C. Provide certificate of compliance from authority having jurisdiction indicating approval of installation of backflow prevention devices.

### **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

## **PART 2 PRODUCTS**

### **2.1 SANITARY SEWER PIPING, ABOVE GRADE**

- A. Cast Iron Pipe: CISPI 301, hubless, service weight.
  - 1. Fittings: Cast iron.
  - 2. Joints: CISPI 310, neoprene gaskets and stainless steel clamp-and-shield assemblies.

### **2.2 WATER PIPING, ABOVE GRADE**

- A. Copper Tube: ASTM B 88 (ASTM B 88M), Type L (B), Drawn (H).
  - 1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
  - 2. Joints: ASTM B 32, alloy Sn95 solder.

### **2.3 FLANGES, UNIONS, AND COUPLINGS**

- A. Unions for Pipe Sizes 3 Inches and Under:
  - 1. Copper tube and pipe: Class 150 bronze unions with soldered joints.
- B. Grooved and Shouldered Pipe End Couplings:
  - 1. Housing: Malleable iron clamps to engage and lock, designed to permit some angular deflection, contraction, and expansion; steel bolts, nuts, and washers; galvanized for galvanized pipe.
  - 2. Sealing gasket: "C" shape composition sealing gasket.

### **2.4 PIPE HANGERS AND SUPPORTS**

- A. Plumbing Piping - Drain, Waste, and Vent:
  - 1. Conform to ASME B31.9.
  - 2. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
  - 3. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
- B. Plumbing Piping - Water:
  - 1. Conform to ASME B31.9.
  - 2. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
  - 3. Hangers for Cold Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
  - 4. Hangers for Hot Pipe Sizes 2 Inches to 4 Inches: Carbon steel, adjustable, clevis.

### **2.5 GLOBE VALVES**

- A. Manufacturers:
  - 1. Nibco, Inc: [www.nibco.com](http://www.nibco.com).
  - 2. Milwaukee Valve Company: [www.milwaukeevalve.com](http://www.milwaukeevalve.com).
  - 3. Stockham: [www.stockham.com](http://www.stockham.com)

### **2.6 BALL VALVES**

- A. Manufacturers:
  - 1. Nibco, Inc: [www.nibco.com](http://www.nibco.com).
  - 2. Milwaukee Valve Company: [www.milwaukeevalve.com](http://www.milwaukeevalve.com).
  - 3. Stockham: [www.stockham.com](http://www.stockham.com)

### **2.7 BUTTERFLY VALVES**

- A. Manufacturers:
  - 1. Hammond Valve: [www.hammondvalve.com](http://www.hammondvalve.com).
  - 2. Crane Co.: [www.cranvalve.com](http://www.cranvalve.com).
  - 3. Milwaukee Valve Company: [www.milwaukeevalve.com](http://www.milwaukeevalve.com).
- B. Construction 1-1/2 Inches and Larger: MSS SP-67, 200 psi CWP, cast or ductile iron body, nickel-plated ductile iron disc, resilient replaceable EPDM seat, wafer ends, extended neck, 10 position lever handle.
- C. Provide gear operators for valves 8 inches and larger, and chain-wheel operators for valves mounted over 8 feet above floor.

## **PART 3 EXECUTION**

### **3.1 PREPARATION**

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.

- C. Prepare piping connections to equipment with flanges or unions.

### **3.2 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- D. Install piping to maintain headroom, conserve space, and not interfere with use of space.
- E. Group piping whenever practical at common elevations.  
Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F. Provide access where valves and fittings are not exposed.
- G. Install valves with stems upright or horizontal, not inverted.
- H. Install water piping to ASME B31.9.
- I. Pipe Hangers and Supports:
  - 1. Install in accordance with ASME B31.9.
  - 2. Support horizontal piping as scheduled.
  - 3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
  - 4. Place hangers within 12 inches of each horizontal elbow.
  - 5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

### **3.3 APPLICATION**

- A. Install unions downstream of valves and at equipment or apparatus connections.

### **3.4 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM**

- A. Disinfect water distribution system in accordance with Section 02515.
- B. Prior to starting work, verify system is complete, flushed and clean.

### **3.5 SCHEDULES - SEE SHEET P-0.1 FOR PIPE SUPPORT SCHEDULE**

**END OF SECTION**

## **SECTION 15146**

### **PLUMBING SPECIALTIES**

#### **PART 1 GENERAL**

##### **1.1 SECTION INCLUDES**

- A. Cleanouts.

##### **1.2 SUBMITTALS**

- A. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.

##### **1.3 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years documented experience.

##### **1.4 DELIVERY, STORAGE, AND HANDLING**

- A. Accept specialties on site in original factory packaging. Inspect for damage.

#### **PART 2 PRODUCTS**

##### **2.1 CLEANOUTS**

- A. Manufacturers:
  - 1. Jay R. Smith Manufacturing Company: [www.jayrsmith.com](http://www.jayrsmith.com).
  - 2. Josam Company: [www.josam.com](http://www.josam.com).
  - 3. Zurn Industries, Inc: [www.zurn.com](http://www.zurn.com).

##### **2.2 REFRIGERATOR VALVE AND RECESSED BOX**

- A. Box Manufacturers:
  - 1. IPS Corporation/Water-Tite: [www.ipscorp.com](http://www.ipscorp.com).
  - 2. Oatey: [www.oatey.com](http://www.oatey.com).
- B. Valve Manufacturers:
  - 1. IPS Corporation/Water-Tite: [www.ipscorp.com](http://www.ipscorp.com).
  - 2. Zurn Industries, Inc: [www.zurn.com](http://www.zurn.com).

#### **PART 3 EXECUTION**

##### **3.1 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.
- C. Install floor cleanouts at elevation to accommodate finished floor.

**END OF SECTION**

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## **SECTION 15182**

### **HYDRONIC PIPING**

#### **PART 1 GENERAL**

##### **1.1 SECTION INCLUDES**

- A. Pipe and pipe fittings for:
  - 1. Heating water piping system.
- B. Valves:
  - 1. Gate valves.
  - 2. Ball valves.
  - 3. Butterfly valves.
  - 4. Check valves.

##### **1.2 REFERENCE STANDARDS**

- A. ASME (BPV IX) - Boiler and Pressure Vessel Code, Section IX - Welding and Brazing Qualifications; The American Society of Mechanical Engineers; 2007.
- B. ASME B16.3 - Malleable Iron Threaded Fittings; The American Society of Mechanical Engineers; 1998 (R2006).
- C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2001 (R2005) (ANSI B16.18).
- D. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2001 (R2005).
- E. ASME B31.9 - Building Services Piping; The American Society of Mechanical Engineers; 2008 (ANSI/ASME B31.9).
- F. ASTM A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2007.
- G. ASTM A 234/A 234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2007.
- H. ASTM A 536 - Standard Specification for Ductile Iron Castings; 1984 (Reapproved 2009).
- I. ASTM B 32 - Standard Specification for Solder Metal; 2008.
- J. ASTM B 88 - Standard Specification for Seamless Copper Water Tube; 2009.
- K. ASTM B 88M - Standard Specification for Seamless Copper Water Tube (Metric); 2005.
- L. AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding; American Welding Society; 2004 and errata.
- M. AWWA C606 - Standard Specification for Grooved and Shouldered Joints; American Water Works Association; 2006.
- N. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2009.
- O. MSS SP-69 - Pipe Hangers and Supports - Selection and Application; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2003.
- P. MSS SP-89 - Pipe Hangers and Supports - Fabrication and Installation Practices; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2003.

##### **1.3 SUBMITTALS**

- A. Product Data: Include data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.
- B. Welders Certificate: Include welders certification of compliance with ASME (BPV IX).
- C. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- D. Project Record Documents: Record actual locations of valves.

#### **1.4 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum three years of documented experience.
- B. Welder Qualifications: Certify in accordance with ASME (BPV IX).

#### **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

### **PART 2 PRODUCTS**

#### **2.1 HYDRONIC SYSTEM REQUIREMENTS**

- A. Comply with ASME B31.9 and applicable federal, state, and local regulations.
- B. Piping: Provide piping, fittings, hangers and supports as required, as indicated, and as follows:
  - 1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
  - 2. Use non-conducting dielectric connections whenever joining dissimilar metals.
  - 3. Grooved mechanical joints may be used in accessible locations only.
    - a. Accessible locations include those exposed on interior of building, in pipe chases, and in mechanical rooms, aboveground outdoors, and as approved by Architect.
    - b. Grooved joints apply to metal piping only.
    - c. Use rigid joints unless otherwise indicated.
  - 4. Provide pipe hangers and supports in accordance with ASME B31.9 unless indicated otherwise.
- C. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges, unions, or grooved couplings to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.
  - 1. Where grooved joints are used in piping, provide grooved valve/equipment connections if available; if not available, provide flanged ends and grooved flange adapters.
- D. Valves: Provide valves where indicated and as follows:
  - 1. Isolate equipment using butterfly valves with lug end flanges or grooved mechanical couplings.
  - 2. For throttling, bypass, or manual flow control services, use globe, ball, or butterfly valves.

3. For shut-off and to isolate parts of systems or vertical risers, use gate, ball, or butterfly valves.

## **2.2 HEATING WATER PIPING, ABOVE GROUND**

- A. Steel Pipe: ASTM A 53/A 53M, Schedule 40, black, using one of the following joint types:
  1. Welded Joints: ASTM A 234/A 234M, wrought steel welding type fittings; AWS D1.1 welded.
  2. Threaded Joints: ASTM B 16.3, malleable iron fittings.
  3. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.
- B. Copper Tube: ASTM B 88 (ASTM B 88M), Type L (B), drawn, using one of the following joint types:
  1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings.
    - a. Solder: ASTM B 32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
    - b. Braze: AWS A5.8/A5.8M BCuP copper/silver alloy.
  2. Grooved Joints: AWWA C606 grooved tube, fittings of same material, and copper-tube-dimension mechanical couplings.
  3. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.

## **2.3 PIPE HANGERS AND SUPPORTS**

- A. Conform to ASME B31.9.
- B. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron, adjustable swivel, split ring.
- C. Hangers for Cold Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
- D. Hangers for Hot Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.
- E. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- F. Vertical Support: Steel riser clamp.
- G. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- H. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
- I. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

## **2.4 UNIONS, FLANGES, AND COUPLINGS**

- A. Unions for Pipe 2 Inches and Under:
  1. Ferrous Piping: 150 psig malleable iron, threaded.
  2. Copper Pipe: Bronze, soldered joints.
- B. Flanges for Pipe Over 2 Inches:
  1. Ferrous Piping: 150 psig forged steel, slip-on.
  2. Copper Piping: Bronze.
- C. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
  1. Grooved-End-Tube Couplings
    - a. Include ferrous housing sections cast with offsetting, angle pattern bolt pads, coated with copper-colored enamel, EDPM-synthetic rubber gaskets of a Flush Seal design suitable for hot and cold water, bolts and nuts. Victaulic Style 606
  2. Grooved-End-Tube Flange Adapters

- a. Ductile-iron casting, coated with copper-colored enamel, flat-faced, for engaging into roll grooved copper tube and fittings and bolting directly to flanges with ANSI Class 125 and 150 bolt hole patterns. Victaulic Style 641
3. Grooved-End-Tube Mechanical-T
  - a. Bronze upper housing and copper-colored enamel coated ductile iron lower housing, threaded outlet and locating collar, EPDM synthetic rubber gasket suitable for hot and cold water, and bolts and nuts. Victaulic Style 622
4. Dimensions and Testing: In accordance with AWWA C606.
5. Housing Material: Malleable iron or ductile iron, galvanized.
6. Gasket Material: EPDM suitable for operating temperature range from -30 degrees F to 230 degrees F.
7. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
8. When pipe is field grooved, provide coupling manufacturer's grooving tools.
9. Flaring of tube and fitting ends to IPS dimensions is not permitted
10. Manufacturers:
  - a. Victaulic Company: [www.victaulic.com](http://www.victaulic.com).

## 2.5 GLOBE OR ANGLE VALVES

- A. Manufacturers:
  1. Victaulic: [www.victaulic.com](http://www.victaulic.com).
  2. Nibco, Inc: [www.nibco.com](http://www.nibco.com).
  3. Milwaukee Valve Company; Model \_\_\_\_\_: [www.milwaukeevalve.com](http://www.milwaukeevalve.com).

## 2.6 BALL VALVES

- A. Manufacturers:
  1. Victaulic: [www.victaulic.com](http://www.victaulic.com).
  2. Nibco, Inc; Model \_\_\_\_\_: [www.nibco.com](http://www.nibco.com).
  3. Milwaukee Valve Company; Model \_\_\_\_\_: [www.milwaukeevalve.com](http://www.milwaukeevalve.com).

## 2.7 BUTTERFLY VALVES

- A. Manufacturers:
  1. Crane Co.: [www.cranevalve.com](http://www.cranevalve.com).
  2. Milwaukee Valve Company: [www.milwaukeevalve.com](http://www.milwaukeevalve.com).
  3. Victaulic Valve [www.victaulic.com](http://www.victaulic.com)

## 2.8 FLOW CONTROLS

- A. Manufacturers:
  1. ITT Bell & Gossett: [www.bellgossett.com](http://www.bellgossett.com).
  2. Griswold Controls: [www.griswoldcontrols.com](http://www.griswoldcontrols.com).
  3. Taco, Inc: [www.taco-hvac.com](http://www.taco-hvac.com).
- B. Construction: Class 125, Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet, blowdown/backflush drain.
- C. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 3.5 psi psi.

## PART 3 EXECUTION

### 3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Prepare pipe for grooved mechanical joints as required by coupling manufacturer.
- C. Remove scale and dirt on inside and outside before assembly.
- D. Prepare piping connections to equipment using jointing system specified.

- E. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- F. After completion, fill, clean, and treat systems. Refer to Section 15189 for additional requirements.

### **3.2 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Install heating water, piping to ASME B31.9 requirements.
- C. Route piping in orderly manner, parallel to building structure, and maintain gradient.
- D. Install piping to conserve building space and to avoid interfere with use of space.
- E. Group piping whenever practical at common elevations.
- F. Sleeve pipe passing through partitions, walls and floors.
- G. Slope piping and arrange to drain at low points.
- H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 15122.
- I. Inserts:
  - 1. Provide inserts for placement in concrete formwork.
  - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
  - 3. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
  - 4. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- J. Pipe Hangers and Supports:
  - 1. Install in accordance with ASME B31.9.
  - 2. Support horizontal piping as scheduled.
  - 3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
  - 4. Place hangers within 12 inches of each horizontal elbow.
  - 5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
  - 6. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
  - 7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- K. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 15082.
- L. Provide access where valves and fittings are not exposed.

### **3.3 SCHEDULES - SEE SHEET M-3.1**

**END OF SECTION**

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## SECTION 15183

### HYDRONIC SPECIALTIES

#### **PART 1 GENERAL**

##### **1.1 SECTION INCLUDES**

- A. Air vents.
- B. Strainers.
- C. Flow indicators, controls, meters.

##### **1.2 SUBMITTALS**

- A. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description, model and dimensions.
- B. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- C. Project Record Documents: Record actual locations of flow controls.
- D. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

##### **1.3 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

##### **1.4 DELIVERY, STORAGE, AND HANDLING**

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

#### **PART 2 PRODUCTS**

##### **2.1 AIR VENTS**

- A. Manufacturers:
  - 1. Armstrong International, Inc: [www.armstronginternational.com](http://www.armstronginternational.com).
  - 2. ITT Bell & Gossett: [www.bellgossett.com](http://www.bellgossett.com).
  - 3. Taco, Inc: [www.taco-hvac.com](http://www.taco-hvac.com).
- B. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.
- C. Float Type:
  - 1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.
  - 2. Cast iron body and cover, float, bronze pilot valve mechanism suitable for system operating temperature and pressure; with isolating valve.

##### **2.2 STRAINERS**

- A. Manufacturers:

1. Armstrong International, Inc: [www.armstronginternational.com](http://www.armstronginternational.com).
  2. Green Country Filtration: [greencountryfiltration.com](http://greencountryfiltration.com).
  3. WEAMCO: [www.weamco.com](http://www.weamco.com).
- B. Size 2 inch and Under:
1. Screwed brass or iron body for 175 psi working pressure, Y pattern with 1/32 inch stainless steel perforated screen.
- C. Size 2-1/2 inch to 4 inch:
1. Flanged iron body for 175 psi working pressure, Y pattern with 3/64 inch stainless steel perforated screen.
- D. Size 5 inch and Larger:
1. Flanged iron body for 175 psi working pressure, basket pattern with 1/8 inch stainless steel perforated screen.

## **2.3 FLOW CONTROLS**

- A. Manufacturers:
1. Amtrol Inc: [www.amtrol.com](http://www.amtrol.com).
  2. ITT Bell & Gossett: [www.bellgossett.com](http://www.bellgossett.com).
  3. Cla-Val Co: [www.cla-val.com](http://www.cla-val.com).
- B. Construction: Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet with blowdown/backflush drain.
- C. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 3.5 psi.

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

- A. Install specialties in accordance with manufacturer's instructions.
- B. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.

**END OF SECTION**

## **SECTION 15212**

### **COMPRESSED AIR SYSTEM**

#### **PART 1 GENERAL**

##### **1.1 SECTION INCLUDES**

- A. Pipe and Pipe Fittings.

##### **1.2 REFERENCE STANDARDS**

- A. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2001 (R2005) (ANSI B16.18).
- B. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2001 (R2005).
- C. ASME B31.1 - Power Piping; The American Society of Mechanical Engineers; 2007 (ANSI/ASME B31.1).
- D. ASTM B 32 - Standard Specification for Solder Metal; 2008.
- E. ASTM B 88 - Standard Specification for Seamless Copper Water Tube; 2009.
- F. ASTM B 88M - Standard Specification for Seamless Copper Water Tube (Metric); 2005.

##### **1.3 SUBMITTALS**

- A. Shop Drawings: Indicate piping system schematic with connection requirements.

#### **PART 2 PRODUCTS**

##### **2.1 PIPE AND PIPE FITTINGS**

- A. Copper Tube: ASTM B 88 (ASTM B 88M), Type K (A), drawn.
  - 1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
  - 2. Joints: ASTM B 32, solder, Grade Sn95.

##### **2.2 UNIONS AND COUPLINGS**

- A. Unions:
  - 1. Copper Tube and Pipe: 150 psi bronze unions with soldered joints.

#### **PART 3 EXECUTION**

##### **3.1 INSTALLATION**

- A. Install takeoffs to outlets from top of main, with shut off valve after take off. Slope take off piping to outlets.
- B. Install compressed air couplings, female quick connectors, and pressure gages where outlets are indicated.
- C. Identify piping system and components. Refer to Section 15075.

##### **3.2 FIELD QUALITY CONTROL**

- A. Compressed Air Piping Leak Test: Prior to initial operation, clean and test compressed air piping in accordance with ASME B31.1.
- B. Repair or replace compressed air piping as required to eliminate leaks, and retest to demonstrate compliance.
- C. Cap and seal ends of piping when not connected to mechanical equipment.

**END OF SECTION**

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## **SECTION 15410**

### **PLUMBING FIXTURES**

#### **PART 1 GENERAL**

##### **1.1 SECTION INCLUDES**

- A. Sinks.
- B. Electric water coolers.
- C. Drinking fountains.

##### **1.2 REFERENCE STANDARDS**

- A. ASME A112.18.1 - Plumbing Supply Fittings; The American Society of Mechanical Engineers; 2005.
- B. ASME A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use); The American Society of Mechanical Engineers; 2008.

##### **1.3 SUBMITTALS**

- A. Product Data: Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.
- B. Manufacturer's Instructions: Indicate installation methods and procedures.
- C. Maintenance Data: Include fixture trim exploded view and replacement parts lists.

##### **1.4 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

##### **1.5 REGULATORY REQUIREMENTS**

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

##### **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Accept fixtures on site in factory packaging. Inspect for damage.
- B. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

#### **PART 2 PRODUCTS**

##### **2.1 SINKS**

- A. Sink Manufacturers:
  - 1. American Standard Inc: [www.americanstandard.com](http://www.americanstandard.com).
  - 2. Kohler Company: [www.kohler.com](http://www.kohler.com).
- B. Single Compartment Bowl:
  - 1. ASME A112.19.3; 25 x 22 x 7 11/16 in outside dimensions, 19 gage thick, Type 304 stainless steel, self rimming and undercoated, with ledge back drilled for trim.
    - a. Drain: 1-1/2 inch chromed brass drain.
- C. Accessories: Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon, wheel handle stop, rigid supplies.

##### **2.2 ELECTRIC WATER COOLERS**

- A. Electric Water Cooler Manufacturers:

1. Tri Palm International/Oasis: [www.tripalmint.com](http://www.tripalmint.com).
2. Elkay Manufacturing Company: [www.elkay.com](http://www.elkay.com).
3. Haws Corporation: [www.hawso.com](http://www.hawso.com).
4. Water Cooler: Electric, mechanically refrigerated; surface handicapped mounted; stainless steel top, stainless steel body, elevated anti-squirt bubbler with stream guard, automatic stream regulator, push button, mounting bracket; integral air cooled condenser and stainless steel grille.
5. Capacity: 8 gallons per minute of 50 degrees F water with inlet at 80 degrees F and room temperature of 90 degrees F, when tested in accordance with ASHRAE Std 18.

## **PART 3 EXECUTION**

### **3.1 EXAMINATION**

- A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.
- B. Verify that electric power is available and of the correct characteristics.
- C. Confirm that millwork is constructed with adequate provision for the installation of counter top lavatories and sinks.

### **3.2 PREPARATION**

- A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

### **3.3 INSTALLATION**

- A. Install each fixture with trap, easily removable for servicing and cleaning.
- B. Install components level and plumb.
- C. Install and secure fixtures in place with wall supports and bolts.
- D. Seal fixtures to wall and floor surfaces with sealant as specified in Section 07900, color to match fixture.

### **3.4 INTERFACE WITH WORK OF OTHER SECTIONS**

- A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

### **3.5 ADJUSTING**

- A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

### **3.6 CLEANING**

- A. Clean plumbing fixtures and equipment.

### **3.7 PROTECTION**

- A. Protect installed products from damage due to subsequent construction operations.
- B. Do not permit use of fixtures by construction personnel.
- C. Repair or replace damaged products before Date of Substantial Completion.

### **3.8 SCHEDULES**

- A. Fixture Heights: Install fixtures to heights above finished floor as indicated.
  1. Drinking Fountain:
    - a. Standard Adult: 40 inches to top of basin rim.

b. Accessible: 36 inches to top of spout.

B. Fixture Rough-In - See sheet P-0.1

**END OF SECTION**

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## **SECTION 15430**

### **PLUMBING EQUIPMENT**

#### **PART 1 GENERAL**

##### **1.1 SECTION INCLUDES**

- A. Water Heaters.
- B. Water Filter.

##### **1.2 SUBMITTALS**

- A. Product Data:
  - 1. Provide dimension drawings of water heaters indicating components and connections to other equipment and piping.
  - 2. Provide electrical characteristics and connection requirements.
- B. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

##### **1.3 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

##### **1.4 CERTIFICATIONS**

- A. Electric Water Heaters: UL listed and labeled to UL 174 or UL 1453.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

#### **PART 2 PRODUCTS**

##### **2.1 WATER HEATER MANUFACTURERS**

- A. Chronomite.
- B. Stiebel Eltron

##### **2.2 WATER FILTER**

- A. Manufacturers:
  - 1. Watts
- B. See sheet P-0.1 for product details

#### **PART 3 EXECUTION**

##### **3.1 INSTALLATION**

- A. Install plumbing equipment in accordance with manufacturer's instructions, as required by code, and complying with conditions of certification, if any.
- B. Coordinate with plumbing piping and related electrical work to achieve operating system.

##### **3.2 SCHEDULES - SEE SHEET P-0.1**

**END OF SECTION**

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## **SECTION 15739**

### **COMPUTER ROOM AC UNITS - UNITARY CEILING**

#### **PART 1 GENERAL**

##### **1.1 SECTION INCLUDES**

- A. Air Conditioning Units.
- B. Controls.

##### **1.2 PERFORMANCE REQUIREMENTS**

- A. Cooling:
  - 1. Capacity: 17,500 Btu/hr.
  - 2. Air flow: 550 cfm.
  - 3. Evaporator fan motor: 1/2 hp.
- B. Air Cooled:
  - 1. Entering air: 74 degrees F.
  - 2. Condenser fan motors: 1/2 hp.
- C. Electrical Characteristics:
  - 1. 277 volts, single phase, 60 Hz.
  - 2. 30 amperes maximum fuse size.

##### **1.3 SUBMITTALS**

- A. Product Data: Provide manufacturers literature and data indicating drain, and electrical characteristics and connection requirements.
- B. Manufacturer's Instructions: Indicate procedures required for rigging and making service connections.
- C. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data.

##### **1.4 QUALITY ASSURANCE**

- A. Manufacturer's Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

#### **PART 2 PRODUCTS**

##### **2.1 MANUFACTURERS**

- A. Liebert Corporation; [www.liebert.com](http://www.liebert.com).
- B. Data Aire.

##### **2.2 AIR CONDITIONING UNITS**

- A. Description: Self contained air cooled, factory assembled, pre-wired and pre-piped unit, consisting of cabinet, fan, filters, controls.
- B. Assembly: For horizontal ceiling mounting to fit 24 x 48 inches T-bar ceiling opening.

##### **2.3 CONTROL SYSTEM**

- A. Controls: Solid state wall mounted with start/stop switch, adjustable temperature setpoint.

#### **PART 3 EXECUTION**

##### **3.1 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.

B. Coordinate installation of air conditioning unit with computer room ceiling installer.

**3.2 SCHEDULES - SEE SHEET M-0.1**

**END OF SECTION**

## SECTION 15810

### DUCTS

#### **PART 1 GENERAL**

##### **1.1 SECTION INCLUDES**

- A. Metal ductwork.
- B. Nonmetal ductwork.
- C. Casing and plenums.
- D. Duct cleaning.

##### **1.2 REFERENCE STANDARDS**

- A. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel; 2008.
- B. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2009a.
- C. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; National Fire Protection Association; 2009.
- D. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems; National Fire Protection Association; 2009.
- E. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual; Sheet Metal and Air Conditioning Contractors' National Association; 1985, First Edition.
- F. SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible; Sheet Metal and Air Conditioning Contractors' National Association; 2005.
- G. SMACNA (FGD) - Fibrous Glass Duct Construction Standards; Sheet Metal and Air Conditioning Contractors' National Association; 2003.
- H. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

##### **1.3 PERFORMANCE REQUIREMENTS**

- A. No variation of duct configuration or sizes permitted except by written permission. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

##### **1.4 SUBMITTALS**

- A. Product Data: Provide data for duct materials, duct liner, and duct connections.
- B. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

##### **1.5 REGULATORY REQUIREMENTS**

- A. Construct ductwork to NFPA 90A standards.

##### **1.6 FIELD CONDITIONS**

- A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
- B. Maintain temperatures within acceptable range during and after installation of duct sealants.

#### **PART 2 PRODUCTS**

## **2.1 DUCT ASSEMBLIES**

## **2.2 MATERIALS**

- A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A 653/A 653M FS Type B, with G60/Z180 coating.
- B. Flexible Ducts:
  - 1. UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound spring steel wire.
    - a. Pressure Rating: 10 inches WG positive and 1.0 inches WG negative.
    - b. Maximum Velocity: 4000 fpm.
    - c. Temperature Range: -20 degrees F to 210 degrees F.
- C. Insulated Flexible Ducts:
  - 1. UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound spring steel wire; fiberglass insulation; polyethylene vapor barrier film.
    - a. Pressure Rating: 10 inches WG positive and 1.0 inches WG negative.
    - b. Maximum Velocity: 4000 fpm.
    - c. Temperature Range: -20 degrees F to 210 degrees F.
- D. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
- E. Hanger Rod: ASTM A 36/A 36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

## **2.3 DUCTWORK FABRICATION**

- A. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.
- B. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- C. T's, bends, and elbows: Construct according to SMACNA (DCS).
- D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- E. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- F. Provide standard 45 degree lateral wye takeoffs unless otherwise indicated where 90 degree conical tee connections may be used.
- G. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

## **2.4 DUCT MANUFACTURERS**

- A. Metal-Fab, Inc: [www.mtlfab.com](http://www.mtlfab.com).
- B. SEMCO Incorporated: [www.semcoinc.com](http://www.semcoinc.com).
- C. United McGill Corporation: [www.unitedmcgill.com](http://www.unitedmcgill.com).

## **2.5 MANUFACTURED DUCTWORK AND FITTINGS**

- A. Manufacture in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

## **2.6 CASINGS**

- A. Fabricate casings in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and construct for operating pressures indicated.
- B. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection.
- C. Fabricate acoustic casings with reinforcing turned inward. Provide 16 gage back facing and 22 gage perforated front facing with 3/32 inch diameter holes on 5/32 inch centers. Construct panels 3 inches thick packed with 4.5 lb/cu ft minimum glass fiber media, on inverted channels of 16 gage.

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

- A. Install, support, and seal ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- B. Install in accordance with manufacturer's instructions.
- C. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- D. Install and seal metal and flexible ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- E. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- F. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- G. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow.
- H. Use double nuts and lock washers on threaded rod supports.
- I. Connect terminal units to supply ducts with one foot maximum length of flexible duct. Do not use flexible duct to change direction.
- J. Connect diffusers or light troffer boots to low pressure ducts with 7 feet maximum length of flexible duct held in place with strap or clamp.
- K. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

### **3.2 CLEANING**

- A. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment that could be harmed by excessive dirt with temporary filters, or bypass during cleaning.

### **3.3 SCHEDULES**

A. Ductwork Material:

1. Low Pressure Supply (Heating Systems): Steel, Aluminum, Fibrous Glass.
2. Low Pressure Supply (System with Cooling Coils): Steel, Aluminum, Fibrous Glass.
3. Return and Relief: Steel, Aluminum.
4. General Exhaust: Steel, Aluminum.
5. Kitchen Hood Exhaust: Steel, Stainless Steel.
6. Outside Air Intake: Steel.
7. Combustion Air: Steel.
8. Evaporative Condenser Intake and Exhaust: Steel.
9. Emergency Generation Ventilation: Steel.

B. Ductwork Pressure Class:

1. Supply (Heating Systems): 1/2 inch
2. Supply (System with Cooling Coils): 1/2 inch.
3. Return and Relief: 1/2 inch.
4. Outside Air Intake: 1/2 inch.
5. Combustion Air: 1/2 inch.
6. Emergency Generation Ventilation: 1/2 inch

**END OF SECTION**

## **SECTION 15820**

### **DUCT ACCESSORIES**

#### **PART 1 GENERAL**

##### **1.1 SECTION INCLUDES**

- A. Air turning devices/extractors.
- B. Backdraft dampers.
- C. Duct access doors.
- D. Duct test holes.
- E. Flexible duct connections.
- F. Volume control dampers.

##### **1.2 REFERENCE STANDARDS**

- A. SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible; Sheet Metal and Air Conditioning Contractors' National Association; 2005.

##### **1.3 SUBMITTALS**

- A. Product Data: Provide for shop fabricated assemblies including volume control dampers, duct access doors, and hardware used. Include electrical characteristics and connection requirements.
- B. Project Record Drawings: Record actual locations of access doors and test holes.

##### **1.4 QUALITY ASSURANCE**

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

##### **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Protect dampers from damage to operating linkages and blades.

#### **PART 2 PRODUCTS**

##### **2.1 AIR TURNING DEVICES/EXTRACTORS**

- A. Manufacturers:
  - 1. Krueger: [www.krueger-hvac.com](http://www.krueger-hvac.com).
  - 2. PCI Industries, Inc; Pottorff Brand: [www.pottorff.com](http://www.pottorff.com).
  - 3. Ruskin Company: [www.ruskin.com](http://www.ruskin.com).
  - 4. Titus: [www.titus-hvac.com](http://www.titus-hvac.com).
- B. Multi-blade device with radius blades attached to pivoting frame and bracket, steel construction, with worm drive mechanism with removable key operator.

##### **2.2 BACKDRAFT DAMPERS**

- A. Manufacturers:
  - 1. Louvers & Dampers, Inc: [www.louvers-dampers.com](http://www.louvers-dampers.com).
  - 2. Nailor Industries Inc: [www.nailor.com](http://www.nailor.com).
  - 3. PCI Industries, Inc; Pottorff Brand: [www.pottorff.com](http://www.pottorff.com).
  - 4. Ruskin Company: [www.ruskin.com](http://www.ruskin.com).

- B. Gravity Backdraft Dampers, Size 18 x 18 inches or Smaller, Furnished with Air Moving Equipment: Air moving equipment manufacturer's standard construction.

## **2.3 DUCT ACCESS DOORS**

- A. Manufacturers:
  - 1. Nailor Industries Inc: [www.nailor.com](http://www.nailor.com).
  - 2. Ruskin Company: [www.ruskin.com](http://www.ruskin.com).
  - 3. SEMCO Incorporated: [www.semcoinc.com](http://www.semcoinc.com).
  - 4. Substitutions: See Section 01600 - Product Requirements.
- B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

## **2.4 DUCT TEST HOLES**

- A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
- B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

## **2.5 FLEXIBLE DUCT CONNECTIONS**

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.
- B. Flexible Duct Connections: Fabric crimped into metal edging strip.

## **2.6 VOLUME CONTROL DAMPERS**

- A. Manufacturers:
  - 1. Louvers & Dampers, Inc: [www.louvers-dampers.com](http://www.louvers-dampers.com).
  - 2. Nailor Industries Inc: [www.nailor.com](http://www.nailor.com).
  - 3. PCI Industries, Inc; Pottorff Brand: [www.portorff.com](http://www.portorff.com).
  - 4. Ruskin Company: [www.ruskin.com](http://www.ruskin.com).
- B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.
- C. Single Blade Dampers: Fabricate for duct sizes up to 6 x 30 inch.
- D. Quadrants:
  - 1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
  - 2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
  - 3. Where rod lengths exceed 30 inches provide regulator at both ends.

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

- A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible. Refer to Section 15810 for duct construction and pressure class.
- B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- C. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated. Provide minimum 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder

access, and as indicated. Provide 4 x 4 inch for balancing dampers only. Review locations prior to fabrication.

- D. Provide duct test holes where indicated and required for testing and balancing purposes.
- E. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.
- F. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment; see Section 15072.
- G. Provide balancing dampers on high velocity systems where indicated. Refer to Section 15840 - Air Terminal Units.
- H. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

**END OF SECTION**

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## **SECTION 15834**

### **AXIAL FANS**

#### **PART 1 GENERAL**

##### **1.1 SECTION INCLUDES**

- A. Propeller fans.
- B. Motors and drives.
- C. Accessories.

##### **1.2 REFERENCE STANDARDS**

- A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; American Bearing Manufacturers Association, Inc.; 1990 (Reapproved 2000).
- B. AMCA 99 - Standards Handbook; Air Movement and Control Association International, Inc.; 2003.
- C. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Ratings; Air Movement and Control Association International, Inc.; 2007 (ANSI/AMCA 210, same as ANSI/ASHRAE 51).
- D. AMCA (DIR) - [Directory of] Products Licensed Under AMCA International Certified Ratings Program; Air Movement and Control Association International, Inc.; <http://www.amca.org/licenses/search.aspx>.
- E. AMCA 301 - Methods for Calculating Fan Sound Ratings From Laboratory Test Data; Air Movement and Control Association International, Inc.; 2006.
- F. SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible; Sheet Metal and Air Conditioning Contractors' National Association; 2005.

##### **1.3 SUBMITTALS**

- A. Product Data: Provide data on axial fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements.

##### **1.4 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

##### **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Protect motors, shafts, and bearings from weather and construction dust.

##### **1.6 FIELD CONDITIONS**

- A. Permanent fans may not be used for ventilation during construction.

#### **PART 2 PRODUCTS**

##### **2.1 MANUFACTURERS**

- A. ACME Engineering and Manufacturing Corporation: [www.acmefan.com](http://www.acmefan.com).
- B. Loren Cook Company: [www.lorencook.com](http://www.lorencook.com).
- C. PennBarry: [www.pennbarry.com](http://www.pennbarry.com).

##### **2.2 PROPELLER FANS**

- A. Impeller: Shaped steel or steel reinforced aluminum blade with heavy hubs, statically and dynamically balanced, keyed and locked to shaft, directly connected to motor or provided with V-belt drive.
- B. Frame: One piece, square steel with die formed venturi orifice, mounting flanges and supports, with baked enamel finish.
- C. Accessories:
  - 1. Safety Screens: Expanded galvanized metal over inlet, motor, drive; to comply with OSHA regulations.

### **PART 3 EXECUTION**

#### **3.1 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.

#### **3.2 SCHEDULES - SEE SHEET M-0.1**

**END OF SECTION**

**SECTION 15835**  
**POWER VENTILATORS**

**PART 1 GENERAL**

**1.1 SECTION INCLUDES**

- A. Ceiling exhaust fans.

**1.2 REFERENCE STANDARDS**

- A. AMCA 99 - Standards Handbook; Air Movement and Control Association International, Inc.; 2003.
- B. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating; Air Movement and Control Association International, Inc.; 2007 (ANSI/AMCA 210, same as ANSI/ASHRAE 51).
- C. AMCA (DIR) - [Directory of] Products Licensed Under AMCA International Certified Ratings Program; Air Movement and Control Association International, Inc.; <http://www.amca.org/licenses/search.aspx>.
- D. AMCA 300 - Reverberant Room Method for Sound Testing of Fans; Air Movement and Control Association International, Inc.; 2008.
- E. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; Air Movement and Control Association International, Inc.; 2006.
- F. UL 705 - Power Ventilators; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

**1.3 SUBMITTALS**

- A. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels at rated capacity, and electrical characteristics and connection requirements.
- B. Manufacturer's Instructions: Indicate installation instructions.

**1.4 FIELD CONDITIONS**

- A. Permanent ventilators may not be used for ventilation during construction.

**PART 2 PRODUCTS**

**2.1 MANUFACTURERS**

- A. Greenheck: [www.greenheck.com](http://www.greenheck.com).
- B. Loren Cook Company: [www.lorencook.com](http://www.lorencook.com).

**2.2 POWER VENTILATORS - GENERAL**

- A. Performance Ratings: Determined in accordance with AMCA 210 and bearing the AMCA Certified Rating Seal.
- B. Sound Ratings: AMCA 301, tested to AMCA 300, and bearing AMCA Certified Sound Rating Seal.
- C. Fabrication: Conform to AMCA 99.
- D. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.
- E. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

F. Kitchen Range Hood Exhaust Fans: Comply with requirements of NFPA 96.

### **2.3 CABINET AND CEILING EXHAUST FANS**

- A. Grille: Aluminum with baked white enamel finish.
- B. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Hung Cabinet Fans:
  - 1. Install flexible connections specified in Section 15820 between fan and ductwork. Ensure metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.
- C. Provide sheaves required for final air balance.
- D. Install backdraft dampers on inlet to roof and wall exhausters.
- E. Provide backdraft dampers on outlet from cabinet and ceiling exhausters fans and as indicated.

### **3.2 SCHEDULES SHOWN ON SHEET M-0.1**

**END OF SECTION**

## **SECTION 15840**

### **AIR TERMINAL UNITS**

#### **PART 1 GENERAL**

##### **1.1 SECTION INCLUDES**

- A. Variable volume terminal units.
- B. Integral heating coils.
- C. Integral controls.

##### **1.2 REFERENCE STANDARDS**

- A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilation Systems; National Fire Protection Association; 2009.
- B. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

##### **1.3 SUBMITTALS**

- A. Product Data: Provide data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings that indicate air flow, static pressure, and NC designation. Include electrical characteristics and connection requirements.
- B. Manufacturer's Installation Instructions: Indicate support and hanging details, and service clearances required.
- C. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant volume regulators.
- D. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

##### **1.4 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

##### **1.5 WARRANTY**

- A. Provide five year manufacturer warranty for air terminal units.

#### **PART 2 PRODUCTS**

##### **2.1 SINGLE DUCT VARIABLE VOLUME UNITS**

- A. Basic Assembly:
  - 1. Casings: Minimum 22 gage galvanized steel.
  - 2. Lining: Minimum 1/2 inch thick neoprene or vinyl coated fibrous glass insulation, 1.5 lb/cu ft density, meeting NFPA 90A requirements and UL 181 erosion requirements. Face lining with mylar film.
  - 3. Plenum Air Inlets: Round stub connections for duct attachment.
  - 4. Plenum Air Outlets: S slip and drive connections.
- B. Basic Unit:
  - 1. Configuration: Air volume damper assembly inside unit casing. Locate control components inside protective metal shroud.

2. Volume Damper: Construct of galvanized steel with peripheral gasket and self lubricating bearings; maximum damper leakage: 2 percent of design air flow at 1 inches rated inlet static pressure.
  3. Mount damper operator to position damper normally open.
- C. Round Outlet: Discharge collar matching inlet size.
- D. Hot Water Heating Coil:
1. Construction: 1/2 inch copper tube mechanically expanded into aluminum plate fins, leak tested under water to 200 psig pressure, factory installed.
  2. Capacity: Based on 180 degree F entering water, 140 degree F leaving water and 30 percent total air volume.
- E. Pneumatic Damper Operator: 8-13 psig spring range.
1. Maximum Volume Controller and Probe: Pneumatic, with calibration pressure taps for high flow limited proportional variable air volume control.
- F. Thermostat: Wall-mounted pneumatic type with appropriate mounting hardware. Refer to Section 15928.

### **PART 3 EXECUTION**

#### **3.1 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Support units individually from structure. Do not support from adjacent ductwork.
- C. Connect to ductwork in accordance with Section 15810.

#### **3.2 ADJUSTING**

- A. Reset volume with damper operator attached to assembly allowing flow range modulation from 100 percent of design flow to 30 percent full flow. Set units with heating coils for minimum 30 percent full flow.

#### **3.3 SCHEDULES SHOWN ON SHEET M-0.1**

**END OF SECTION**

## **SECTION 15850**

### **AIR OUTLETS AND INLETS**

#### **PART 1 GENERAL**

##### **1.1 SECTION INCLUDES**

- A. Diffusers.
- B. Registers/grilles.

##### **1.2 REFERENCE STANDARDS**

- A. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating; Air Movement and Control Association International, Inc.; 2007.
- B. ARI 890 - Standard for Air Diffusers and Air Diffuser Assemblies; Air-Conditioning and Refrigeration Institute; 2008.
- C. ASHRAE Std 70 - Method of Testing for Rating the Performance of Air Outlets and Inlets; American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.; 2006.
- D. SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible; Sheet Metal and Air Conditioning Contractors' National Association; 2005.

##### **1.3 SUBMITTALS**

- A. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

##### **1.4 QUALITY ASSURANCE**

- A. Test and rate air outlet and inlet performance in accordance with ASHRAE Std 70.

#### **PART 2 PRODUCTS**

##### **2.1 MANUFACTURERS**

- A. Krueger: [www.krueger-hvac.com](http://www.krueger-hvac.com).
- B. Price Industries: [www.price-hvac.com](http://www.price-hvac.com).
- C. Titus: [www.titus-hvac.com](http://www.titus-hvac.com).

##### **2.2 PERFORATED FACE CEILING DIFFUSERS**

- A. Type: Perforated face with fully adjustable pattern and removable face.
- B. Frame: Surface mount type. In plaster ceilings, provide plaster frame and ceiling frame.
- C. Fabrication: Steel with steel frame and baked enamel finish.
- D. Color: As selected by Architect from manufacturer's standard range.

##### **2.3 CEILING EXHAUST AND RETURN REGISTERS/GRILLES**

- A. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with blades set at 45 degrees, horizontal face.
- B. Frame: 1 inch margin with countersunk screw mounting.
- C. Color: To be selected by Architect from manufacturer's standard range.

- D. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face where not individually connected to exhaust fans.

### **PART 3 EXECUTION**

#### **3.1 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.
- C. Install diffusers to ductwork with air tight connection.
- D. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.

#### **3.2 SCHEDULES SHOWN ON SHEET M-0.1**

**END OF SECTION**

## **SECTION 15928**

### **INSTRUMENTS AND CONTROL ELEMENTS**

#### **PART 1 GENERAL**

##### **1.1 SECTION INCLUDES**

- A. Air supply system.
- B. Thermostats.
- C. Control valves.
- D. Automatic dampers.
- E. Damper operators.
- F. Time clocks.
- G. Miscellaneous accessories.

##### **1.2 REFERENCE STANDARDS**

- A. AMCA 500-D - Laboratory Methods for Testing Dampers for Rating; Air Movement and Control Association International, Inc.; 2007.
- B. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2001 (R2005).
- C. ASTM B 32 - Standard Specification for Solder Metal; 2008.
- D. ASTM B 88 - Standard Specification for Seamless Copper Water Tube; 2009.
- E. ASTM B 88M - Standard Specification for Seamless Copper Water Tube (Metric); 2005.
- F. ASTM B 819 - Standard Specification for Seamless Copper Tube for Medical Gas Systems; 2000 (Reapproved 2006).
- G. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilation Systems; National Fire Protection Association; 2009.

##### **1.3 SUBMITTALS**

- A. Product Data: Provide description and engineering data for each control system component. Include sizing as requested. Provide data for each system component and software module.
- B. Shop Drawings: Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. For automatic dampers indicate arrangement, velocities, and static pressure drops for each system.
- C. Manufacturer's Instructions: Provide for all manufactured components.
- D. Project Record Documents: Record actual locations of control components, including panels, thermostats, and sensors. Accurately record actual location of control components, including panels, thermostats, and sensors.
  - 1. Revise shop drawings to reflect actual installation and operating sequences.
- E. Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.

## **1.4 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

## **PART 2 PRODUCTS**

### **2.1 EQUIPMENT - GENERAL**

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

### **2.2 AIR SUPPLY**

- A. Pressure Regulators:
  - 1. Zinc or aluminum castings, rated for service with elastomeric diaphragm, balanced construction to automatically prevent pressure build up, and producing flat, reduced pressure curve for system capacity demand.
- B. Pressure Reducing Stations:
- C. Control and Instrumentation Tubing:
  - 1. Copper Tube: ASTM B 819 Type K, or ASTM B 88 (ASTM B 88M) Type K, seamless, H or O temper (drawn or annealed).
    - a. Fittings: ASME B16.22, wrought copper.
    - b. Joints: Solder, lead free, ASTM B 32, HB alloy (95-5 tin-antimony), or tin and silver.

### **2.3 CONTROL VALVES**

- A. Globe Pattern:
  - 1. Up to 2 inches: Bronze body, bronze trim, rising stem, renewable composition disc, screwed ends with backseating capacity repackable under pressure.
  - 2. Hydronic Systems:
    - a. Rate for service pressure of 125 psig at 250 degrees F.
    - b. Size for 3 psig maximum pressure drop at design flow rate.
    - c. Two way valves shall have equal percentage characteristics, three way valves linear characteristics. Size two way valve operators to close valves against pump shut off head.
- B. Butterfly Pattern:
  - 1. Iron body, bronze disc, resilient replaceable seat for service to 180 degrees F wafer or lug ends, extended neck.
  - 2. Hydronic Systems:
    - a. Rate for service pressure of 125 psig at 250 degrees F.
    - b. Size for 3 psig maximum pressure drop at design flow rate.
- C. Pneumatic Operators:
  - 1. Rolling diaphragm, spring loaded, piston type with spring range 2 to 5 psig.
  - 2. Valves shall spring return to normal position as indicated on freeze, fire, or temperature protection.
  - 3. Select operator for full shut off at maximum pump differential pressure.

### **2.4 DAMPERS**

- A. Performance: Test in accordance with AMCA 500-D.
- B. Frames: Galvanized steel, welded or riveted with corner reinforcement, minimum 12 gage.
- C. Blades: Galvanized steel, maximum blade size 8 inches wide, 48 inches long, minimum 22 gage, attached to minimum 1/2 inch shafts with set screws.

- D. Jamb Seals: Spring stainless steel.
- E. Leakage: Less than one percent based on approach velocity of 2000 ft/min and 4 inches wg.

## **2.5 DAMPER OPERATORS**

- A. General: Provide smooth proportional control with sufficient power for air velocities 20 percent greater than maximum design velocity and to provide tight seal against maximum system pressures. Provide spring return for two position control and for fail safe operation.
  - 1. Provide sufficient number of operators to achieve unrestricted movement throughout damper range.
  - 2. Provide one operator for maximum 36 sq ft damper section.
- B. Inlet Vane Operators:
  - 1. High pressure with pilot positioners and sufficient force to move vanes when fan is started with vanes in closed position. Return vane operator to closed position on fan shutdown.
  - 2. Product:

## **2.6 INPUT/OUTPUT SENSORS**

- A. Temperature Sensors
- B. Static Pressure Sensors
- C. Equipment Operation Sensors:
  - 1. Status Inputs for Fans: Differential pressure switch with adjustable range of 0 to 5 inches wg.
- D. Damper Position Indication: Potentiometer mounted in enclosure with adjustable crank arm assembly connected to damper to transmit 0 - 100 percent damper travel.
- E. Carbon Monoxide Detectors:
  - 1. Single or multichannel dual level detectors, using solid state sensors with three year minimum life. Sensor replacement shall take maximum 15 minutes. Suitable over temperature range of 23 to 130 degrees F.

## **2.7 THERMOSTATS**

- A. Pneumatic Room Thermostats:
  - 1. Adjustable proportioning type, single setpoint, containing single bimetallic element for heating or cooling only.
  - 2. Covers: Locking with set point adjustment, with thermometer.
- B. Room Thermostat Accessories:
  - 1. Insulating Bases: For thermostats located on exterior walls.
  - 2. Aspirating Boxes: Where indicated for thermostats requiring flush installation.
- C. Airstream Thermostats:
  - 1. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint in middle of range and adjustable throttling range.

## **2.8 TIME CLOCKS**

- A. Seven day programming switch timer with synchronous timing motor and seven day dial, continuously charged Ni-cad battery driven power failure 8 hour carry over and multiple switch trippers to control systems for minimum of two and maximum of eight signals per day with two normally open and two normally closed output switches.

## **PART 3 EXECUTION**

### **3.1 EXAMINATION**

- A. Verify that systems are ready to receive work.

- B. Beginning of installation means installer accepts existing conditions.
- C. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.
- D. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.
- E. Ensure installation of components is complementary to installation of similar components.

### **3.2 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Solder copper tubing except at instruments or equipment where compression fittings may be used.
- C. Conceal tubing. Run exposed only in mechanical rooms, storage rooms and like, in neat manner and properly supported.
- D. Mechanically attached tubing to supporting surfaces. Sleeve through concrete surfaces in minimum one inch sleeves, extended 6 inches above floors and one inch below bottom surface of slabs.
- E. Purge tubing with dry, oil-free compressed air before connecting control instruments.
- F. Check and verify location of thermostats with plans and room details before installation. Locate 60 inches above floor. Align with lighting switches. Refer to Section 16140.
- G. Mount control panels adjacent to associated equipment on vibration free walls or free standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.
- H. Provide conduit and electrical wiring in accordance with Section 16155. Electrical material and installation shall be in accordance with appropriate requirements of Division 16.

### **END OF SECTION**

## **SECTION 15940**

### **HVAC SEQUENCE OF OPERATION**

#### **PART 1 GENERAL**

##### **1.1 SECTION INCLUDES**

- A. This section defines the manner and method by which controls function. Requirements for each type of control system operation are specified. Equipment, devices, and system components required for control systems are specified in other sections.

##### **1.2 SUBMITTALS**

- A. Project Record Documents: Record actual locations of components and setpoints of controls, including changes to sequences made after submission of shop drawings.

#### **PART 3 EXECUTION**

##### **2.1 CENTRAL FAN SYSTEMS**

- A. Safety Devices:
  - 1. Plenum High Temperature Protection: start fans and close outside dampers if temperature in return air plenum is above 90 degrees F; signal alarm.

##### **2.2 EXCESS PRESSURE CONTROLS**

- A. Maintain constant pressure differential between supply and return lines by modulating bypass valves.

##### **2.3 TERMINAL AIR UNITS**

- A. Single temperature thermostat set at 75 degrees F maintains constant space temperature by modulating variable volume damper operator.
- B. Where reheat coils or radiation is also provided, sequence two-way heating control valve with damper operator having spring range of 3 to 7 psig.

**END OF SECTION**

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## **SECTION 15950**

### **TESTING, ADJUSTING, AND BALANCING**

#### **PART 1 GENERAL**

##### **1.1 SECTION INCLUDES**

- A. Testing, adjustment, and balancing of air systems.
- B. Testing, adjustment, and balancing of hydronic systems.
- C. Measurement of final operating condition of HVAC systems.
- D. Commissioning activities.

##### **1.2 REFERENCE STANDARDS**

- A. AABC MN-1 - AABC National Standards for Total System Balance; Associated Air Balance Council; 2002.
- B. ASHRAE Std 111 - Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 1988, with 1997 Errata.
- C. SMACNA (TAB) - HVAC Systems Testing, Adjusting, and Balancing; Sheet Metal and Air Conditioning Contractors' National Association; 2002.

##### **1.3 SUBMITTALS**

- A. The contractor shall procure the services of an independent Air Balance and Testing Agency, approved by the Engineer, which specializes in the balancing and testing of heating, ventilating, and air conditioning systems. The independent agency shall be certified and in good standing with the AABC.
- B. Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.
- C. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
  - 1. Submit to Architect.
  - 2. Include certification that the plan developer has reviewed the contract documents, the equipment and systems, and the control system with Architect and other installers to sufficiently understand the design intent for each system.
  - 3. Include at least the following in the plan:
    - a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
    - b. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
    - c. Identification and types of measurement instruments to be used and their most recent calibration date.
    - d. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
    - e. Final test report forms to be used.
    - f. Expected problems and solutions, etc.
    - g. Criteria for using air flow straighteners or relocating flow stations and sensors.
    - h. Details of how TOTAL flow will be determined; for example:

- 1) Air: Sum of terminal flows via control system calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations.
  - i. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and methods to verify this.
  - j. Confirmation of understanding of the outside air ventilation criteria under all conditions.
  - k. Method of verifying and setting minimum outside air flow rate will be verified and set and for what level (total building, zone, etc.).
  - l. Method of checking building static and exhaust fan and/or relief damper capacity.
  - m. Time schedule for deferred or seasonal TAB work, if specified.
  - n. False loading of systems to complete TAB work, if specified.
  - o. Exhaust fan balancing and capacity verifications, including any required room pressure differentials.
  - p. Procedures for field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
  - q. Procedures for formal progress reports, including scope and frequency.
  - r. Procedures for formal deficiency reports, including scope, frequency and distribution.
- D. Field Logs: Submit at least twice a week to Commissioning Authority.
- E. Progress Reports.
- F. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
  1. Submit to the Commissioning Authority within two weeks after completion of testing, adjusting, and balancing.
  2. Revise TAB plan to reflect actual procedures and submit as part of final report.
  3. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
  4. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
  5. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
  6. Units of Measure: Report data in both I-P (inch-pound) and SI (metric) units.
  7. Include the following on the title page of each report:
    - a. Name of Testing, Adjusting, and Balancing Agency.
    - b. Address of Testing, Adjusting, and Balancing Agency.
    - c. Telephone number of Testing, Adjusting, and Balancing Agency.
    - d. Project name.
    - e. Project location.
    - f. Project Architect.
    - g. Project Engineer.

## **PART 2 PRODUCTS - NOT USED**

## **PART 3 EXECUTION**

### **3.1 GENERAL REQUIREMENTS**

- A. Perform total system balance in accordance with one of the following:
  1. AABC MN-1, AABC National Standards for Total System Balance.
  2. ASHRAE Std 111, Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
  3. SMACNA HVAC Systems Testing, Adjusting, and Balancing.
  4. Maintain at least one copy of the standard to be used at project site at all times.

- B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.
- C. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.
- D. TAB Agency Qualifications:
  - 1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
  - 2. Certified by the following:
    - a. AABC, Associated Air Balance Council: [www.aabchq.com](http://www.aabchq.com); upon completion submit AABC National Performance Guaranty.
- E. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

### **3.2 EXAMINATION**

- A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
  - 1. Systems are started and operating in a safe and normal condition.
  - 2. Temperature control systems are installed complete and operable.
  - 3. Proper thermal overload protection is in place for electrical equipment.
  - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
  - 5. Duct systems are clean of debris.
  - 6. Fans are rotating correctly.
  - 7. Fire and volume dampers are in place and open.
  - 8. Air coil fins are cleaned and combed.
  - 9. Access doors are closed and duct end caps are in place.
  - 10. Air outlets are installed and connected.
  - 11. Duct system leakage is minimized.
  - 12. Hydronic systems are flushed, filled, and vented.
  - 13. Service and balance valves are open.
- B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.
- C. Beginning of work means acceptance of existing conditions.

### **3.3 ADJUSTMENT TOLERANCES**

- A. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.
- B. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

### **3.4 RECORDING AND ADJUSTING**

- A. Field Logs: Maintain written logs including:
  - 1. Running log of events and issues.
  - 2. Discrepancies, deficient or uncompleted work by others.
  - 3. Contract interpretation requests.
  - 4. Lists of completed tests.
- B. Ensure recorded data represents actual measured or observed conditions.
- C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- D. Mark on the drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.

- E. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

### **3.5 AIR SYSTEM PROCEDURE**

- A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities.
- B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- E. Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
- F. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
- G. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- H. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- I. Where modulating dampers are provided, take measurements and balance at extreme conditions.
- J. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.02 inches negative static pressure in chemical storage rooms.
- K. For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.

### **3.6 WATER SYSTEM PROCEDURE**

- A. Adjust water systems to provide required or design quantities.
- B. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- C. Effect system balance with automatic control valves fully open to heat transfer elements.
- D. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

### **3.7 COMMISSIONING**

- A. Perform prerequisites prior to starting commissioning activities.
- B. Fill out Prefunctional Checklists for:
  - 1. Air side systems.
  - 2. Water side systems.
- C. Furnish to the Commissioning Authority, upon request, any data gathered but not shown in the

final TAB report.

- D. Re-check a random sample equivalent to 25 percent of the final TAB report data as directed by Commissioning Authority.
  - 1. Original TAB agency shall execute the re-checks, witnessed by the Commissioning Authority.
  - 2. Use the same test instruments as used in the original TAB work.
  - 3. Failure of more than 10 percent of the re-checked items of a given system shall result in the rejection of the system TAB report; rebalance the system, provide a new system TAB report, and repeat random re-checks.
  - 4. For purposes of re-check, failure is defined as follows:
    - a. Air Flow of Supply and Return: Deviation of more than 10 percent of instrument reading.
    - b. Minimum Outside Air Flow: Deviation of more than 20 percent of instrument reading; for inlet vane or VFD OSA compensation system using linear proportional control, deviation of more than 30 percent at intermediate supply flow.
    - c. Temperatures: Deviation of more than one degree F.
    - d. Air and Water Pressures: Deviation of more than 10 percent of full scale of test instrument reading.
    - e. Sound Pressures: Deviation of more than 3 decibels, with consideration for variations in background noise.
  - 5. For purposes of re-check, a whole system is defined as one in which inaccuracies will have little or no impact on connected systems; for example, the air distribution system served by one air handler or the hydronic chilled water supply system served by a chiller or the condenser water system.
- E. In the presence of the Commissioning Authority, verify that:
  - 1. Final settings of all valves, splitters, dampers and other adjustment devices have been permanently marked.
  - 2. The air system is being controlled to the lowest possible static pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from fan to diffuser having all balancing dampers wide open and that during full cooling of all terminal units taking off downstream of the static pressure sensor, the terminal unit on the critical leg has its damper 90 percent or more open.

### 3.8 SCOPE

- A. Test, adjust, and balance the following:
  - 1. Computer Room Air Conditioning Units
  - 2. Fans
  - 3. Air Terminal Units
  - 4. Air Inlets and Outlets
  - 5. Controls Compressor

### 3.9 MINIMUM DATA TO BE REPORTED

- A. Electric Motors:
  - 1. Manufacturer
  - 2. Model/Frame
  - 3. HP/BHP
  - 4. Phase, voltage, amperage; nameplate, actual, no load
  - 5. RPM
  - 6. Service factor
- B. Heating Coils:
  - 1. Identification/number
  - 2. Location
  - 3. Service

4. Manufacturer
  5. Air flow, design and actual
  6. Water flow, design and actual
  7. Water pressure drop, design and actual
  8. Entering water temperature, design and actual
  9. Leaving water temperature, design and actual
  10. Entering air temperature, design and actual
  11. Leaving air temperature, design and actual
  12. Air pressure drop, design and actual
- C. Return Air/Outside Air:
1. Identification/location
  2. Design air flow
  3. Actual air flow
  4. Design return air flow
  5. Actual return air flow
  6. Return air temperature
- D. Exhaust Fans:
1. Location
  2. Manufacturer
  3. Model number
  4. Serial number
  5. Air flow, specified and actual
  6. Total static pressure (total external), specified and actual
  7. Inlet pressure
  8. Discharge pressure
  9. Sheave Make/Size/Bore
  10. Number of Belts/Make/Size
  11. Fan RPM
- E. Duct Traverses:
1. System zone/branch
  2. Duct size
  3. Area
  4. Design velocity
  5. Design air flow
  6. Test velocity
  7. Test air flow
  8. Duct static pressure
  9. Air temperature
  10. Air correction factor
- F. Duct Leak Tests:
1. Description of ductwork under test
  2. Duct design operating pressure
  3. Duct design test static pressure
  4. Duct capacity, air flow
  5. Maximum allowable leakage duct capacity times leak factor
  6. Test apparatus
  7. Test static pressure
  8. Test orifice differential pressure
  9. Leakage
- G. Terminal Unit Data:
1. Manufacturer
  2. Type, constant, variable, single, dual duct
  3. Identification/number

4. Location
  5. Model number
  6. Size
  7. Minimum static pressure
  8. Minimum design air flow
  9. Maximum design air flow
  10. Maximum actual air flow
  11. Inlet static pressure
- H. Air Distribution Tests:
1. Air terminal number
  2. Room number/location
  3. Terminal type
  4. Terminal size
  5. Area factor
  6. Design velocity
  7. Design air flow
  8. Test (final) velocity
  9. Test (final) air flow
  10. Percent of design air flow

**END OF SECTION**

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## SECTION 16010

### BASIC ELECTRICAL REQUIREMENTS

#### PART 1 - GENERAL

##### 1.1 SCOPE

- A. This section supplements all sections of this division and shall apply to all phases of work hereinafter specified, shown on the drawings, or required to provide a complete installation of electrical systems for the Project. The work required under this division is not limited to the electrical specifications and drawings. Refer to all bid documents including Civil, Architectural, Structural, and Mechanical documents which may designate Work to be accomplished. The intent of the Specifications is to provide a complete and operable electrical system, which shall include all documents that are a part of the entire Project Contract.
  - 1. Work included: Furnish all labor, material, tools, equipment, facilities, transportation, skilled supervision necessary for, and incidental to, performing operations in connection with furnishing, delivery, and installation of the work in this division complete as shown or noted on the Drawings and specified herein.
- B. Related Work Specified Elsewhere:
  - 1. Refer to all sections in the general contract conditions, Contract Requirements and Division 1, General Requirements.
- C. Work Installed but Furnished by Others:
  - 1. The electrical work includes the installation or connection of certain materials and equipment furnished by others. Verify installation details. Foundations for apparatus and equipment will be furnished by others unless otherwise noted or detailed.

##### 1.2 GENERAL REQUIREMENTS

- A. Guarantee See General Conditions:
  - 1. Except as may be specified under other Sections in the specification, guarantee equipment furnished under the specifications for a period of one year, except for equipment required to have a longer guarantee period, from date of final completion. Guarantee all work against defective workmanship, material, and improper installation. Upon notification of failure, correct deficiency immediately and without additional cost to the Owner.
  - 2. Standard warranty of manufacturer shall apply for replacement of parts after expiration of the above period. Manufacturer shall furnish replacement parts to the Owner or his service agency as approved. Furnish to the Owner, through the Architect, printed manufacturer's warranties complete with material included and expiration dates, upon completion of project. Conform to Division 01.
- B. Equipment Safety: All electrical materials and equipment shall be new and shall be listed by Underwriter's Laboratories and bear their label, or listed and certified by a nationally recognized testing authority where UL does not have an approval. Custom made equipment must have complete test data submitted by the manufacturer attesting to its safety.
- C. Codes and Regulations:
  - 1. Design, manufacturer, testing and method of installation of all apparatus and materials furnished under the requirements of these specifications shall conform to the latest publications or standard rules of the following:
    - a. Institute of Electrical and Electronic Engineers - IEEE
    - b. National Electrical Manufacturers' Association - NEMA
    - c. Underwriters' Laboratories, Inc. - UL
    - d. National Fire Protection Association - NFPA
    - e. American Society for Testing and Materials - ASTM
    - f. American National Standards Institute - ANSI
    - g. California Electrical Code - CEC, Title 24, Part 3

- h. California Code of Regulations, Title 8, Subchapter 5
  - i. California Building Code-CBC, Title 24 Parts 1 & 2
  - j. State & Municipal Codes in Force in the Specific Project Area
  - k. Occupational Safety & Health Administration - OSHA
  - l. California State Fire Marshal
  - m. California Fire Code- CFC, Title 24 Part 9
  - n. National Electrical Testing Association - NETA
2. The term "Code", when used within the specifications, shall refer to the Publications, Standards, ordinances and codes, listed above. In the case where the codes have different levels of requirements the most stringent rules shall apply.
- D. Requirements of Regulatory Agencies:
- 1. Codes, Permits, and Fees: Where the Contract Documents exceed minimum requirements, the Contract Documents take precedence. Where code conflicts occur, the most stringent shall apply. The most stringent condition shall be as interpreted by the Engineer.
    - a. Comply with all requirements for permits, licenses, fees and Code. Permits, licenses, fees, inspections and arrangements required for the Contractor at his expense shall obtain the Work, unless otherwise specified.
    - b. Comply with the requirements of the applicable utility companies serving the Project. Make all arrangements with the utility companies for proper coordination of the Work.
- E. Shop Drawings:
- 1. See Division 01 for additional requirements.
  - 2. Time Schedules for Submission and Ordering: The Contractor shall prepare, review and coordinate his schedule of submissions carefully, determining the necessary lead time for preparing, submitting, checking, ordering and delivery of materials and equipment for timely arrival. The Contractor shall be responsible for conformance with the overall construction schedule.
  - 3. Submittals will be checked for general compliance with specifications only. The Contractor shall be responsible for deviations from the drawings or specifications and for errors or omissions of any sort in submittals.
  - 4. Submit a complete list of materials and equipment proposed for the job, including manufacturers names and catalog numbers.
  - 5. Shop drawings shall be submitted in completed groups of materials (i.e., lighting fixtures or switchgear). The Contractor shall add and sign the following paragraph on equipment and materials submitted for review. "It is hereby certified that the (equipment) (material) shown and marked in this submittal is that proposed to be incorporated into the project; is in compliance with the Contract Drawings and specifications and can be installed in the allocated spaces". Failure to add the above written statement for compliance will result in return of submittals without review.
    - a. Bind catalog cuts, plate numbers, descriptive bulletins and drawings, 11" x 17" (275 mm x 435 mm) or smaller, in sets with covers neatly showing titles.
    - b. The Contractor shall verify dimensions of equipment and be satisfied as to Code compliance for fit prior to submitting shop drawings for approval.
    - c. Where current limiting devices are specified, submit technical data to substantiate adequate protection of equipment cascaded downstream. Submittals shall not be reviewed unless supporting calculations and data are submitted therewith.
    - d. Include complete catalog information such as construction, ratings, insulation systems, as applicable.

- e. For any material specified to meet UL or trade standards, furnish the manufacturers or vendor's certification that the material furnished for the work does in fact equal or exceed such specifications.
  - f. Reference listings to the specifications' Sections and Article to which each is applicable.
- 6. Contractor shall prepare coordinated drawings when required by Division 01 or where noted otherwise.
- F. Interpretations: The Contractor through the Architect must make Requests for interpretations of drawings and specifications. Any such requests made by equipment manufacturers or suppliers will be referred to the Contractor.
- G. Standard of Quality
  - 1. The contract Drawings and Specifications establish the "MINIMUM STANDARD OF QUALITY" each product and/or system must meet to be considered acceptable. Products of other manufactures will be considered if the product and/or system meet or exceed the "MINIMUM STANDARD OF QUALITY" established by this Contract Document.
  - 2. Items for similar application shall be of the same manufacturer.
  - 3. The label of listing by UL shall appear on all materials and equipment for which standards have been established by the agency.
  - 4. Where codes as listed in Section General Requirement Section of the Specifications that establish label or approved requirements, furnish all materials and equipment with either the required labels affixed or the necessary written approval.
  - 5. Provide the type and quantity of electrical materials and equipment necessary to complete Work and all systems in operation, tested and ready for use.
  - 6. Provide and install all incidental items that belong to the Work described and which are required for complete systems.
  - 7. All switchboards, distribution boards, panel boards and circuit breakers shall be of the same manufacturer.
  - 8. All wiring devices such as switches and receptacles shall be of the same manufacturer.
- H. Substitutions: Refer to Division 01
- I. Submit comprehensive material list, shop drawings and complete technical data for the following equipment and materials:
  - 1. General Requirements:
    - a. Main service and distribution switchboards.
    - b. Panelboards.
    - c. Disconnect switches and Starters.
    - d. Standard lighting fixtures, specially fabricated fixtures, ballasts and lamps, with samples and sample of standard finish available (where requested).
    - e. Control devices, standard and special receptacles, switches, outlets and finish device plates.
    - f. Cabinets for signal and telephone system, special terminals and cabinets. Include all cabinet dimensions.
    - g. Fire alarm system.
    - h. Transformers
- J. Record Drawings: Refer to Division 01, Contract Closeout.
- K. Work Responsibilities:

1. The drawings indicate diagrammatically the desired locations or arrangement of conduit runs, outlets, junction boxes and equipment and are to be followed. Execute the work so as to secure the best possible installation in the available space and to overcome local difficulties due to space limitations. The Contractor is responsible for the correct placing of his work. Where conflicts occur in plans and/or specifications, the most stringent application shall apply and shall be part of the base bid.
  2. Locations shown on architectural plan or on wall elevations shall take precedence over electrical plan locations, but where a major conflict is evident, notify the Architect.
  3. In the event minor changes in the indicated locations or arrangement are necessary due to developed conditions in the building construction or rearrangement of furnishings or equipment or due to interference with other trades, such changes shall be made without extra cost.
  4. Verify dimensions and the correct location of Owner-Furnished equipment before proceeding with the roughing-in of connections.
  5. All scaled and figured dimensions are approximate of typical equipment of the class indicated. Before proceeding with work carefully check and verify dimensions and sizes with the drawings to see that the furnished equipment will fit into the spaces provided without violation of applicable Codes.
  6. Should any changes to the work indicated on the drawings or described in the specifications be necessary in order to comply with the above requirements, notify the Architect.
  7. Contractor shall be responsible for coordination of coordinated drawings when required by the Architect.
  8. Replace or repair, without additional compensation any work which does not comply with or which is installed in violation of any of these requirements.
- L. Installation General: For special requirements, refer to specific equipment under these requirements.
1. Unless otherwise specified elsewhere in the specifications, do all excavating necessary for the proper installation of the electrical work.
  2. Locations of Openings: Locate chases, shafts and openings required for the installation of the electrical work during framing of the structure. Do any additional cutting and patching required. Cutting or drilling in any structural member is prohibited without approval of the Architect. Furnish all access panels to make all boxes, connections and devices accessible as required by CEC.
  3. Location of Sleeves: Where conduits pass through concrete walls, suspended slabs or metal deck floors, install sleeves of adequate size to permit installation of conduit. Sleeves shall be installed prior to pouring of concrete and shall have ends flush with the wall or extend 2 inches above floor surfaces. Verify locations.
  4. Wherever conduit extends through roof, install flashings in accordance with drawings and details.
  5. Contractor shall be responsible for cutting and patching which may be required for the proper installation of the electrical work.
  6. Protect work, materials and equipment and provide adequate and proper storage facilities during the progress of the work. Storage outdoors shall be weather protected and shall include space heaters to prevent condensation. Provide for the safety and good condition of all work until final acceptance of the work. Replace all damaged or defective work, materials and equipment before requesting final acceptance.
  7. Conduit and Equipment to be Installed: Clean thoroughly to remove plaster, spattered paint, cement and dirt on both exterior and interior. All underground conduits shall be mandrelled prior to pulling wire.

8. Conduit and Equipment to be Painted: Clean conduit exposed to view in completed structure by removing plaster and dirt. Remove grease, oil and similar material from conduit and equipment by wiping with clean rags and suitable solvents in preparation for paint.
9. Items with Factory Finish: Remove cement, plaster, grease and oil, and leave surfaces, including cracks and corners, clean and polished. Touch up scratched or bare spots to match finish.
10. Site Cleaning: Remove from site all packing cartons, scrap materials and other rubbish on a weekly basis. Vacuum out all cabinets, switchgear and panels and junction boxes prior to pulling any conductors.
11. Electrical equipment and materials exposed to public and in finished areas shall be finish-painted after installation in accordance with the Painting Section. All exposed screw-type fasteners, exterior, or interior in restrooms, shall be vandal-resistant spanner type; include tool.

M. Tests

1. Equipment and systems for which the National Electrical Testing Association (NETA) has an approved or recommended procedure, shall be tested in accordance with that procedure. Test values shall equal values recommended by NETA. Copies of test reports shall be submitted as required under shop drawing submittals.
2. Resistance to ground tests shall be accomplished by a qualified independent testing firm to measure resistance to ground at grounding electrodes. Make tests before slabs or affected areas are poured in order that corrective measures, if required, may be taken. Submit a report showing the results of these measurements. If the resistances exceed values specified elsewhere or NETA test procedure recommendations, perform corrective measures required to reduce resistance to acceptable values.
3. Prior to energizing any motor, measure the service voltage for phase balance and report if unbalance exceeds 1% from mean.
4. Measure the three-phase voltage at no load and at maximum load conditions and submit to the engineer a report showing the results of these measurements.
5. Upon completion of the work and adjustment of all equipment, conduct an operating test. Conduct the test in the presence of an authorized representative of the Owner's Representative. Demonstrate system and equipment to operate in accordance with requirements of the Contract Documents and to be free from electrical and mechanical defects. Provide systems free from short circuits and grounds and show an insulation resistance between phase conductors and ground not less than the requirements of the governing electric code. Test circuits for proper neutral connection.
6. Complete tests prior to final inspection of project, including corrective work based on the results of the tests.
7. Perform special tests on systems and equipment as specified herein using personnel qualified to perform such tests.

- N. Protection: Protect finish parts of the materials and equipment against damage during the progress of the work and until final completion and acceptance. Cover materials and equipment in storage and during construction in such a manner that no finished surfaces will be damaged or marred. Keep moving parts clean, dry and lubricated.

O. Cleaning Up:

1. Upon completion of the work and at various time during the progress of the work, remove from the building all surplus materials, rubbish and debris resulting from the work of this Division.
2. Thoroughly clean switchgear including busses, apparatus, exposed conduit, metal work including the exterior and interior, and accessories for the work of this Division, of cement, plaster and other deleterious materials; remove grease and oil spots with cleaning solvent; carefully wipe surfaces and scrape cracks and corners clean.
3. Thoroughly polish chromium or plated work. Remove dirt and stains from lighting fixtures.

4. Leave the entire installation in a clean condition.
- P. Completion:
1. The work will not be reviewed for final acceptance until operating and maintenance data, manufacturer's literature, panel directories and nameplates specified herein have been approved and properly posted or installed and final cleaning of equipment and premises has been completed.
  2. When the installation is complete and adjustments have been made, operate the system for a period of one week, during which time demonstrate that systems are completed and operating in conformance with the specifications.
- Q. Operating and Maintenance Data: Submit complete and at one time, prior to acceptance of the installation, 4 copies of manufacturer's instructions for operation and maintenance of electrical equipment, including replacement parts lists. As specified in Division 01
- R. Inspection and Acceptance Procedures: The Architect will submit observation reports periodically during the construction phase detailing Contract deficiencies. The Contractor is responsible for making corrections immediately. Notice of Completion of the project will not be made until all items have been corrected.
- S. Final Completion of Electrical Systems:
1. Prior to Final Completion of operating electrical systems, the Contractor shall:
    - a. Provide materials of the type and quality specified and as necessary for proper operation, tested and ready for use.
    - b. Furnish the required Operating and Maintenance Data/Manuals.
    - c. Clean up of the project pertaining to this Division of the work.
    - d. After installation has been completed and adjustments made, operate the system for a period of one week, during which time, demonstrate to the Architect that systems are complete and operating in conformance with Contract Documents.
    - e. Conduct tests required and as specified in this Division and submit test reports and corrective actions taken.
    - f. Submission of warranties and guarantees.
  2. Final Completion of Work Shall be Contingent On:
    - a. Contractor replacing defective materials and workmanship.
    - b. Upon completion of work and adjustments made, Contractor shall conduct an operating test for each system for approval at such time as Architect directs. Conduct test in presence of authorized representative of Architect and demonstrate that systems and equipment do operate in accordance with requirements of the Contract Documents and are free from electrical and mechanical defects.
    - c. Contractor shall provide the necessary training programs and instructions to the Owner's representative. Number of hours shall be a minimum of four (4) hours for each system or days as required under separate Sections of these Specifications. Complete operation and maintenance manuals shall be provided at least two (2) weeks prior to training.
    - d. Submit copies of manufacturer's instructions and maintenance of electrical equipment including replacement parts lists. Each set shall include one set of shop drawings of equipment installed.
- T. Submittals for Change Orders: When changes are made during the construction phase, deletions and additions shall be presented in a manner that will indicate the cost of each item of material and corresponding labor. Markup shall be then added in accordance with the requirements of the General Conditions as modified by the Supplementary Conditions.
- U. The Contractor at a time convenient to the Owner shall provide instruction to the Owner's operating personnel in the proper operation and maintenance of all equipment and systems. The instructors shall have received factory training and shall be thoroughly familiar with the equipment installed. The operating personnel shall receive the number of days instruction as indicated in other sections.

### 1.3 PROJECT RECORD DOCUMENTS

- A. Record Set During the Work: At site, maintain at least one set of Drawings as a Field Record Set. Also maintain at least one copy of all Addenda, Modifications, approved submittals, correspondence, and transmittals at site. Keep Drawings and data in good order and readily available to Architect and Owner.
- B. Changes: Clearly and correctly mark Record Drawings to show changes made during the construction process at the time the changed work is installed. No such changes shall be made in the work unless authorized by the Architect.
- C. Final Record Drawings: Conform to Division 01 requirements.
- D. Preparation of Final Record Drawings: Contractor shall transfer recorded changes in the work indicated on the Field Record Set to the record set. Changes shall be neatly and clearly drawn and noted by skilled draftsmen, and shown technically correct.
- E. Approval: Prior to Architect's inspection for Substantial Completion, submit the Final Record Drawings to the Architect for review, and make such revisions as may be necessary for Final Record Drawings to be a true, complete, and accurate record of the work.
- F. Manuals: Obtain data from the various manufacturers and submit instruction, operation, and maintenance manuals as required and to the extent required under other Sections.
- G. At all times when the work is in progress, maintain at the workplace, fabrication shop or Project Site as applies, a complete separate, clean, undamaged set of the latest stamped, actioned submittals. As work progresses, maintain records of "as installed" conditions on this set in suitable ink or chemical fluid. Update the set daily. After successful completion of Project Site testing specified herein, and after completion of Punch List corrections, copy all records of "as installed" conditions on to originals.
- H. Quantity:
  - 1. Review sets: As for Shop and Field Drawings.
  - 2. Record set: Refer to Division 01.
- I. Format: Record Drawings:
  - 1. Pencil, permanent ink or permanent photographic process.
    - a. Front face only of Mylar at least 3.0 mils thick.
    - b. Appliqué film or lettering prohibited.
    - c. Suitable for microfilming. Lettering 1/8" (.8 mm) high minimum.
- J. Content: All drawings required under "Field and Shop Drawings". Show "as installed" condition. Where room designations according to Project permanent signage differ from construction designations in the Contract Documents, show both designations.
- K. Warranty Certificates: Comply with Division 01.

### PART 2 - PRODUCT

#### 2.1 Not Used

### PART 3 - INSTALLATION

#### 3.1 Not Used

**END OF SECTION**

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## **SECTION 16060**

### **GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**

#### **PART 1 GENERAL**

##### **1.1 SECTION INCLUDES**

- A. Grounding and bonding components.
- B. Provide all components necessary to complete the grounding system(s) consisting of:
  - 1. Metal frame of the building.

##### **1.2 REFERENCE STANDARDS**

- A. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2009.
- B. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2007.
- C. NFPA 70 - National Electrical Code; National Fire Protection Association; 2008.
- D. NFPA 99 - Standard for Health Care Facilities; National Fire Protection Association; 2005.

##### **1.3 PERFORMANCE REQUIREMENTS**

- A. Grounding System Resistance: 5 ohms.

##### **1.4 QUALITY ASSURANCE**

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

#### **PART 2 PRODUCTS**

##### **2.1 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 (6 mm) in diameter.
  - 5. Bonding Conductor: No. 4 AWG, stranded conductor.
  - 6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
  - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

##### **2.2 CONNECTORS AND ACCESSORIES**

- A. Mechanical Connectors: Bronze.
- B. Exothermic Connections:
  - 1. Cadweld or approved equal.
- C. Wire: Stranded copper.

- D. Grounding Electrode Conductor: Size to meet NFPA 70 requirements.

## **PART 3 EXECUTION**

### **3.1 EXAMINATION**

- A. Verify existing conditions prior to beginning work.

### **3.2 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. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
  2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
  3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
- C. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.
- D. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.
- E. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- F. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
1. Install bus on insulated spacers 1 inch (25 mm), minimum, from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.
  2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus.
- G. 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.
- H. Provide bonding to meet requirements described in Quality Assurance.

### **3.3 FIELD QUALITY CONTROL**

- A. Perform inspections and tests listed in NETA STD ATS, Section 7.13.

**END OF SECTION**

## SECTION 16070

### HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

#### PART 1 GENERAL

##### 1.1 SECTION INCLUDES

- A. Hangers and supports for electrical equipment and systems.
- B. Construction requirements for concrete bases.

##### 1.2 REFERENCE STANDARDS

- A. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting; National Electrical Contractors Association; 2006.
- B. NFPA 70 - National Electrical Code; National Fire Protection Association; 2008.

##### 1.3 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

#### PART 2 PRODUCTS

##### 2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Allied Tube & Conduit.
    - b. Cooper B-Line, Inc.; a division of Cooper Industries.
    - c. ERICO International Corporation.
    - d. GS Metals Corp.
    - e. Thomas & Betts Corporation.
    - f. Unistrut; Tyco International, Ltd.
    - g. Wesanco, Inc.
  - 3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
  - 4. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
  - 5. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
  - 6. Channel Dimensions: Selected for applicable load criteria.
- B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least 1 surface.
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Allied Tube & Conduit.
    - b. Cooper B-Line, Inc.; a division of Cooper Industries.
    - c. Fabco Plastics Wholesale Limited.

- d. Seasafe, Inc.
- 3. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
- 4. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
- 5. Rated Strength: Selected to suit applicable load criteria.
- C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- D. 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.
- E. 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.
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
  - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
    - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Hilti Inc.
      - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      - 3) MKT Fastening, LLC.
      - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
  - 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
    - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
      - 2) Empire Tool and Manufacturing Co., Inc.
      - 3) Hilti Inc.
      - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      - 5) MKT Fastening, LLC.
  - 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
  - 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
  - 5. 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.

## **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 CEC. 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 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 two-bolt conduit clamps.

### **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 CEC.
- 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 or Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
  - 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. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- B. 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.
- 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 manufacturers written instructions.

### **3.5 INSTALLATION**

- A. Install hangers and supports as required to adequately and securely support electrical system components, in a neat and workmanlike manner, as specified in NECA 1.
  - 1. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.
  - 2. Obtain permission from Architect before drilling or cutting structural members.
- B. Rigidly weld support members or use hexagon-head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.
- C. Install surface-mounted cabinets and panelboards with minimum of four anchors.
- D. In wet and damp locations use steel channel supports to stand cabinets and panelboards 1 inch off wall.
- E. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

**END OF SECTION**

## **SECTION 16075**

### **IDENTIFICATION FOR ELECTRICAL SYSTEMS**

#### **PART 1 GENERAL**

##### **1.1 SECTION INCLUDES**

- A. Nameplates and labels.
- B. Wire and cable markers.

##### **1.2 REFERENCE STANDARDS**

- A. ASTM D 709 - Standard Specification for Laminated Thermosetting Materials; 2001 (Reapproved 2007).
- B. NFPA 70 - National Electrical Code; National Fire Protection Association; 2008.

#### **PART 2 PRODUCTS**

##### **2.1 IDENTIFICATION APPLICATIONS**

- A. Buried Electrical Lines: Underground warning tapes.
- B. Communication Cabinets: Nameplates.
- C. Electrical Distribution and Control Equipment Enclosures: Nameplates.
- D. Junction Box Load Connections: Wire markers.
- E. Outlet Box Load Connections: Wire markers.
- F. Panel Gutter Load Connections: Wire markers.
- G. Pull Box Load Connections: Wire markers.

##### **2.2 NAMEPLATES AND LABELS**

- A. Nameplates: Engraved three-layer laminated plastic, black letters on white background.
- B. Plastic: Conform to ASTM D 709.
- C. Letter Size:
  - 1. Use 1/8 inch letters for identifying individual equipment and loads.
  - 2. Use 1/4 inch letters for identifying grouped equipment and loads.

##### **2.3 WIRE MARKERS**

- A. Description: Vinyl cloth type self-adhesive wire markers.
- B. Color: Black on white.
- C. Legend:
  - 1. Power and Lighting Circuits: Branch circuit or feeder number indicated on drawings.

#### **PART 3 EXECUTION**

##### **3.1 PREPARATION**

- A. Degrease and clean surfaces to receive nameplates and labels.

##### **3.2 INSTALLATION**

- A. Install nameplates and labels parallel to equipment lines.
- B. Secure nameplates to equipment front using screws.
- C. Secure nameplates to inside surface of door on panelboard that is recessed in finished

locations.

### **3.3 WIRE IDENTIFICATION**

- A. Provide wire markers on each conductor in panelboard gutters, pull boxes, outlet and junction boxes, and at load connection. Identify with panel and branch circuit or feeder number for power and lighting circuits, and with control wire number as indicated on schematic and interconnection diagrams equipment manufacturer's shop drawings for control wiring.

### **3.4 NAMEPLATE ENGRAVING**

- A. Provide nameplates to identify all circuits in the service distribution and power distribution panelboards; branch circuit panelboards; separately mounted starting switches; disconnecting switches; motor control push-button stations; selector switches; terminal cabinets; telephone cabinets, etc. Clearly identify on the nameplate the equipment such as "Air Handling Unit AH-1" and "Hot Water Cir. Pump P-1" in lieu of abbreviated plan references such as "AH-1" or "P-1".
  - 1. Provide nameplates of minimum letter height as scheduled below.
    - a. Panelboards and Switchboards: 1/4 inch; identify equipment designation, voltage rating, and source.
- B. Individual Circuit Breakers In Switchboards: 1/8 inch; identify circuit and load served, including location.
- C. Individual Circuit Breakers, Enclosed Switches and Motor Starters: 1/8 inch; identify voltage rating, ampere rating and load served including location.
- D. HVAC and Plumbing Control Equipment: 1/8 inch; identify equipment designation and equipment served including location.
- E. Communication Terminal Cabinets: 1/4 inch; identify cabinet designation and type of system.
- F. Transformers: 1/4" inch; Identify equipment designation.

### **END OF SECTION**

## **SECTION 16123**

### **LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES**

#### **PART 1 GENERAL**

##### **1.1 SECTION INCLUDES**

- A. Wire and cable for 600 volts and less.
- B. Wiring connectors and connections.

##### **1.2 REFERENCE STANDARDS**

- A. NECA 1 - Standard for Good Workmanship in Electrical Contracting; National Electrical Contractors Association; 2006.
- B. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2009.
- C. NFPA 70 - National Electrical Code; National Fire Protection Association; 2008.

##### **1.3 SUBMITTALS**

- A. Product Data: Provide for each cable assembly type.

##### **1.4 QUALITY ASSURANCE**

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience and with service facilities within 300 miles of Project.
- C. Products: Furnish products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

#### **PART 2 PRODUCTS**

##### **2.1 WIRE MANUFACTURERS**

- A. Anaconda Power Cables.
- B. Carol Cable
- C. Rome Wire and Cable
- D. Pirelli Wire and Cable
- E. Okonite Wire
- F. Canada Wire

##### **2.2 BUILDING WIRE**

- A. Description: Single conductor insulated wire.
- B. Conductor: Copper.
- C. Insulation Voltage Rating: 600 volts.
- D. Type THHN/THWN insulation for dry interior locations, in raceway.
- E. Type THWN for exterior or wet locations, in raceway.

#### **PART 3 EXECUTION**

### 3.1 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that mechanical work likely to damage wire and cable has been completed.
- C. Verify that raceway installation is complete and supported.

### 3.2 PREPARATION

- A. Completely and thoroughly swab raceway before installing wire.

### 3.3 INSTALLATION

- A. Provide conductors continuous from outlet to outlet and splice only at outlet or junction boxes.
- B. Install products in accordance with manufacturers instructions.
- C. Use solid conductor for feeders and branch circuits 10 AWG and smaller.
- D. Use stranded conductors for control circuits.
- E. Use conductor not smaller than 12 AWG for power and lighting circuits.
- F. Low voltage control wiring shall be No. 14 AWG minimum, insulated cable for each conductor. Voltage rating of cable shall be suitable for either Class I or Class II, remote control or signal circuit, as determined by the code and the actual installation.
- G. Use 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 75 feet (450-m).
- H. Use 10 AWG conductors for 20 ampere, 277 volt branch circuits longer than 200 feet (600-m).
- I. Install all conductors in a single raceway at one time, insuring that conductors do not cross one another while being pulled into raceway. Leave sufficient cable at all fittings or boxes and prevent conductor kinks. Keep all conductors within the allowable tension and exceeding the minimum-bending radius.
- J. Use suitable wire pulling lubricant for building wire 4 AWG and larger. Lubricants for wire pulling shall conform to UL requirements for the insulation and raceway material.
- K. Provide conductor supports as required by Code and recommended by the cable manufacturer. Where required, provide cable supports in vertical conduits similar to OZ Gedney Type CMT and provide the lower end of conduit with OZ Gedney Type KVF ventilators.
- L. No splicing or joints will be permitted in either feeder or branch circuits except at outlet or accessible junction boxes.
- M. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- N. Clean conductor surfaces before installing lugs and connectors.
- O. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise. Keep splices in underground junction boxes, handholes, and manholes to an absolute minimum. Where splices are necessary, use resin pressure splices and resin splicing kits manufactured by the 3M Company to totally encapsulate the splice. Arrange the splicing kit to minimize the effects of moisture.
- P. Use split bolt connectors for copper conductor splices and taps, 6 AWG and larger. Tape uninsulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor.

- Q. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.
- R. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.
- S. Provide all power and control conductors, that terminate on equipment or terminal strips, with solderless lugs or tork and flanged tongue terminals. Provide T & B "Sta-kon" tongue terminal. This type conductor termination is not required when the equipment is provided with solderless connectors.
- T. Install wire and cable securely, in a neat and workmanlike manner, as specified in NECA 1.
- U. Route wire and cable as required to meet project conditions.
  - 1. Wire and cable routing indicated is approximate unless dimensioned.
  - 2. Where wire and cable destination is indicated and routing is not shown, determine exact routing and lengths required.
  - 3. Include wire and cable of lengths required to install connected devices within 10 ft of location shown.
- V. Use wiring methods indicated.

### **3.4 INTERFACE WITH OTHER PRODUCTS**

- A. Identify wire and cable under provisions of Section "Identification for Electrical Systems"
- B. Identify each conductor with its circuit number or other designation indicated on Drawings.
- C. Conductor Identification: All branch circuit conductors (No. 10 AWG and smaller) throughout the project shall be provided with color-coded insulation as follows:
  - 1. 208Y/120V
    - a. Phase A - Black
    - b. Phase B - Red
    - c. Phase C - Blue
    - d. Neutral - White
    - e. Ground - Green
  - 2. 480Y/277V
    - a. Phase A - Brown
    - b. Phase B - Orange
    - c. Phase C - Yellow
    - d. Neutral - Grey
- D. Conductors No. 8 and larger shall be black with bands of colored nonaging, plastic tape to color code the conductors, utilizing the same scheme as for branch circuits. The bands shall occur within each enclosure where a tap, splice or termination is made.
- E. Color code all control wire insulation and label each termination

### **3.5 FIELD QUALITY CONTROL**

- A. Inspect and test in accordance with NETA STD ATS, except Section 4.
- B. Perform inspections and tests listed in NETA STD ATS, Section 7.3.2.

**END OF SECTION**

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## SECTION 16131

### CONDUIT

#### PART 1 GENERAL

##### 1.1 SECTION INCLUDES

- A. Conduit, fittings and conduit bodies.

##### 1.2 REFERENCE STANDARDS

- A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2005.
- B. ANSI C80.3 - American National Standard for Steel Electrical Metallic Tubing (EMT); 2005.
- C. ANSI C80.5 - American National Standard for Electrical Rigid Aluminum Conduit (ERAC); 2005.
- D. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting; National Electrical Contractors Association; 2006.
- E. NECA 101 - Standard for Installing Steel Conduit (Rigid, IMC, EMT); National Electrical Contractors Association; 2006.
- F. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical Manufacturers Association; 2007.
- G. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit; National Electrical Manufacturers Association; 2005.
- H. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit; National Electrical Manufacturers Association; 2003.
- I. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing; National Electrical Manufacturers Association; 2004.
- J. NFPA 70 - National Electrical Code; National Fire Protection Association; 2008.

##### 1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. ENT: Electrical nonmetallic tubing.
- C. EPDM: Ethylene-propylene-diene terpolymer rubber.
- D. FMC: Flexible metal conduit.
- E. IMC: Intermediate metal conduit.
- F. LFMC: Liquidtight flexible metal conduit.
- G. LFNC: Liquidtight flexible nonmetallic conduit.
- H. NBR: Acrylonitrile-butadiene rubber.
- I. RNC: Rigid nonmetallic conduit.

##### 1.4 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

#### PART 2 PRODUCTS

##### 2.1 CONDUIT REQUIREMENTS

- A. Conduit Size: Comply with NFPA 70.
  - 1. Minimum Size: 3/4 inch unless otherwise specified.

- B. Wet and Damp Locations: Use rigid steel conduit or intermediate metal conduit.
- C. Dry Locations:
  - 1. Concealed: Use rigid steel conduit or electrical metallic tubing.
  - 2. Exposed, Not subject to physical damage: Use rigid steel conduit or electrical metallic tubing.
  - 3. Exposed and Subject to Physical Damage: IMC. Includes but not limited to, raceways in the following locations:
    - a. Shop Areas.
    - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    - c. Mechanical rooms.
    - d. Kitchen Areas.
- D. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
- E. All exposed conduit runs, fittings and supports in Building exteriors and interiors finished areas shall be painted to match the finish.
- F. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
- G. Do not install aluminum conduits in contact with concrete.

## 2.2 METAL CONDUIT AND TUBING

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. AFC Cable Systems, Inc.
  - 2. Alflec Inc.
  - 3. Allied Tube & Conduit; a Tyco International Ltd. Co.
  - 4. Anamet Electrical, Inc.; Anaconda Metal Hose.
  - 5. Electri-Flex Co.
  - 6. Manhattan/CDT/Cole-Flex.
  - 7. Maverick Tube Corporation.
  - 8. O-Z Gedney; a unit of General Signal.
  - 9. Wheatland Tube Company.
- C. Rigid Steel Conduit: ANSI C80.1.
- D. Aluminum Rigid Conduit: ANSI C80.5.
- E. IMC: ANSI C80.6.
- F. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
  - 1. Comply with NEMA RN 1.
  - 2. Coating Thickness: 0.040 inch (1 mm), minimum.
- G. EMT: ANSI C80.3.
- H. FMC: Zinc-coated steel.
- I. LFMC: Flexible steel conduit with PVC jacket.
- J. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
  - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
  - 2. Fittings for EMT: Steel, raintight compression with integral insulated throat.

3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
- K. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

### **2.3 NONMETALLIC CONDUIT AND TUBING**

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. AFC Cable Systems, Inc.
  2. Anamet Electrical, Inc.; Anaconda Metal Hose.
  3. Arnco Corporation.
  4. CANTEX Inc.
  5. CertainTeed Corp.; Pipe & Plastics Group.
  6. Condux International, Inc.
  7. ElecSYS, Inc.
  8. Electri-Flex Co.
  9. Lamson & Sessions; Carlon Electrical Products.
  10. Manhattan/CDT/Cole-Flex.
  11. RACO; a Hubbell Company.
  12. Thomas & Betts Corporation.
- C. ENT: NEMA TC 13.
- D. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.
- E. RNC: NEMA TC 2, Type EPC-80-PVC, unless otherwise indicated.
- F. LFNC: UL 1660.
- G. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.
- H. Fittings for LFNC: UL 514B.

## **PART 3 EXECUTION**

### **3.1 EXAMINATION**

- A. Verify routing and termination locations of conduit prior to rough-in.
- B. Conduit routing is shown on drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

### **3.2 INSTALLATION**

- A. Install conduit securely, in a neat and workmanlike manner, as specified in NECA 1.
- B. Arrange supports to prevent misalignment during wiring installation.
- C. Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
- D. Group related conduits; support using conduit rack. Construct rack using steel channel; provide space on each for 25 percent additional conduits.
- E. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports.
- F. Do not attach conduit to ceiling support wires.

- G. Arrange conduit to maintain headroom and present neat appearance.
- H. Only where approved, route exposed conduit parallel and perpendicular to walls.
- I. Route conduit installed above accessible ceilings parallel and perpendicular to walls.
- J. Route conduit in and under slab from point-to-point.
- K. Maintain adequate clearance between conduit and piping.
- L. Cut conduit square using saw or pipecutter; de-burr cut ends.
- M. Bring conduit to shoulder of fittings; fasten securely.
- N. Use conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations.
- O. Install no more than equivalent of three 90 degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use hydraulic one shot bender to fabricate bends in metal conduit larger than 2 inch size.
- P. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.
- Q. Provide suitable fittings to accommodate expansion and deflection where conduit crosses seismic and expansion joints and between building and walkway covers.
- R. Provide suitable pull string in each empty conduit except sleeves and nipples.
- S. Use suitable caps to protect installed conduit against entrance of dirt and moisture.
- T. Ground and bond conduit under provisions of Section 16060.
- U. Identify conduit under provisions of Section 16075.
- V. Where conduit penetrates fire-rated walls and floors, provide mechanical firestop fittings with UL listed fire rating equal to wall or floor rating.
- W. Do not install conduit in slabs above grade.
- X. PVC conduit shall not be used in any locations above grade.
- Y. Seal conduit from exterior outlets at first interior junction to prevent moisture from entering the building through the conduit.
- Z. Use insulating fittings on conduits where entering pullboxes, junction boxes, outlet boxes, cabinets and similar enclosures, and for signal and telephone conduits terminated in cabinets or backboards.
- AA. Conduit risers and ell's through concrete shall be PVC Schedule 80.
- AB. All conduit shall be concealed unless specifically noted otherwise.

### **3.3 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS**

- A. Coordinate sleeve selection and application with selection and application of firestopping.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Rectangular Sleeve Minimum Metal Thickness:
  - 1. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side greater than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
  - 2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches (1270 mm) and 1 or more sides equal to, or greater than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

- E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- F. Cut sleeves to length for mounting flush with both surfaces of walls.
- G. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.
- H. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway unless sleeve seal is to be installed or unless seismic criteria require different clearance.
- I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
- J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint.
- K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials.
- L. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.
- M. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

### **3.4 SLEEVE-SEAL INSTALLATION**

- A. Install to seal underground, exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

### **3.5 FIRESTOPPING**

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

### **3.6 INTERFACE WITH OTHER PRODUCTS**

- A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods specified in plans and specifications.
- B. Route conduit through roof openings for piping and ductwork wherever possible; otherwise, route through roof jack with pitch pocket. Where separate roofing penetration is required, coordinate location and installation method with roofing installation.

**END OF SECTION**

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## **SECTION 16138**

### **BOXES**

#### **PART 1 GENERAL**

##### **1.1 SECTION INCLUDES**

- A. Wall and ceiling outlet boxes.
- B. Floor boxes.
- C. Pull and junction boxes.

##### **1.2 REFERENCE STANDARDS**

- A. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting; National Electrical Contractors Association; 2006.
- B. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical Manufacturers Association; 2007.
- C. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; National Electrical Manufacturers Association; 2008.
- D. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports; National Electrical Manufacturers Association; 2008.
- E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2008.
- F. NFPA 70 - National Electrical Code; National Fire Protection Association; 2008.

##### **1.3 QUALITY ASSURANCE**

- A. Conform to requirements of NFPA 70.
- B. Products: Provide products listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

#### **PART 2 PRODUCTS**

##### **2.1 MANUFACTURERS**

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
  - 2. EGS/Appleton Electric.
  - 3. Erickson Electrical Equipment Company.
  - 4. Hoffman.
  - 5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
  - 6. O-Z/Gedney; a unit of General Signal.
  - 7. RACO; a Hubbell Company.
  - 8. Robroy Industries, Inc.; Enclosure Division.
  - 9. Scott Fetzer Co.; Adalet Division.
  - 10. Spring City Electrical Manufacturing Company.
  - 11. Thomas & Betts Corporation.
  - 12. Walker Systems, Inc.; Wiremold Company (The).
  - 13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

## **2.2 OUTLET BOXES**

- A. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
- B. Nonmetallic Outlet Boxes: NEMA OS 2.
- C. Cast Boxes: NEMA FB 1, Type FD, aluminum. Provide gasketed cover by box manufacturer. Provide threaded hubs.

## **2.3 FLOOR BOXES**

- A. Floor Boxes: NEMA OS 1, fully adjustable, 1-1/2 inches deep.
- B. Material: Cast metal.
- C. Shape: Round.

## **2.4 PULL AND JUNCTION BOXES**

- A. Sheet Metal Boxes: NEMA OS 1, galvanized steel.

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

- A. Install boxes securely, in a neat and workmanlike manner, as specified in NECA 1.
- B. Install in locations as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and as required by NFPA 70.
- C. Electrical boxes are shown on Drawings in approximate locations unless dimensioned.
  - 1. Adjust box locations up to 10 feet if required to accommodate intended purpose.
- D. Orient boxes to accommodate wiring devices oriented as specified in Section 16140.
- E. Maintain headroom and present neat mechanical appearance.
- F. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- G. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.
- H. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.
- I. Locate outlet boxes to allow luminaires positioned as shown on reflected ceiling plan.
- J. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.
- K. Use flush mounting outlet box in finished areas.
- L. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
- M. Do not install flush mounting box back-to-back in walls; provide minimum 6 inches separation. Provide minimum 24 inches separation in acoustic rated walls.
- N. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
- O. Use stamped steel bridges to fasten flush mounting outlet box between studs.
- P. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
- Q. Use adjustable steel channel fasteners for hung ceiling outlet box.
- R. Do not fasten boxes to ceiling support wires.

- S. Support boxes independently of conduit, except cast box that is connected to two rigid metal conduits both supported within 12 inches of box.
- T. Use gang box where more than one device is mounted together. Do not use sectional box.
- U. Use gang box with plaster ring for single device outlets.
- V. Use cast outlet box in exterior locations exposed to the weather and wet locations.
- W. Use cast floor boxes for installations in slab on grade; formed steel boxes are acceptable for other installations.
- X. Set floor boxes level.

### **3.2 ADJUSTING**

- A. Adjust floor boxes flush with finish flooring material.
- B. Adjust flush-mounting outlets to make front flush with finished wall material.
- C. Install knockout closures in unused box openings.

### **3.3 CLEANING**

- A. Clean interior of boxes to remove dust, debris, and other material.
- B. Clean exposed surfaces and restore finish.

**END OF SECTION**

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## SECTION 16139

### CABINETS AND ENCLOSURES

#### **PART 1 GENERAL**

##### **1.1 SECTION INCLUDES**

- A. Hinged cover enclosures.
- B. Cabinets.

##### **1.2 REFERENCE STANDARDS**

- A. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting; National Electrical Contractors Association; 2006.
- B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2008.
- C. NEMA ICS 4 - Industrial Control and Systems: Terminal Blocks; National Electrical Manufacturers Association; 2005.
- D. NFPA 70 - National Electrical Code; National Fire Protection Association; 2008.

##### **1.3 QUALITY ASSURANCE**

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

#### **PART 2 PRODUCTS**

##### **2.1 ENCLOSURE MANUFACTURERS**

- A. Cooper B-Line: [www.bline.com](http://www.bline.com).
- B. Qube Corporation: [www.qubeinc.com](http://www.qubeinc.com).
- C. Robroy Industries: [www.robroy.com](http://www.robroy.com).
- D. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
- E. Hoffman.
- F. O-Z/Gedney; a unit of General Signal.

##### **2.2 HINGED COVER ENCLOSURES**

- A. Construction: NEMA 250, Type 1 steel enclosure.
- B. Covers: Continuous hinge, held closed by flush latch operable by screwdriver.
- C. Provide interior plywood panel for mounting terminal blocks and electrical components; finish with white enamel.
- D. Enclosure Finish: Manufacturer's standard enamel.

##### **2.3 CABINETS**

- A. Boxes: Galvanized steel.
- B. Backboard: Provide 3/4 inch thick plywood backboard for mounting terminal blocks. Paint matte white.

- C. Fronts: Steel, flush type with concealed trim clamps, door with concealed hinge, and flush lock keyed to match branch circuit panelboard. Finish with gray baked enamel.
- D. Provide metal barriers to form separate compartments wiring of different systems and voltages.
- E. Keys: Provide two of each different key.

### **PART 3 EXECUTION**

#### **3.1 INSTALLATION**

- A. Install securely, in a neat and workmanlike manner, as specified in NECA 1.
- B. Install enclosures and boxes plumb. Anchor securely to wall and structural supports at each corner under the provisions of Section 16070.
- C. Install cabinet fronts plumb.

#### **3.2 CLEANING**

- A. Clean electrical parts to remove conductive and harmful materials.
- B. Remove dirt and debris from enclosure.
- C. Clean finishes and touch up damage.

**END OF SECTION**

## **SECTION 16140**

### **WIRING DEVICES**

#### **PART 1 GENERAL**

##### **1.1 SECTION INCLUDES**

- A. Wall switches.
- B. Wall dimmers.
- C. Receptacles.
- D. Wall plates.
- E. Floor box service fittings.
- F. Poke-through assemblies.
- G. Access floor boxes.

##### **1.2 REFERENCE STANDARDS**

- A. FS W-C-596 - Connector, Electrical, Power, General Specification for; Federal Specification; Revision G, 2001.
- B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush-mounted (General Specification); Federal Specification; Revision F, 1999.
- C. NECA 1 - Standard for Good Workmanship in Electrical Contracting; National Electrical Contractors Association; 2006.
- D. NEMA WD 1 - General Color Requirements for Wiring Devices; National Electrical Manufacturers Association; 1999 (R 2005).
- E. NEMA WD 6 - Wiring Device -- Dimensional Requirements; National Electrical Manufacturers Association; 2002 (R2008).
- F. NFPA 70 - National Electrical Code; National Fire Protection Association; 2008.
- G. UL 20 - General-Use Snap Switches; Current Edition, Including All Revisions.
- H. UL 498 - Attachment Plugs and Receptacles; Current Edition, Including All Revisions.
- I. UL 514D - Cover Plates for Flush-Mounted Wiring Devices; Current Edition, Including All Revisions.
- J. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.
- K. UL 1472 - Solid-State Dimming Controls; Current Edition, Including All Revisions.

##### **1.3 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:
  - 1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
  - 2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
  - 3. Coordinate the placement of outlet boxes for wall switches with actual installed door swings.
  - 4. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.

5. Coordinate the core drilling of holes for poke-through assemblies with the work covered under other sections.
6. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

B. Sequencing:

1. Do not install wiring devices until final surface finishes and painting are complete.

#### **1.4 QUALITY ASSURANCE**

- A. Conform to requirements of NFPA 70.

#### **1.5 DELIVERY, STORAGE, AND PROTECTION**

- A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

### **PART 2 PRODUCTS**

#### **2.1 MANUFACTURERS**

- A. Hubbell Incorporated; : [www.hubbell-wiring.com](http://www.hubbell-wiring.com).
- B. Leviton Manufacturing Company, Inc; : [www.leviton.com](http://www.leviton.com).
- C. Pass & Seymour, a brand of Legrand North America, Inc; : [www.legrand.us](http://www.legrand.us)
- D. Arrow
- E. Source Limitations: Where possible, for each type of wiring device furnish products produced by a single manufacturer and obtained from a single supplier.

#### **2.2 APPLICATIONS**

- A. Provide wiring devices suitable for intended use and with ratings adequate for load served.
- B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.
- C. Provide weather resistant GFI receptacles with specified weatherproof covers for all receptacles installed outdoors or in damp or wet locations.
- D. Provide GFI receptacles for all receptacles installed within 6 feet of sinks.
- E. Provide GFI receptacles for all receptacles installed in kitchens.
- F. Provide GFI receptacles for all receptacles serving electric drinking fountains.
- G. Provide isolated ground receptacles for all receptacles serving computers.
- H. Unless noted otherwise, do not use combination switch/receptacle devices.
- I. For flush floor service fittings, use tile rings for installations in tile floors.
- J. For flush floor service fittings, use carpet flanges for installations in carpeted floors.

#### **2.3 ALL WIRING DEVICES**

- A. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- B. Coordinate color of finish, style and device face plate color with Architect prior to ordering devices.

#### **2.4 WALL SWITCHES**

- A. Manufacturers:
1. Hubbell Incorporated: [www.hubbell-wiring.com](http://www.hubbell-wiring.com).

2. Leviton Manufacturing Company, Inc: [www.leviton.com](http://www.leviton.com).
  3. Pass & Seymour, a brand of Legrand North America, Inc: [www.legrand.us](http://www.legrand.us)
- B. All Wall Switches: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.
1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.
- C. Standard Wall Switches: Industrial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

## 2.5 WALL DIMMERS

- A. Manufacturers:
1. Leviton Manufacturing Company, Inc: [www.leviton.com](http://www.leviton.com).
  2. Lutron Electronics Company, Inc: [www.lutron.com](http://www.lutron.com).
  3. Pass & Seymour, a brand of Legrand North America, Inc: [www.legrand.us](http://www.legrand.us)
- B. All Wall Dimmers: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 1472; types and ratings suitable for load controlled as indicated on the drawings.
- C. Incandescent Wall Dimmers: 120 V AC, slide control type with separate on/off switch; single pole or three way as indicated on the drawings.
1. Power Rating: 1000 W unless otherwise indicated or required to control the load indicated on the drawings.
- D. Magnetic Low-Voltage Wall Dimmers: 120 V AC, slide control type with separate on/off switch; single pole or three way as indicated on the drawings.
1. Power Rating: 1000 VA unless otherwise indicated or required to control the load indicated on the drawings.
- E. Electronic Low-Voltage Wall Dimmers: 120 V AC, slide control type with separate on/off switch; single pole or three way as indicated on the drawings.
1. Power Rating: 400 VA unless otherwise indicated or required to control the load indicated on the drawings.
- F. Fluorescent Wall Dimmers: 120 V AC, slide control type with separate on/off switch, compatible with dimming ballast controlled; single pole or three way as indicated on the drawings.
1. Power Rating: 1000 VA unless otherwise indicated or required to control the load indicated on the drawings.

## 2.6 RECEPTACLES

- A. Manufacturers:
1. Hubbell Incorporated: [www.hubbell-wiring.com](http://www.hubbell-wiring.com).
  2. Leviton Manufacturing Company, Inc: [www.leviton.com](http://www.leviton.com).
  3. Pass & Seymour, a brand of Legrand North America, Inc: [www.legrand.us](http://www.legrand.us)
- B. All Receptacles: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
  2. NEMA configurations specified are according to NEMA WD 6.
- C. Convenience Receptacles:
1. Standard Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-

- 20R; single or duplex as indicated on the drawings.
- 2. Isolated Ground Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, with ground contacts isolated from mounting strap; single or duplex as indicated on the drawings.
- 3. Weather Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R,, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.
- D. GFI Receptacles:
  - 1. All GFI Receptacles: Provide with feed-through protection, light to indicate ground fault tripped condition and loss of protection, and list as complying with UL 943, class A.
    - a. Provide test and reset buttons of same color as device.
  - 2. Standard GFI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.
  - 3. Weather Resistant GFI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.

## 2.7 WALL PLATES

- A. All Wall Plates: Comply with UL 514D.
  - 1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
  - 2. Size: Standard.
  - 3. Screws: Metal with slotted heads finished to match wall plate finish.
- B. Nylon Wall Plates: Smooth finish, high-impact thermoplastic.
- C. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.
- D. Galvanized Steel Wall Plates: Rounded corners and edges, with corrosion resistant screws.

## 2.8 FLOOR BOX SERVICE FITTINGS

- A. Manufacturers:
  - 1. Wiremold, a brand of Legrand North America, Inc: [www.legrand.us](http://www.legrand.us)
- B. Description: Service fittings compatible with floor boxes provided under Section 16138 with all components, adapters, and trims required for complete installation.
- C. Flush Floor Service Fittings:
  - 1. Dual Service Flush Combination Outlets:
    - a. Cover: Rectangular.
    - b. Configuration:
      - 1) Power: One standard convenience duplex receptacle(s) with duplex flap opening(s).
      - 2) Communications:.
  - 2. Dual Service Flush Furniture Feed:
    - a. Cover: Rectangular.
    - b. Configuration:
      - 1) Power: One 2-1/8 inch by 3/4 inch combination threaded opening(s).
      - 2) Communications: One 2-1/8 inch by 1 inch combination threaded opening(s).

## 2.9 POKE-THROUGH ASSEMBLIES

- A. Manufacturers:
  - 1. Wiremold, a brand of Legrand North America, Inc: [www.legrand.us](http://www.legrand.us)
- B. Description: Assembly comprising floor service fitting, poke-through component, fire stops and

smoke barriers, and junction box for conduit termination; fire rating listed to match fire rating of floor and suitable for floor thickness where installed.

### **PART 3 EXECUTION**

#### **3.1 EXAMINATION**

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C. Verify that wall openings are neatly cut and will be completely covered by wall plates.
- D. Verify that final surface finishes are complete, including painting.
- E. Verify that floor boxes are adjusted properly.
- F. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- G. Verify that core drilled holes for poke-through assemblies are in proper locations.
- H. Verify that openings in access floor are in proper locations.
- I. Verify that conditions are satisfactory for installation prior to starting work.

#### **3.2 PREPARATION**

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

#### **3.3 INSTALLATION**

- A. Perform work in a neat and workmanlike manner in accordance with NECA 1, including mounting heights specified in that standard unless otherwise indicated.
- B. Coordinate locations of outlet boxes provided under Section 16138 as required for installation of wiring devices provided under this section.
  - 1. Mounting Heights: Unless otherwise indicated, as follows:
    - a. Wall Switches: 48 inches above finished floor.
    - b. Wall Dimmers: 48 inches above finished floor.
    - c. Receptacles: 15 inches above finished floor or 6 inches above counter.
  - 2. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
  - 3. Provide minimum of 24 inches horizontal separation between flush mounted outlet boxes installed on opposite sides of fire rated walls.
  - 4. Where multiple receptacles, wall switches, or wall dimmers are installed at the same location and at the same mounting height, gang devices together under a common wall plate.
  - 5. Provide separate outlet boxes for wiring devices connected to emergency power and normal power systems.
  - 6. Unless otherwise indicated, provide separate outlet boxes for line voltage and low voltage devices.
  - 7. Locate wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.
  - 8. Locate receptacles for electric drinking fountains concealed behind drinking fountain according to manufacturer's instructions.
  - 9. Locate outlet boxes so that wall plate does not span different building finishes.
  - 10. Locate outlet boxes so that wall plate does not cross masonry joints.

- C. Install wiring devices in accordance with manufacturer's instructions.
- D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- E. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.
- F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.
- G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- H. For isolated ground receptacles, connect wiring device grounding terminal only to identified branch circuit isolated equipment grounding conductor. Do not connect grounding terminal to outlet box or normal branch circuit equipment grounding conductor.
- I. Provide GFI receptacles with integral GFI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.
- J. Install wiring devices plumb and level with mounting yoke held rigidly in place.
- K. Install wall switches with OFF position down.
- L. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.
- M. Do not share neutral conductor on branch circuits utilizing wall dimmers.
- N. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.
- O. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- P. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.
- Q. Install identification label for wall switches and wall dimmers in accordance with Section 16075 indicating load served when controlling loads that are not visible from the control location or multiple wall switches or wall dimmers are installed at one location.
- R. Install poke-through closure plugs in all unused core holes to maintain fire rating of floor.

### **3.4 FIELD QUALITY CONTROL**

- A. Inspect each wiring device for damage and defects.
- B. Operate each wall switch, wall dimmer, and fan speed controller with circuit energized to verify proper operation.
- C. Test each receptacle to verify operation and proper polarity.
- D. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.
- E. Correct wiring deficiencies and replace damaged or defective wiring devices.

### **3.5 ADJUSTING**

- A. Adjust devices and wall plates to be flush and level.

### **3.6 CLEANING**

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

**END OF SECTION**

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## SECTION 16272

### DRY TYPE TRANSFORMERS

#### **PART 1 GENERAL**

##### **1.1 SECTION INCLUDES**

- A. General purpose transformers.
- B. K-factor transformers rated for nonlinear loads.

##### **1.2 REFERENCE STANDARDS**

- A. IEEE C57.94 - Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type General Purpose Distribution and Power Transformers; 1982 (R2006).
- B. IEEE C57.96 - Guide for Loading Dry-Type Distribution and Power Transformers; 1999 (R2004).
- C. NECA 1 - Standard for Good Workmanship in Electrical Contracting; 2006.
- D. NECA 409 - Recommended Practice for Installing and Maintaining Dry-Type Transformers; 2002.
- E. NEMA ST 20 - Dry-Type Transformers for General Applications; National Electrical Manufacturers Association; 1992 (R1997).
- F. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2008
- G. NEMA TP 1 - Guide for Determining Energy Efficiency for Distribution Transformers; 2002.
- H. NEMA TP 2 - Standard Test Method for Measuring the Energy Consumption of Distribution Transformers; 2005.
- I. NEMA TP 3 - Standard for the Labeling of Distribution Transformer Efficiency; 2000.
- J. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2009.
- K. NFPA 70 - National Electrical Code; National Fire Protection Association; 2008.
- L. UL 506 - Standard for Specialty Transformers; Current Edition, Including All Revisions.
- M. UL 1561 - Standard for Dry-Type General Purpose and Power Transformers; Current Edition, Including All Revisions.

##### **1.3 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination: Coordinate the work with placement of support framing and anchors required for mounting of transformers.

##### **1.4 SUBMITTALS**

- A. Product Data: Include voltage, kVA, impedance, tap configurations, insulation system class and rated temperature rise, efficiency, sound level, enclosure ratings, outline and support point dimensions, weight, required clearances, service condition requirements, and installed features.

##### **1.5 QUALITY ASSURANCE**

- A. Conform to requirements of NFPA 70.

##### **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for

the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

## **1.7 FIELD CONDITIONS**

- A. Ambient Temperature: Do not exceed 86 degrees F average or 104 degrees F maximum measured during any 24 hour period during and after installation of transformers.

## **PART 2 PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Eaton Corporation; Cutler-Hammer Products: [www.eaton.com](http://www.eaton.com).
- B. Schneider Electric; Square D Products: [www.schneider-electric.us](http://www.schneider-electric.us).
- C. Source Limitations: Furnish transformers produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

### **2.2 ALL TRANSFORMERS**

- A. Description: Factory-assembled, dry type transformers for 60 Hz operation designed and manufactured in accordance with NEMA ST 20 and listed and labeled by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- B. Unless noted otherwise, transformer ratings indicated are for continuous loading according to IEEE C57.96 under the following service conditions:
  - 1. Altitude: Less than 6,600 feet.
  - 2. Ambient Temperature: Not exceeding 86 degrees F average or 104 degrees F maximum measured during any 24 hour period.
- C. Core: High grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Keep magnetic flux densities substantially below saturation point, even at 10 percent primary overvoltage. Tightly clamp core laminations to prevent plate movement and maintain consistent pressure throughout core length.
- D. Impregnate core and coil assembly with non-hydroscopic thermo-setting varnish to effectively seal out moisture and other contaminants.
- E. Basic Impulse Level: 10 kV.
- F. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.
- G. Isolate core and coil from enclosure using vibration-absorbing mounts.
- H. Nameplate: Include transformer connection data, ratings, wiring diagrams, and overload capacity based on rated winding temperature rise.

### **2.3 GENERAL PURPOSE TRANSFORMERS**

- A. Description: Self-cooled, two winding transformers listed and labeled as complying with UL 506 or UL 1561; ratings as indicated on the drawings.
- B. Insulation System and Allowable Average Winding Temperature Rise:
  - 1. Less than 15 kVA: Class 185 degrees C insulation system with 115 degrees C average winding temperature rise.
  - 2. 15 kVA and Larger: Class 220 degrees C insulation system with 150 degrees C average winding temperature rise.
- C. Coil Conductors: Continuous copper windings with terminations brazed or welded.
- D. Winding Taps:
  - 1. Less than 3 kVA: None.

2. 3 kVA through 15 kVA: Two 5 percent full capacity primary taps below rated voltage.
  3. 15 kVA through 300 kVA: Two 2.5 percent full capacity primary taps above and four 2.5 percent full capacity primary taps below rated voltage.
  4. 500 kVA and Larger: Two 2.5 percent full capacity primary taps above and two 2.5 percent full capacity primary taps below rated voltage.
- E. Energy Efficiency: Standard efficiency complying with NEMA TP 1.
1. Test efficiency according to NEMA TP 2.
  2. Label transformer according to NEMA TP 3.
- F. Sound Levels: Low sound levels at least 3 db less than NEMA ST 20 standard sound levels.
- G. Mounting Provisions:
1. Less than 15 kVA: Suitable for wall mounting.
  2. 15 kVA through 75 kVA: Suitable for wall, floor, or trapeze mounting.
  3. Larger than 75 kVA: Suitable for floor mounting.
- H. Transformer Enclosure: Comply with NEMA ST 20.
1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
    - a. Indoor clean, dry locations: Type 2.
    - b. Outdoor locations: Type 3R.
  2. Construction: Heavy gage steel.
    - a. Less than 15 kVA: Totally enclosed, non-ventilated.
    - b. 15 kVA and Larger: Ventilated.
  3. Finish: Manufacturer's standard grey, suitable for outdoor installations.
  4. Provide lifting eyes or brackets.
- I. Accessories:
1. Mounting Brackets: Provide manufacturer's standard brackets.
  2. Weathershield Kits: Provide for ventilated transformers installed outdoors to provide a listed NEMA 250, type 3R assembly.
  3. Lug Kits: Sized as required for termination of conductors as indicated on the drawings.

## **2.4 K-FACTOR TRANSFORMERS RATED FOR NONLINEAR LOADS**

- A. Description: Self-cooled, two winding transformers listed and labeled as complying with UL 1561, and designed to supply nonlinear loads to the degree designated by the UL defined K-factor; ratings as indicated on the drawings.
- B. K-factor Rating: K-4, or higher.
- C. Insulation System and Allowable Average Winding Temperature Rise: Class 220 degrees C insulation system with 150 degrees C average winding temperature rise.
- D. Coil Conductors: Continuous aluminum windings with terminations brazed or welded. Individually insulate secondary conductors and arrange to minimize hysteresis and eddy current losses at harmonic frequencies. Size secondary neutral conductor at twice the secondary phase conductor ampacity.
- E. Winding Taps: Two 2.5 percent full capacity primary taps above and four 2.5 percent full capacity primary taps below rated voltage.
- F. Neutral Bus: Sized to accommodate twice the rated secondary current.
- G. Energy Efficiency: Standard efficiency complying with NEMA TP 1.
1. Test efficiency according to NEMA TP 2.
  2. Label transformer according to NEMA TP 3.
- H. Sound Levels: Standard sound levels complying with NEMA ST 20.
- I. Mounting Provisions:

1. Up to 75 kVA: Suitable for wall, floor, or trapeze mounting.
  2. Larger than 75 kVA: Suitable for floor mounting.
- J. Transformer Enclosure: Comply with NEMA ST 20.
1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
  2. Construction: Heavy gage steel, ventilated.
  3. Finish: Manufacturer's standard grey, suitable for outdoor installations.
  4. Provide lifting eyes or brackets.

## **2.5 SOURCE QUALITY CONTROL**

- A. Factory test transformers according to NEMA ST 20.

## **PART 3 EXECUTION**

### **3.1 EXAMINATION**

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that suitable support frames and anchors are installed where required and that mounting surfaces are ready to receive transformers.
- C. Perform pre-installation tests and inspections on transformers per manufacturer's instructions and as specified in NECA 409. Correct deficiencies prior to installation.
- D. Verify that conditions are satisfactory for installation prior to starting work.

### **3.2 INSTALLATION**

- A. Perform work in a neat and workmanlike manner in accordance with NECA 1.
- B. Install transformers in accordance with manufacturer's instructions.
- C. Install transformers in accordance with NECA 409 and IEEE C57.94.
- D. Use flexible conduit, under the provisions of Section 16131, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.
- E. Arrange equipment to provide minimum clearances as specified on transformer nameplate and in accordance with manufacturer's instructions and NFPA 70.
- F. Mount wall-mounted transformers using integral flanges or accessory brackets furnished by the manufacturer.
- G. Mount floor-mounted transformers using vibration isolators suitable for isolating the transformer noise from the building structure.
- H. Mount trapeze-mounted transformers as indicated.
- I. Provide seismic restraints.
- J. Provide grounding and bonding in accordance with Section 16060.
- K. Remove shipping braces and adjust bolts that attach the core and coil mounting bracket to the enclosure according to manufacturer's recommendations in order to reduce audible noise transmission.

- L. Where not factory-installed, install lugs sized as required for termination of conductors as shown on the drawings.
- M. Where furnished as a separate accessory, install transformer weathershield per manufacturer's instructions.
- N. Install transformer identification nameplate in accordance with Section 16075.

### **3.3 FIELD QUALITY CONTROL**

- A. Inspect and test in accordance with NETA STD ATS, except Section 4.

### **3.4 ADJUSTING**

- A. Measure primary and secondary voltages and make appropriate tap adjustments.
- B. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

### **3.5 CLEANING**

- A. Clean dirt and debris from transformer components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

**END OF SECTION**